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PEACE USER MANUAL CHAPTER 1

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<u>Change Sheet since Cluster 1</u>

Minor changes throughout text
Alterations of text and figures to reflect altered data products
Alterations of text and figures to reflect removal of fine zones.
Some material removed, as now in other chapters.

1. INSTRUMENT DESCRIPTION

PEACE, the Plasma Electron and Current Experiment is designed to measure the three dimensional velocity of electrons on the multispacecraft Cluster mission. The instrument consists of two sensors, HEEA the High Energy Electron Analyser and LEEA the Low Energy Electron Analyser, and the DPU (Data Processing Unit). Each of these units is described in this chapter.

1.1 Overall Objectives

1.1.1 Mission Objectives

The importance of particle measurements in the magnetosphere has been obvious since the discovery of the Earth's radiation belts in 1957. For just as long, it has been known that those in-situ measurements suffer from a fundamental ambiguity. A time change in the measurement made by spacecraft along its orbit may in principle be due to either a temporal change in the magnetosphere or a spatial change along the spacecraft track, or indeed a combination of the two. It has also long been apparent that both spatial and temporal changes do indeed occur (sometimes simultaneously) and that such changes can be of comparable magnitudes. A second difficulty has become apparent recently with the development of the science: namely that many of the important physical quantities, in what we now know to be a complex electromagnetic system, are vector gradient quantities the measurement of which fundamentally depends on simultaneous multipoint observations.

The problem of spatial/temporal ambiguity has been tackled by a number of missions in the past by using two co-orbiting spacecraft, separated by a variable distance along their common orbit. These missions include the International Sun Earth Explorer (ISEE) and the Active Magnetospheric Particle Tracer Explorer (AMPTE) missions. Both have made important advances in the science of magnetospheric boundaries, their structure and their movement, but only in a one dimensional way. They could only measure structure and movement along the baseline defined by the vector from one spacecraft to the other. If the data allows one to model the underlying structure as planar and the orientation of the plane can be estimated, e.g. by minimum variance analysis, then the motion and the vector gradients can be obtained from the dual-spacecraft observations. However, what we know of the physics of the magnetospheric boundaries and other structures makes it quite clear that they are three dimensional (i.e. not necessarily planar, even locally) and may move in any direction.

The Cluster mission extends the multispacecraft approach by deploying four identical spacecraft in nearby, non-coplanar orbits and promises to show us, for the first time without assumptions, magnetospheric fine structure which is inherently 3 dimensional, whatever its orientation and to enable us to determine vector gradients. Cluster with its four spacecraft will place new demands on the instrumentation on both extending the range and scope of the measurements and meeting the new requirements involved in four point measurements.

1.1.2 Review of the Scientific Objectives of PEACE

The science objectives of a single instrument cannot be separated from the objectives of the spacecraft as a whole which should be considered as an observatory for plasma diagnostics. The first task of the electron instrument is to ensure that it plays its role in supporting the measurements of the full spacecraft by deducing moments to the distribution function of the electrons as frequently and as accurately as the spacecraft telemetry will allow. In particular the electron measurements will be used to determine the nature and causes of the processes, such as energization, scattering, and diffusion, that modify the electron distribution, especially at plasma boundaries. These processes are invariably velocity dependent as we show in the following examples

In the solar wind, anisotropy's are formed at the lowest energies by radial drift of electrons away from the sun. At higher energies the anisotropy's (strahls) are controlled by the magnetic field topology, and/or magnetic-field-aligned energization. The nature of wave-electron interaction is inherently velocity dependent, with the bulk of the plasma being heated by non-resonant interactions, whilst frequently high-energy tails are formed by resonant interactions.

At the bow shock, the central question concerns the dissipation processes which act to convert bulk plasma flow energy into thermal and magnetic energy, and the way those processes vary with upstream conditions such as Mach number, magnetic field orientation, etc. In light of the importance of the macroscopic fields for controlling the dissipation, it is important to know what the three-dimensional spatial structure of the shock surface is (i.e., how planar is it?) as well as how steady the structure is in time. These questions are particularly important for quasi-parallel shocks, where unsteadiness and spatial structure may be especially crucial. To answer them requires the four spacecraft capability to separate spatial from temporal variations as well as the ability to observe the various particle populations in three velocity dimensions at very high time resolution, i.e., with several full distributions resolved as the spacecraft crosses the shock ramp typically in a few seconds. The ability to resolve the solar wind ion electron distributions at high time resolution continuously as they evolve through the shock is important to be able to determine how the transmitted core of the distribution is heated, thereby helping to identify the microscopic plasma instabilities which contribute to the shock dissipation. Parallel and perpendicular to the magnetic field, high time resolution, three-dimensional measurements of the electron distribution will help establish the macroscopic electrostatic potential structure of the shock so that variations in the particle distributions can be compared with the macroscopic field structure and with the currents (from 4-spacecraft measurements of curl B) for additional clues to the microscopic dissipation processes. In particular the measurements should be extended to the lowest energy possible to study the transmission of the core electron distribution to assess the relative contribution of any resonant wave-particle energization. Frequently the lack of accurate measurements of electrons at energies < 10 eV in the solar wind, and at the bow shock, has hindered interpretation of data from earlier missions where there are data gaps at these low energies. AMPTE-UKS and HELIOS measurements have indicated that the low energy population in the solar wind may not be Maxwellian as expected, and the AMPTE-UKS measurements at the bow shock suggest that this low energy population may have behave differently from what is expected. Determination of the nature of this core population, and its behaviour as it is transported through the bow shock and magnetopause will be a major objective of studies using measurements from the electron sensors.

At the magnetopause the electron measurements are ideally suited to investigate the process that leads to an apparently systematic decrease in density earthward of the magnetopause. It is not clear whether this is simply the result of diffusion across the magnetopause, or is controlled by electron transport through regions of magnetic field reconnection, or is because of loss to the atmosphere. This investigation requires a multi-spacecraft measurement of electrons, including those at the lowest energies, with fine angular resolution. Fine angle resolution is also necessary for an investigation into the processes that produce the region of counterstreaming electrons that are almost invariably detected within the magnetosphere halo.

Electron measurements made simultaneously on the four spacecraft can also be used to study the magnetopause at times when it is deformed, either by surface waves or flux transfer events. Sequences of plasma changes, similar to those found during straightforward traverses of the magnetopause boundary layers, are found when flux transfer events (FTEs) are encountered, but it is not clear whether the inflated flux tube of a flux transfer event is simply causing the layered plasma to drape around the tube or whether formation of the FTE itself stimulates energization and diffusion. Such draping, i.e. the spatial deformation of the plasma, would also be observed accompanying surface waves, raising the still unresolved question of how FTEs can be distinguished from surface waves. The four spacecraft measurements of the electron distributions with the high time and fine angular resolution will play a significant role in such magnetopause studies.

1.1.3 Summary of Expected Distributions

Plasma characteristics to be sampled during the Cluster mission are highly variable. Plasma densities range from ~10^{-3} cm^{-3} in the empty lobes to greater than 10^{+2} cm^{-3} in the disturbed solar wind; temperatures range from fractions of an eV within the plasmasphere and polar wind to ~ 10^{+4} eV within the plasma sheet; and flow speeds range from nearly stagnant (less than a few 10's of km/s) in the inner magnetosphere and central plasma sheet to greater than 1000km/s in the disturbed solar wind and plasma sheet boundary layer.

In many regions of greatest interest to the Cluster mission more than one particle population is often present. For example, magnetospheric electron populations within the dayside magnetosphere commonly contain both a cold (~10 eV) ionospheric (photoelectron) component and a hot (1000 eV) plasma sheet component. In addition to the above, other complexities are often present. For example, electron distributions often contain a field-aligned beam within the bowshock and may be flat-topped at low energies within the magnetosheath and behind strong interplanetary shocks. In order to provide an accurate characterisation of the plasma, instrumentation must resolve and distinguish the above complexities on a rapid temporal scale. For not only do these complexities strongly influence both the calculation and the interpretation of plasma moments, but also in many cases they provide the essential clues about the relevant physical processes taking place. Since the limited spacecraft data rates will prevent the transmission of full velocity distributions at high temporal resolution, appropriately reduced distributions or specially designed moments which adequately describe the non-Maxwellian character of the distributions in the foreshock and upstream region will be needed.

An important technical objective for the instrument which will enhance the measurements compared with previous missions is to make reliable observations of the electron distribution at energies from 10 eV down to as low an energy as possible. The energy of 10 eV has been an effective lower limit for differential measurements of the electron distribution in the outer magnetosphere for a number of reasons which we explain below. Observations in this energy range will be important for several scientific objectives. The dominant part of the electron distribution is in this range in the solar wind and the bow shock. It is likely that the current-carrying particles in some of the current layers are electrons in this energy range. Also these electrons can play a very important role in controlling wave-particle interactions.

1.2 Measurements

1.2.1 Measurement of Plasma Populations

The most important characteristics for the instrument to have are:-

(a) complete and uniform coverage of viewing direction

The sensors must be able to obtain the details of the plasma population however it is moving with respect to the spacecraft and its spin axis. In practice this is most easily accomplished by using an analyser with a wide field of view in a plane containing the spin axis so that, as the spacecraft rotates, the entire distribution is surveyed.

(b) wide dynamic range

Many important populations in the magnetosphere have very low number densities but may nevertheless be important to the physics of the region, for example, plasma in the tail lobes, and the cold plasma component in equatorial regions. The flux of such particles is many orders of magnitude less than the solar wind flux. This requires that the sensors cover a wide dynamic range in flux so that all populations are adequately recorded.

(c) fast time resolution

The fastest three-dimensional distributions obtained so far in the outer magnetosphere were those obtained by the AMPTE-UKS sensors at a rate of one per 5 seconds. They show that such time resolution is essential and imply that faster time resolution would reveal even more structure. Therefore one spin (4 seconds) is the slowest acceptable time resolution and preferably it should be much faster.

(d) energy range extended to lowest energies

In recent projects (e.g. ISEE, AMPTE) the lowest energy of the measurements has been of the order of 10 eV. The population of electrons (in the solar wind and bow shock) below this energy is known to be important.

1.2.2 Problems Associated With the use of Four Spacecraft

1.2.2.1 Relative Accuracy

To make use of the data from four identical spacecraft involves taking the differences between the individual measurements to find the gradients. If the difference between them is small, to obtain the gradient with modest accuracy the individual measurements must be made with very small errors relative to each other. We can express this in terms of a relative accuracy as follows. A relative accuracy of 1% means that if two sensors are measuring parameters in the same plasma the difference between them should be less than 1% of the value. The absolute value may be in error by more than 1% but for differential measurements the relative accuracy is most important. We have set a target value of 1% relative accuracy for the sensors, which means that a difference of 10% would be measured with an accuracy of 10%. As we show below many factors influence the relative accuracy and have to be taken into account in the design. A value of 1% is a challenge to current techniques but one which we believe can be met in some, but not all, conditions. To approach this value at all requires a careful approach in several areas of the instrument design as is shown below.

(a) count rate

The first source of error is the statistical fluctuation in the measurement due to the finite number of counts collected by the detector. In order to estimate the magnitude of the error we carried out simulations of the operation of a sensor and the on-board moment calculations. It is not surprising to find that the amplitude of the density fluctuations is given by the Poisson value $1/\sqrt{N}$ where N is the total number of counts in the distribution. It is perhaps less expected that the velocity and temperature fluctuations are of the same order of magnitude.

To achieve 1% relative accuracy therefore requires a minimum of 10000 counts per distribution. This in turn depends on the characteristics of the distribution and the geometric factor of the analyser. Increasing the sensitivity will improve the accuracy. However the sensitivity cannot be increased without limit; if the fluxes become too high the sensor will saturate electronically. Given the dynamic range of the sensor therefore we can determine the range of fluxes for which the sensor can achieve 1% relative accuracy.

(b) resolution

The detector counts are collected in a finite number of energy, angle bins to form a three-dimensional matrix of counts. The smaller the bins (i.e. the better the resolution of the analyser) the more accurately the distribution is recorded. However the resolution cannot be improved arbitrarily without an impact on the resources (e.g. mass, power) required. Furthermore increasing the number of matrix elements increases the computational burden on the data processing unit. The angular width of a supersonic distribution can be expressed as $\arctan^{-1}$ (Vth/V). When the angle $\arctan^{-1}$ (Vth/Vflow) becomes smaller than the resolution element, then the difference between the measured and real values increases sharply. Simulations indicate, not surprisingly, that the angular resolution of the sensor must be smaller than the angular width of the distribution it is measuring, though not by a great deal. A similar consideration applies to the energy resolution. While an angular resolution of 150 and an energy resolution of $\Delta E/E \sim 40\%$ will be adequate for many magnetospheric ion populations, we know that some field-aligned electron populations will require better resolution.

(c) reproducibility of sensors and calibration

It is important that similar sensors on different spacecraft are measuring in the same region of velocity space. This requires that the sensors are constructed with a high degree of reproducibility. The relative performance of different sensors has been studied by constructing a detailed theoretical response map of the analyser by ray-tracing. This shows that eccentric offsets between the hemispheres of the electrostatic analysers can have a serious effect on the performance. The offset must be less than a few percent of the gap of 3mm between the hemispheres to maintain such accuracy.

The responses will be checked by comparison with the ray tracing results by comprehensive calibration in a beam system; (The aim has been to produce a response map which differs from the theoretical response map by no more than 10% of the integrated response)

Furthermore the relative response will be checked by in-flight calibration procedures carried out routinely. Two types of procedure are foreseen at this stage. First, checks on the performance of each sensor to establish proper operating voltages for microchannel plates, gains or thresholds of amplifiers. Secondly, detailed statistical intercomparison of the distributions obtained by different sensors in a relatively uniform plasma environment. Finally the flight spare sensors will be maintained in full operating configuration for post flight checks and intercalibration with different beam systems used for the calibration of other sensors on the spacecraft if appropriate.

1.2.2.2 Time Resolution

The separation of the spacecraft may vary from 200 km to 18000 km during the mission. Plasma bulk velocities in magnetospheric structures are typically of order 100 km/s but may be much higher, sometimes more than 1000 km/s. To follow the fastest motion between two spacecraft at their closest requires time resolution of 0.1s. Three-dimensional plasma measurements have typically been coupled to the spin to provide an angular scan. This limits measurements of the complete distribution with our pair of sensors with a combined field-of-view of 360° to twice per spin i.e. a time resolution of 2s for Cluster for those parts of the energy range which is covered by both sensors.

1.2.2.3 Reliability and Redundancy

It is important for the scientific objectives not only to have four spacecraft but to have an operational sensor on each one. It can be shown that if the average sensor lifetime is 6 years then there is only a 30% probability that four instruments will be operating after the two years of the Cluster main mission. To increase the probability to 70% requires a detector lifetime of 21 years. An additional way of increasing the probability is to arrange for an element of redundancy between sensors. Then if one fails, the other can take over at least part of its function. With pairs of sensors the probability of the four spacecraft capability surviving two years returns to 70% even with a detector lifetime of 6 years. The implications of this analysis are obvious. First every effort must be made to increase the detector lifetime far beyond the apparent 2 year lifetime of the mission and secondly that there is great value in redundancy of operation between sensors. Our arrangement of two independent sensors which can each cover the operations of the other to a reasonable extent provides such redundancy.

1.2.3 Problems of Low Energy Electron Measurements

1.2.3.1 Internal secondary electrons

Secondary electrons are generated inside the aperture of an electron sensor by solar ultraviolet light and by electrons of higher energy than the electrostatic analyser is set to measure. Both sources create electrons with an energy of the order of 1 to 10 eV. If the electrostatic analyser is set to an electron energy of 3 eV then in addition to the ambient electrons of this energy it will also be recording the flux of internally-produced secondary electrons of the same energy. The secondary may well be more intense than the natural electrons. It is essential to reduce these secondary to a very low level if reliable electron measurements are to be made.

1.2.3.2 Spacecraft-plasma interactions

The same type of secondary electrons are produced on the surface of the spacecraft and form a sheath around the spacecraft which may be many metres thick. The photoelectrons created by sunlight are normally the most numerous and usually control the spacecraft potential as the largest current element. When the spacecraft is in eclipse the secondary electrons generated by energetic electron impact may become the dominant influence. These electrons affect low energy measurements in two ways. In sunlight the spacecraft will take up a small positive potential such that enough photoelectrons are emitted to achieve a current balance. Then all ambient electrons will have an energy corresponding to the potential added to their natural energy. If they are accelerated too much the distribution becomes highly compressed in energy and difficult to resolve in an analyser. Below the energy corresponding to spacecraft potential, the sensor will detect photoelectrons returning to the spacecraft. It should be possible to detect the spacecraft potential in the electron spectrum as a minimum in the flux. However the photoelectron distribution will have to be removed and this may create problems for on board data processing. The spacecraft potential is to be actively controlled on Cluster by the ASPOC instrument and this should be helpful. It will be important to control the external surfaces of the spacecraft to ensure that they are all conducting and grounded and that there are no exposed voltages to disturb the potentials around the spacecraft. One potentially serious problem is created by the star mapper which has a large mirror with an insulated surface which is always shielded from sunlight. It is therefore capable of charging to negative potentials in high temperature plasma and affecting the potential of the complete spacecraft. A similar effect has already been observed on the METEOSAT spacecraft.

1.3 Summary of PEACE Requirements

The PEACE requirements were as follows:-

(a) To cover an energy / charge range from 0.7 eV - 30 keV for electrons.

(b) To cover a full 4π of angular directions.

(b) To cover the widest possible dynamic range of fluxes from a maximum in the solar wind downwards to the sensitivity required for the tail lobes.

(d) To have a time resolution of one half spin (2 sec).

(e) To have the capability, where the count rates are high enough, to make measurements to 1% relative accuracy between the four spacecraft.

(f) Where possible to have redundancy in coverage between different sensors to increase the probability of completing the mission with the four-spacecraft capability as well as to improve the time resolution.

(g) An on-board processing capability to calculate the moments of the distribution with an accuracy of 1% and to select suitable parts of the complete distribution for transmission.

(h) Sensors designed to minimise the production of internal secondary electrons.

1.4. Technical Description of Sensors

1.4.1 Overview

To meet the requirements we determined that two sensors were necessary. The Low Energy Electron Analyser (LEEA) is designed specialise in coverage of the very lowest electron energies (0.6 - 10 eV) but is also capable of covering the full energy range up to 26.5 keV. Apart from precautions to minimise the background it has a geometric factor appropriate for the high fluxes to be found at low energy. The High Energy Electron Analyser (HEEA) has a larger geometric factor which extends the dynamic range of the combination of sensors and can also be operated over the full energy range from 0.6 eV to 26.5 keV. Both sensors are of the same basic type consisting of hemispherical electrostatic analysers of the so-called Top Hat type and an annular microchannel plate with a position sensitive readout as detector. Unlike the usual types, which have a field of view of 360° they have a field of view of only 180°, which enables the detector to be mounted so that it views radially from the spacecraft. The pair of sensors are mounted opposite to each other on the spacecraft so that they cover the complete angular range in a half rotation of the spacecraft (Figure 1). The radial viewing minimises the access of electrons produced on the surface of the spacecraft into the aperture of the sensor.

1.4.2 Electron Optics

Both sensors use axisymmetric hemispherical electrostatic analysers of the Top Hat type (Carlson et al 1983, Sablik et al 1988). HEEA and LEEA have identical electron optical designs except for the input aperture and collimator (Figure 2). The top hat plate radii are 40, 43, 46 mm respectively. The top hat angle is 19°. The planned performance figures are shown below.

Low Energy Electrostatic Analyser (LEEA)

- 180° field of view covering 0° to 180° with respect to the spacecraft spin axis.
- Viewing radially oppositely directed to the HEEA, offset 43 mm from the centre line.
- Geometric factor = 3.2×10^{-4} cm^2 sr eV/eV per 15° anode
- Intrinsic energy resolution $\Delta E/E = 0.13$
- Field of view perpendicular to fan = 2°

High Energy Electrostatic Analyser (HEEA)

- 180° field of view covering 0° to 180° with respect to the spacecraft spin axis.
- Viewing radially, oppositely directed to the LEEA, offset 43mm from the centre line.
- Geometric factor = 1.1×10^{-3} cm^2 sr eV/eV per 15° anode
- Intrinsic energy resolution $\Delta E/E = 0.16$
- Field of view perpendicular to fan = 5.2°

A detailed programme of ray-tracing has been carried out to determine the theoretical performance. The geometric factors of the two sensors have been chosen so that the instrument spans the dynamic range whose limits are set by the need to maintain the accuracy of the measurements, to avoid the effects of saturation, and to obtain significant count-rates within a short time even in the least dense plasmas. The range of intensities that has to be measured is 10^{10} to $10^{17}(m^2\ s\ sr\ keV)^{-1}$, i.e. a range of seven orders of magnitude. The highest intensities are expected for energies of a few eV in the solar wind and (possibly) the magnetosheath. The lowest intensities will be found at the highest energies, usually > 1 keV, although in the solar wind and tail lobes, these lowest intensities may even be present at energies as low as 100 eV. Within the available resources, the detectors and their front end electronics would be capable of coping with only six orders of magnitude with the present state of development, we have extended the dynamic range of the measurements by using different geometric factors for the two sensors. At times of very dense solar wind the high energy sensor could saturate at energies of a few 100 eVs in the magnetosheath. However, data will not be lost because this saturation will

usually fall within the energy range of the sensor overlap and LEEA will still be able to measure the flux. We estimate that this saturation would occur for less than 1% of the mission.
The two main sources of background that would could produce erroneous measurements from the low-energy sensor are electrons outside the energy bandwidth of the sensor which can strike the analyser plates, thereby producing secondary electrons, and photoelectrons produced by sunlight inside the sensor. The effect of both sources of unwanted electrons have been minimised by the design of the input baffle which consists of a series of thin parallel plates (Figure 2). The only production of internal secondary is by particles or light scattered off the knife-edges of the baffle elements. The electrostatic analyser is also coated in a UV absorbent material.

1.4.3 Energy Coverage

The energy range of the instrument is from 0.6 eV to 26,460 eV in 92 levels (0 to 91). The first 16 energy levels are equally spaced linearly in the range from 0.6 eV to 9.5 eV. Levels 16 to 87 inclusive are equally space logarithmically over the rest of the range. Levels 88-91 inclusive are identical to level 88 and are defined for technical reasons. The full energy range can be used by both sensors although it is intended that HEEA will normally be operated over a higher energy range than LEEA.

An energy step is defined to be the change from one energy level to the energy level below. An accumulation bin is a time interval corresponding to the spin period divided by 1024. A spin period is divided up into 16 basic segments - each basic segment has a duration of 64 accumulation bins. The instrument operates by periodically varying the energy of electrons which are allowed to reach the electron counting device. This is achieved by sweeping through the selected energy range in a series of energy steps (from high to low energy) at regular intervals. Due to the rotation of the spacecraft, the azimuthal look direction as well as the sampled energy changes slightly with each new accumulation bin. At the completion of an energy sweep there is a short flyback interval during which the instrument resets itself to begin the next sweep from a high energy level (time is needed for the high voltage supply to stabilise at the selected high voltage). Although data is acquired for every accumulation bin, the data from those 4 bins in each group of 64 which are associated with flyback are discarded.

There are four data acquisition modes. These are the three sweep modes, LAR, MAR and HAR, and the Fixed Energy Mode. Their characteristics follow:

Low Angular Resolution (LAR mode):

energy range:	60 energy steps/ sweep
energy resolution:	60 bins @ 1 energy step/ accumulation bin
time to cover one energy step:	3.9 ms (assumes 4.0 sec spin period)
sweep rate:	16 sweeps/ spin (azimuthal resolution 22.5°)
flyback duration (range)/ sweep:	4 accumulation bins (4 energy steps)
energy range (preset to bottom):	64 energy steps

Medium Angular Resolution (MAR mode):

energy range:	60 energy steps/ sweep
energy resolution:	30 bins @ 2 energy step/ accumulation bin
time to cover one energy step:	1.95 ms (assumes 4.0 sec spin period)
sweep rate:	32 sweeps/ spin (azimuthal resolut'n 11.25°)
flyback duration (range)/ sweep:	2 accumulation bins (4 energy steps)
energy range (preset to bottom):	64 energy steps

High Angular Resolution (HAR mode):

energy range:	30 energy steps/ sweep
energy resolution:	15 bins @ 2 energy step/ accumulation bin
time to cover one energy step:	1.95 ms (assumes 4.0 sec spin period)
sweep rate:	64 sweeps/ spin (azimuthal resolut'n 5.625°)
flyback duration (range)/ sweep:	1 accumulation bin (2 energy steps)
energy range (preset to bottom):	32 energy steps

Fixed Energy Mode:

the sensor is at a constant energy for one (or more) spin(s). Data is acquired in every accumulation bin (every 3.9 ms). There is no flyback in this mode.

Note that all measurements are spin synchronised, so that accumulation times will vary from spacecraft to spacecraft unless all spacecraft share identical spin periods.

The energy sweep may in principle be started from any level, called the sensor preset level, over the full range of the sweep. In practice, presets should not be chosen for which the sweep would be set to values smaller than 0. The sweeps start at high energies and decrease in energy exponentially until the low energy range (energy level 16 and below) is reached when the decrease becomes linear. The same sweep modes are available to both sensors. The sensors are capable of operating in different sweep modes, or of starting from different levels, simultaneously.

Table 1 below summarises the resolution and coverage in energy and angle of the three sweep modes LAR, MAR and HAR.

	resoln e	resoln p	resoln a	dim e	dim p	dim a	en cov
LAR	1 step /bin	π/12	π/8	60 bin	12 bin	16 bin	60 step
		15°	22.5°				
MAR	2 step /bin	π/12	π/16	30 bin	12 bin	32 bin	60 step
		15°	11.25°				
HAR	2 step /bin	π/12	π/32	15 bin	12 bin	64 bin	30 step
		15°	5.625°				

Table 1: Properties of Sweep Modes

Table 2 lists the energies of the 88 different energy levels. Individual sensors may have slightly different behaviour (this is to be confirmed by calibration) but the table is the best guide currently available to the expected values of the energy levels.

1.4.4 Detectors

The electron detectors are double-thickness chevron-pair microchannel plates (MCP) in low-resistivity glass similar to those used on Ampte-UKS and Giotto (Johnstone et al., 1987). These plates are expected to give a saturated pulse-height distribution with a full-width-half maximum of 70% at a modal gain of the order of $2x10^6$. The low-resistivity glass should allow the plate to respond to count rates up to $2x10^4$ per sq. mm. Actual performance will be determined during calibration analysis and may vary from MCP to MCP. These have proven to be reliable and repeatable in their characteristics. The primary electrons are accelerated into the MCP by a 150 V bias at the cathode end of the MCP. To ensure optimum performance of the microchannel plates during the full lifetime of the mission, the power supply operating the microchannel plate of each sensor will have 32 possible levels (off, 100 V for ground testing, and 30 in-flight operating levels).

The background generated by penetrating radiation is measured by biasing the grid in front of the MCP negatively (to -8 Volts) to repel sub-8 eV electrons and setting the plate voltage to the minimum of 0.6 eV. In this state fewer electrons can reach the detector.

Level	Energy		Level	Energy		Level	Energy
0	0. 000						
1	*0. 589*		*31*	*47. 349*		*61*	*1 324. 082*
2	1. 178		32	52. 851		62	1 479. 452
3	1. 768		33	58. 990		63	1 653. 652
4	2. 358		34	66. 394		64	1 846. 569
5	2. 948		35	73. 839		65	2 063. 156
6	3. 538		36	82. 576		66	2 305. 759
7	4. 128		37	92. 630		67	2 576. 960
8	4. 719		38	103. 393		68	2 879. 542
9	5. 310		39	115. 524		69	3 216. 402
10	5. 902		40	129. 055		70	3 593. 675
11	6. 493		41	144. 029		71	4 015. 331
12	7. 085		42	161. 150		72	4 485. 220
13	7. 677		43	179. 825		73	5 011. 577
14	8. 270		44	200. 792		74	5 604. 590
15	8. 862		45	224. 147		75	6 257. 032
16	9. 455		46	250. 707		76	6 990. 199
17	10. 048		47	279. 919		77	7 818. 023
18	11. 236		48	313. 401		78	8 735. 844
19	12. 424		49	349. 918		79	9 752. 292
20	14. 208		50	391. 216		80	10 906. 150
21	15. 399		51	436. 858		81	12 185. 330
22	17. 784		52	488. 011		82	13 597. 360
23	19. 575		53	545. 159		83	15 199. 110
24	21. 968		54	608. 870		84	16 988. 430
25	24. 364		55	680. 739		85	18 978. 890
26	27. 366		56	760. 715		86	21 225. 920
27	30. 375		57	849. 747		87	23 700. 160
28	33. 994		58	948. 966		88	26 460. 000
29	38. 229		59	1 060. 088			
30	42. 477		60	1 184. 895			

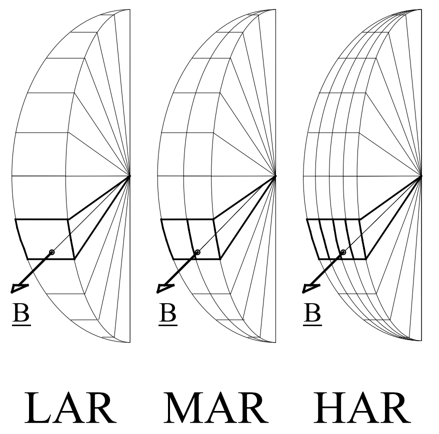
Table 2: Approximate electron energy for each level of the HV sweep generator. Note that this differs from the mean energy of electrons accumulated during a sweep step, during which time the sweep voltage changes from a higher to a lower level. More accurate tables will be produced during calibration analysis.

1.4.5 Angular Coverage

The only feasible type of position sensitive readout to achieve the high count rates necessary for a wide dynamic range is the discrete-anode method. Each anode is connected to an amplifier and counter. The angular position readout uses an array of discrete anodes. The Cluster I PEACE instrument anodes were patterned to give both coarse and fine resolution (in a method previously used in the LEPA instrument on the CRRES spacecraft). Both sensors had the same pattern, with 12 coarse zones 15° wide, and 4 fine zones 3.75° wide within in each coarse zone (Figure 4). Only one coarse zone of each sensor can be selected for fine zone readout. Fine zone counts are accumulated in coincidence with counts in the selected coarse zone. Both coarse and fine zone counters have a capacity of 16 bits.

The fine zones are not used on Cluster II, though the sensor electronics remain in place.

The figure below shows 12 polar "coarse zones".



The HEEA polar zone from which raw counts data is sent to the DWP/Correlator will usually be chosen to contain the magnetic field direction once or twice per spin (see Chapter 6).

For each sensor, data is collected from each polar coarse zone, for all azimuth sectors during a spin and for all energies. Thus, whatever the sweep mode, there are 11520 bins of data per sensor in the complete coarse zone data set.

The start of a spin occurs on reception of a rephased sun pulse. The rephase angle can be changed on command and can be set so that the spin phasing is coincident with the CIS experiment spin phasing. This will ensure that electron and ion moments will be measured simultaneously.

1.4.6 Data Accumulation

The data are accumulated in 16 bit counters in the sensors and then passed to the DPU for processing. There will be 1024 accumulation periods per spin in all modes. At the nominal spin period of 4 s, the accumulation period will be 3.9ms. In sweep modes MAR and HAR there are 2 high voltage sweep steps per accumulation period so that the instrumental energy resolution is 2 out of 88 energy steps. In sweep mode LAR there is only 1 high voltage step per accumulation period and the ultimate energy resolution is achieved.

A deadtime correction will be performed in the DPU on all count values transmitted from the sensors. The DPU will adjust the deadtime algorithm to account for variations in the spin period. It also allows for different deadtimes for each discrete anode to compensate for differences in the amplifiers. These factors can be changed in flight by uplinking new values determined from an analysis of the data. The maximum count output from the deadtime correction is limited to 8032 counts per accumulation by the DPU capacity.

1.5 Onboard Data Processing

1.5.1 Data Processing Unit

The tasks of the Data Processing Unit (DPU) include the following:

(a) Interface to spacecraft: power conditioning and distribution, command processing and distribution, telemetry interface to spacecraft, signal (e.g. sun pulse) interface to spacecraft, data compression.

(b) Interface to sensors: sensor data control, data processing.

(c) Autonomous control of the instrument: on-board house-keeping monitoring, experiment control.

The above tasks will be handled in a central unit which is split into three main parts: the interface processor, the science processor and the power conditioning unit (Figures 5, 6). The science processor carries the main data processing load (Figure 7). Both devices are based on Transputer T222 processors and combine high throughput with an architecture designed for parallel and distributed processing. The functions of the on-board software are to reduce the three-dimensional counts arrays of size (ne energy bins x np polar angle bins x na azimuthal angle bins) produced by each of the sensors as follows:

- On-board calculation of moments of the particle distributions
- Reducing resolution by combining adjacent rows and/ or columns of the original matrix
- Transmitting selected distributions
- Forming 2d distributions
- Data compression

1.5.2 Moment Sums Computation

The moments sums are usually dual sensor data products. The values calculated on board are:

$\int f(v)dv$ 1 value

$\int vf(v)dv$ 3 values

$\int vvf(v)dv$ 6 values

$\int v\left|v^2\right|f(v)dv$ 3 values

(although the calculations are summations of discrete values and not integrations!) and the total counts making 14 values per distribution. These summations will be converted to the usual plasma parameters on the ground. The moment calculations are carried out for (see Figure 8):

- HEEA from its preset level to the start of the LEEA sweep once/spin
- HEEA levels overlapping the LEEA sweep, twice/spin
- LEEA levels overlapping the HEEA sweep, twice/spin
- LEEA from the bottom of the overlap to level 17, once/spin

The resolution of the moment computations is independent of the sweep mode and is as follows:

15 energies x 6 polar angles x 16 azimuthal bins

The size of moment distribution is:

14 values x 16 bit range x 6 sets per spin = 1344 bits per spin

Moments are not corrected on board for interference from either WHISPER or EDI.

The process of transmitting data from the spacecraft to the ground involves compressing and decompressing the data, which can introduce an error, i.e. a difference between the value onboard the spacecraft and the corresponding value after decompression on the ground. The difference may be very small, depending on the value to be telemetered, but an upper limit can be assigned for the worst case. For values in the MOM-D data product the worst case error range is ± 0.4%.

1.5.3 Treatment of Low Energy Range (E < 10 eV)

Data collected at the low energy range of the instrument must be treated differently because it is likely to be affected by the interaction between the spacecraft and its local environment (see 1.2.3). Moments calculated in this energy range may be inaccurate if photoelectrons associated with the spacecraft enter the instrument since they cannot be distinguished from electrons belonging to the ambient plasma. Ground analysis may permit correction for such effects, but the onboard processing system cannot make such corrections. The low energy range is taken to be the linear range of the sweep from levels 1 to 16 (0.6 eV < E < 9.5 eV). The data will be treated in two ways; first of all, the simplest parameter to describe the interaction, the spacecraft potential will be estimated from the energy spectrum and then in order to provide as much detailed information as possible, 3-dimensional distributions will be telemetered.

1.5.3.1 Spacecraft Potential Estimate

The spacecraft potential estimate is a single sensor data product, usually from LEEA. It will be obtained by the following algorithm;

i) A reduced resolution matrix will be produced from a spin of data in the following way;

energy range	- the lowest 16 steps in the sweep will be taken whatever the preset.
azimuth	- 8 successive sweeps will be taken; the phasing of these sweeps relative to the solar direction pulse will be selected by command.
polar	- 4 successive polar zones will be taken by command

ii) From the 32 spectra of counts so obtained the algorithm searches from the highest energy to find the energy at which the slope becomes negative. It then searches in the energy range from there to the lowest energy to find the energy with the absolute minimum count rate. This gives 32 values for the energy of the minimum. From these energies the average, the variance, and the maximum and minimum values are telemetered. There are the following control options for the calculation:

- the starting sweep position relative to the solar direction can be selected
- either LEEA or HEEA can be selected;
- the computation can be commanded off;
- a fixed value that can be uplinked from ground;
- generate an incrementing test pattern.

There is no compression error associated with transmission of SCP-S since the SCP-S data is transmitted without being compressed.

1.5.3.2 Low Energy Range Distributions

The low energy distributions are single sensor data products. When possible the low energy distributions will be transmitted with full available resolution usually from LEEA, although HEEA may also be used. They contain:

High resolution distribution

LAR mode 12p x 16e x 16a	(3DX-anl-16w00 for LEEA)
MAR mode 12p x 8e x 32a	(3DX-anl-16w00 for LEEA)
HAR mode 12p x 4e x 64a	(3DX-anl-08w00 for LEEA)

The lowest 4, 8 or 16 energy bins in the sweep are taken, depending on the choice of sweep mode. Note that in HAR mode, the energy range coverage is only 8 steps from the nominal 16 steps of the low energy range.

If there is not enough telemetry capacity for the full distribution, distributions with reduced resolution LER-S which will be telemetered, again usually from LEEA, as follows:

LER-S distribution

LAR mode:- 16e x 4a x 3p:
MAR mode:- 8e x 8a x 3p
HAR mode:- 8e x 8a x 3p

The elements are selected as follows;

energy - the lowest 8 or 16 levels in the sweep as appropriate, whatever the preset.
azimuth - in the LAR mode every fourth sweep is selected out of 16 in a spin.
On the succeeding three spins the other sweeps are selected in a quasi subcommutation. In MAR every fourth sweep out of 32 for a total of 8 is taken, with a subcom of 4 spins; in HAR mode every eighth sweep out of 64 for a total of 8 is taken, with a subcom of 8 spins.
polar - the 3 polar elements are obtained by summing over four consecutive polar zones for each.
The error range associated with compression/decompression for transmission is, at worst, ± 3%.

1.5.4 Pitch Angle Distributions (PAD-D)

This is a dual sensor data product. The pitch angle distribution is obtained by first identifying the energy sweep in which the field line direction passes through the field of view of the detector. Then the polar bin through which the field direction passes is also identified. Then the pitch angle distribution is taken as the distribution around the field of view of the detector. In order to select the data in this way the magnetic field direction is required once per spin. Two methods may be used for identifying the field line direction on board:

- from the on board magnetometer using a suitable algorithm.
- from the symmetry direction of the 3d distribution calculated from the PEACE data.

There are six possible sources for the symmetry direction;

i) top moments once per spin, can be HEEA or LEEA
ii) LEEA overlap 1 & LEEA overlap 2 once per spin
iii) HEEA overlap 1 & HEEA overlap 2 once per spin
iv) LEEA overlap 1 & HEEA overlap 1 once per spin
v) LEEA overlap 2 & HEEA overlap 2 once per spin
vi) bottom moments once per spin, can be HEEA or LEEA

The source to be used is selected by command.

The transmitted distributions will be obtained the following way. We first define the polar zone numbering as 1, 12 where 1 is the zone closest to the positive spin axis direction and 12 the zone at 180°. Then in the first half spin assume that the magnetic field is located in polar zone n of HEEA and therefore in zone 12 - n of LEEA. Data is taken from zones n to 12 for HEEA and zones 12 - n to 12 of LEEA. In the second half spin the magnetic field is now located in zone n of LEEA and 12 - n of HEEA. Data is now taken from zones n to 12 of LEEA and 12 - n to 12 of HEEA. From these data a two-dimensional pitch angle/energy distribution can be constructed with the basic angular resolution of the analyser of 15° over the full range from 0 to 180°. In each half spin we get 13 polar samples. The number of energies in each zone is 15, therefore the total number of samples is;

15e x 13p x 2a x 2 (sensors) per spin = 780 samples/spin.

The error range associated with compression/decompression for transmission is, at worst, ± 1.5%.

1.5.6 Three Dimensional Distributions (3DF-D and 3DR-D)

This is a dual sensor data product. The (3DF-D) distribution contains both LEEA and HEEA coarse zone data at the full resolution of which the instrument is capable. The total number of samples is;

3DF-D distribution

LAR	60e x 12p x 16a x 2s
MAR	30e x 12p x 32a x 2s
HAR	15e x 12p x 64a x 2s
Total	23040 values

The error range associated with compression/decompression for transmission is, at worst, ± 1.5%.

For the (3DR-D) distribution the resolution is halved in the polar dimension and reduced by 4 in energy for LAR, 4 in azimuth for HAR, and halved in both energy and azimuth for MAR. This produces a distribution with one eighth of the size of the full distribution. The total number of samples is always;

3DR-D distribution

(all)	15e x 6p x 16a x 2s
Total	2880 values

The error range associated with compression/decompression for transmission is, at worst, ± 3%.

1.5.7 The Variable Three Dimensional Distribution (3DX)

The variable 3DX distribution is a data product that allows maximum flexibility over the selection of data telemetered. It usually, though not always, takes data from one sensor only (see below). A 3DX distribution is constructed by taking a parent distributions and reducing its size. Reduction may be achieved by several means, as outlined below. In principle, a very large number of 3DX distributions can be constructed, although in practice we expect to use only a relatively small number of 3DX distributions.

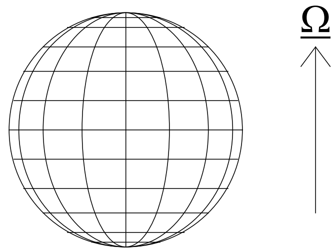
Two 3DX distributions can be sent per spin, telemetry perimitting.

1.5.7.1 The 3DX Parent Distribution

The 3DX parent distribution has the same dimensions as a single sensor version of the 3DF-D distribution, and just as for 3DF-D contains data at the measurement resolution. The 3DX parent distribution can be a spin of data from LEEA, a spin of data from HEEA or a combination of half a spin of data from LEEA with half a spin of data from HEEA (acquired during the same half spin interval). The later case corresponds to a 2 second complete 3 dimensional distribution. The polar coarse zone data set (12 coarse zones) or the polar fine zone data set (4 fine zones from a selected coarse zone) can be used to create a parent 3DX distribution. In either case, data is available from the full range of energy bins and azimuth bins. Thus, combined with a full set of azimuth data, polar coarse zone data provides complete coverage of the sky (see left-hand figure below) while fine zone data provides only a strip of coverage corresponding to one polar coarse zone rotated about the spin axis (see right-hand figure below). However, the polar coarse zone from which the fine zone data is taken may be changed every spin so as to step through the 12 coarse zones in 12 successive spins, thereby providing all sky coverage with high polar resolution (4π steradians) every 12 spins.

3DX parent distribution (case of polar coarse zone data)

LAR	60e x 12p x 16a x 1s
MAR	30e x 12p x 32a x 1s
HAR	15e x 12p x 64a x 1s
Total	11520 values

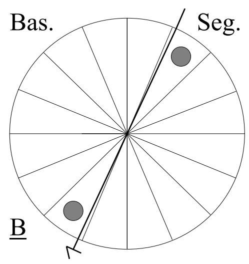


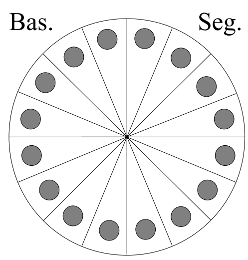
1.5.7.2 3DX Reduction: Basic Segment Selection

The synchronisation of energy sweeping and data acquisition is based on the unit of an accumulation bin (1/1024th of a spin) and the basic segment (1/16th of a spin) as noted in 1.4.3 above. The basic segment may contain 1, 2 or 4 energy sweeps according to the sweep mode (i.e. for LAR, MAR or HAR). The basic segment is the natural basis from which to construct data packets for transmission to the ground.

In constructing a 3DX distribution, it is possible to

- send all 16 basic segments (no data product size reduction)
- send only 2 basic segments acquired at azimuths 180° apart (/8 size reduction)
  N.B. these may be chosen to contain the magnetic field direction and are in effect pitch angle distributions (more complete than PAD-D).

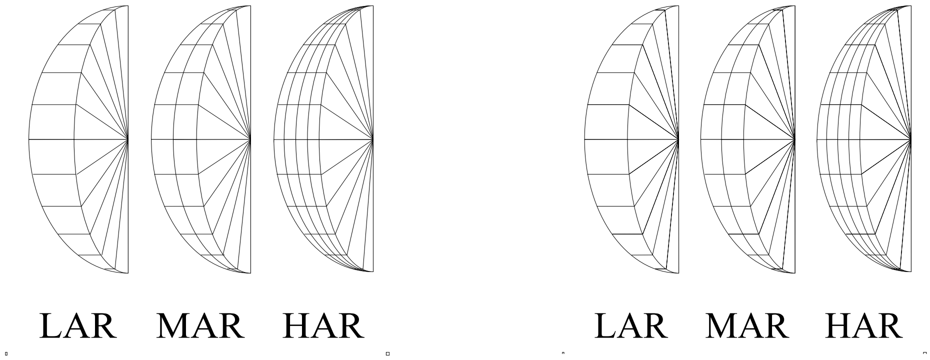




These two possibilities are illustrated above. The 16 basic segments are illustrated (as though looking down along the spin axis and seeing a slice through the equator of sphere shown in the figures above) and those to be transmitted are indicated by grey dots.

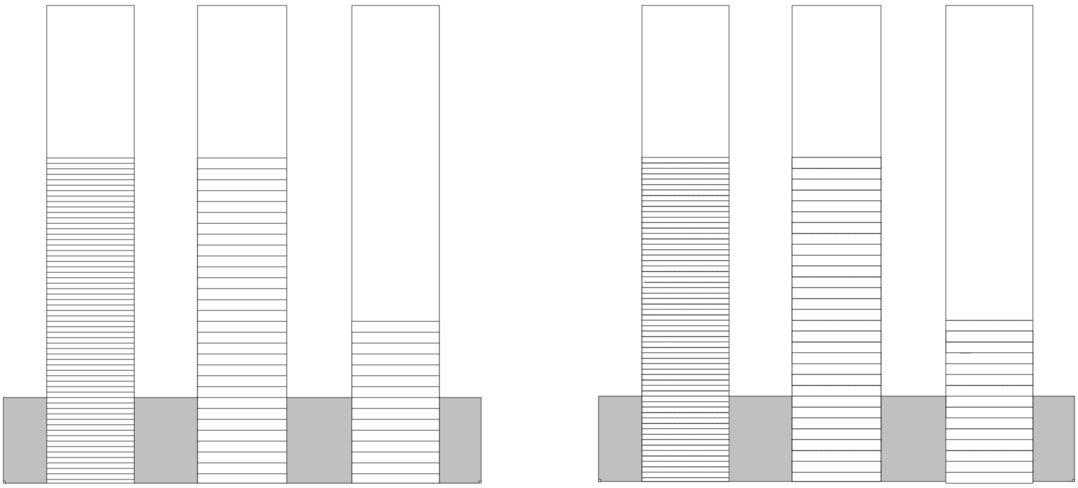
1.5.7.3 3DX Reduction: Summing of Neighbouring Bins

It is possible to reduce the 3DX data product size by summing adjacent polar bins, or summing adjacent energy bins. One cannot sum BOTH energy and polar bins. One cannot sum azimuth bins.



The polar bin summation option is illustrated above. The left hand figure shows a basic segment for each of the cases of the three sweep modes illustrating the angular resolution in each case. The right hand figure shows the effect on angular resolution of summing adjacent polar bins.

Similarly the figure below illustrates the energy resolution and coverage for LAR, MAR and HAR, before (left) and after (right) summing of energy bins. Note that in the case of HAR there are 15 bins originally, so one must be discarded.



1.5.7.4 3DX Reduction: Discarding Bins from Selected Energy Range

It is possible to reduce the 3DX data product size by discarding energy bins. A part of the measured energy range is specified using an energy window. Energy bins lying outside (above or below) the energy levels which specify the bounds of the window are discarded.

For example, assume that we have a sensor covering the energy range from level 0 upwards (to level 60 for LAR and MAR, or level 30 for HAR). In order to retain only the energy steps between levels 16 and zero we specify a window thus:

e.g. -16w00

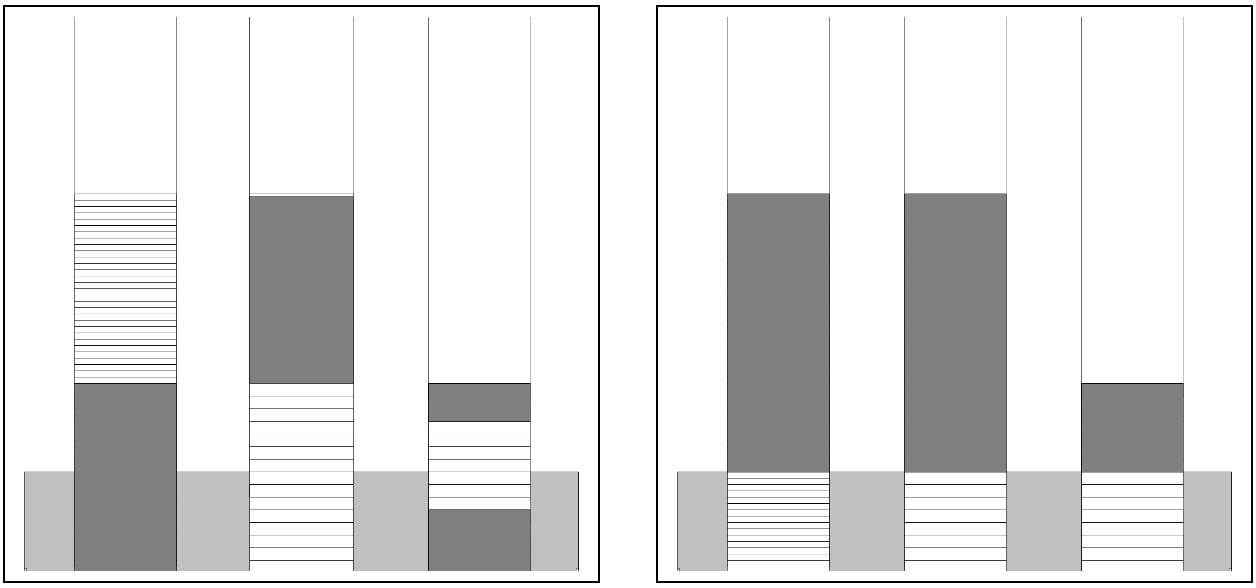
In LAR mode the uppermost energy bin remaining after the window is applied is the bin in which the energy step is from energy level 16 to energy level 15. The lowest bin is that in which the energy step is from energy level 1 to energy level 0. This window specifies a data product containing 16 energy bins in LAR mode.

In MAR and HAR modes the same window description refers to a distribution containing 8 energy bins, since in these sweep modes the sweep covers two steps per bin. The uppermost energy bin is a double step from energy level 16 to energy level 14, and the lowest energy bin is a double step from energy level 2 to energy level 0.

The following rules apply when designing an energy window:

- the specified window energy range must lie within the energy range covered by the source sensor (check the sensor configuration)
- the specified window energy range must cover an even number of energy steps in MAR and HAR sweep modes, though it may be either odd or even for the LAR sweep mode.

The following examples show some of the possible uses of energy windows. On the left hand side the energy windows have been used to select half the sensor energy range, but for each sweep mode a different part of the range has been selected (top half for LAR, bottom half for MAR and upper middle for the LAR example). In the right hand side figure energy steps below level 16 only have been selected for all three sweep modes.



The 16w00 window shown on the right illustrates an important point. Assuming equal numbers of azimuth and polar bins, the HAR distribution will be twice as large as the LAR and MAR data products using this energy window.

1.5.7.5. 3DX Transmission: Compression Errors

The error range associated with compression/decompression for transmission is, at worst, ± 3% for those 3DX data products in which summing over polars or energies has been performed. In all other cases, the error range is ± 1.5%.

1.6 Telemetry Outputs

There are 2 different science telemetry formats;

i) normal science data

ii) on board memory dump

The format of the normal science data telemetry packet is shown in Figure 9. The science data format "floats" within the spacecraft format and is based on one spin of data. The first part of the format contains high priority "core" data which provide a standard characterisation of the electron distribution and is sized such that it will always be transmitted whatever the spin period (within the specified range of 3.6 to 4.4 sec.). If, before the end of a spin, all the previous distribution has been transmitted, then the telemetry will transmit all the next distribution before going on to the next spin's core data. This means that this next spin of data will be transmitted slightly late but the whole of its core data will be transmitted before the following spin of data is started on. Eventually the transmission will catch up and be able to transmit the distribution after the core again but only after some time. Thus distributions near the boundary are always transmitted whole but irregularly. This principle is applied through the format whatever the telemetry rate. It helps to ensure that the telemetry capacity is nearly always fully used.

The structure of the science data format is as follows where the numbers are data bytes per distribution;

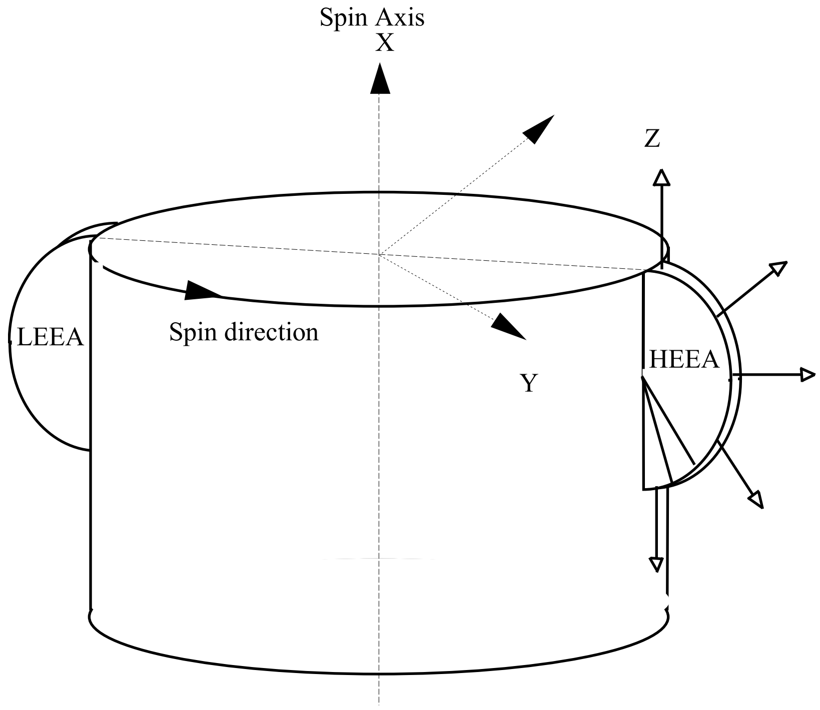
CORE DATA			
	moments	168 bytes	MOM-D
	s/c potential, etc.	7 bytes	SCP-S
OPTIONAL DISTRIBUTIONS			
	pitch angle distribution	780 bytes	PAD-D
	low energy reduced	192 bytes	LER-S
	low energy full	3072 bytes	3DX-canl-16w00 (for MAR mode)
	high polar resolution	480 bytes	HIP-D
	3d full resolution	3040 bytes	3DF-D
	3d reduced resolution	2880 bytes	3DR-D
	3d variable distribution	Variable	3DX

The size of the packaged data is slightly larger, as explained in Appendix D.

The instrument can adapt to 6 different science telemetry output rates automatically;

i)	NM1	normal	2515.42 b/s	
ii)	NM2	basic	1521.67 b/s	CIS priority
iii)	NM3	enhanced	3540.22 b/s	Peace priority
iv)	BM1	burst mode 1	15980.68 b/s	
v)	BM2	burst mode 2	3658.23 b/s	
vi)	BM3	burst mode 3	1926.00 b/s	

The amount of data, and types of distribution transmitted in each format in the standard science mode (see Chapter 6) are shown in Figure 10.



Both HEEA and LEEA observe perpendicular to spacecraft spin axis with 180 degrees polar fans.(Look direction range illustrated for HEEA).

Figure 1. The deployment of the analysers on the spacecraft

Figure 2. A crossection of the LEEA analyser assembly showing the structure of the input collimator, the electrostatic analyser and the anode pattern.

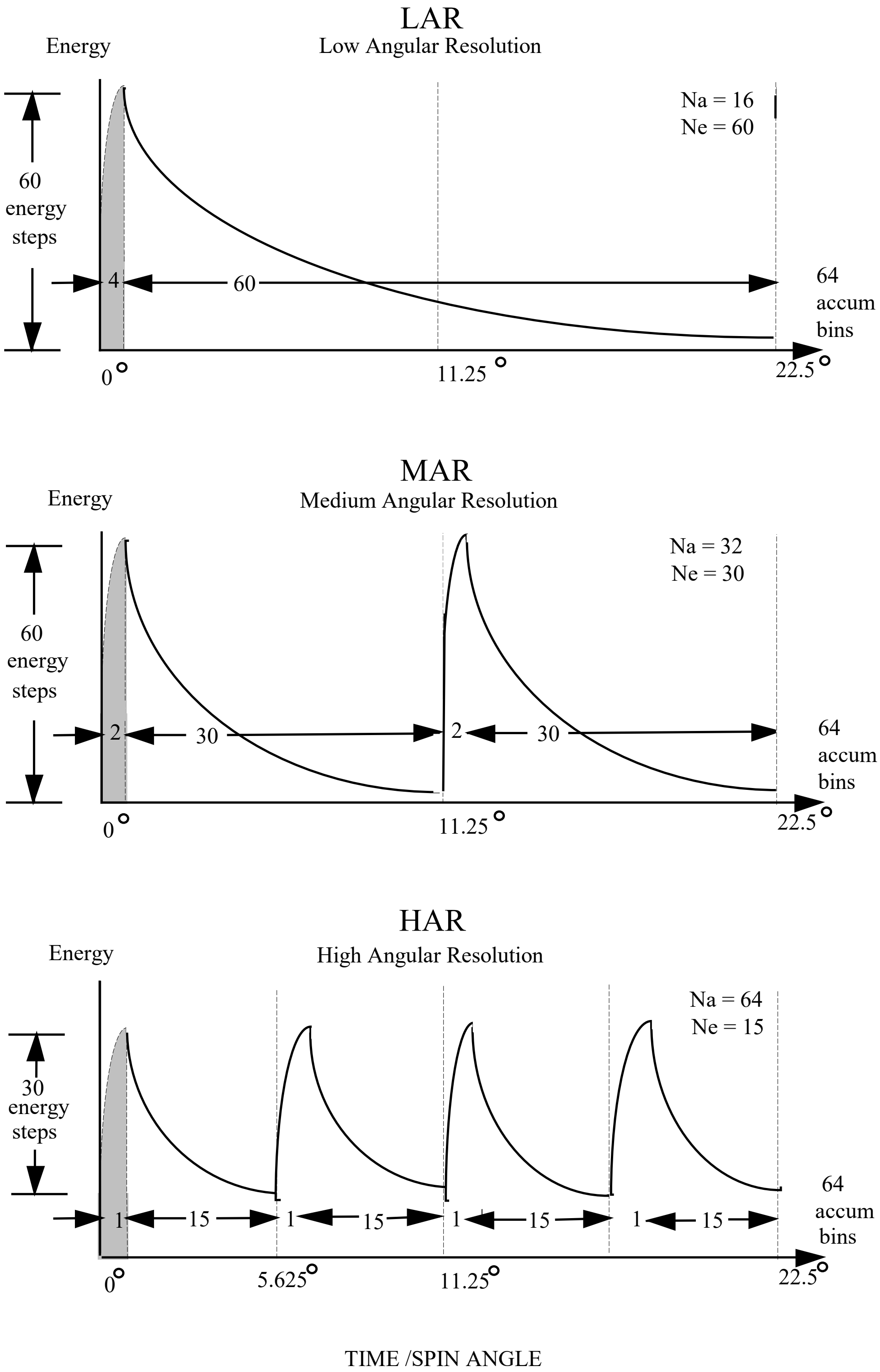


Figure 3. The pattern of the energy sweeps in the three main modes (flyback in grey, only one flyback interval has been highlighted per sweep mode)

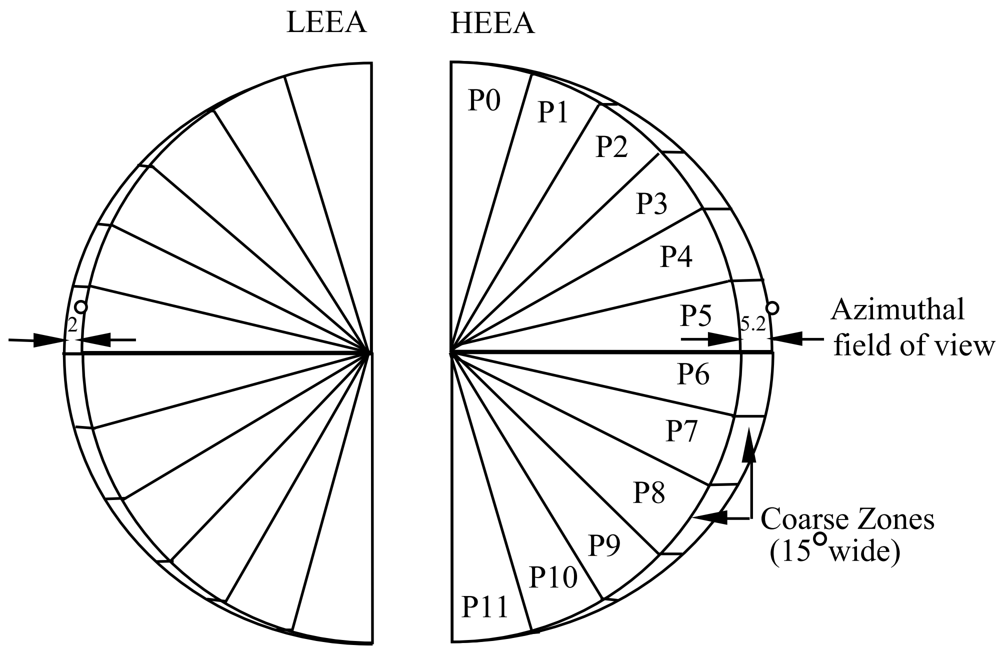


Figure 4. The angular response of the two analysers. Fine zone capability removed for Cluster II and not illustrated here.

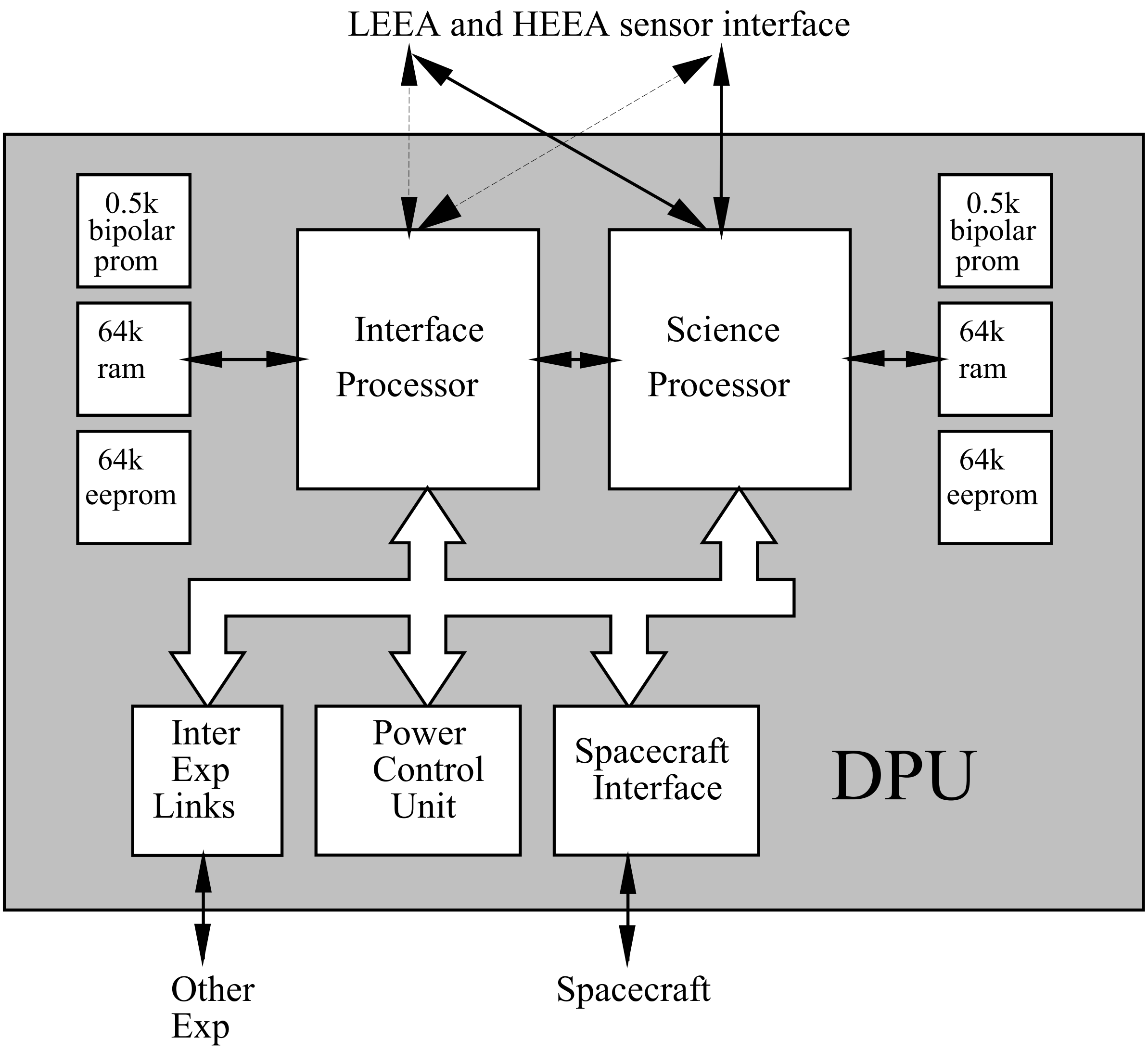


Figure 5. Block diagram of the Data Processing Unit

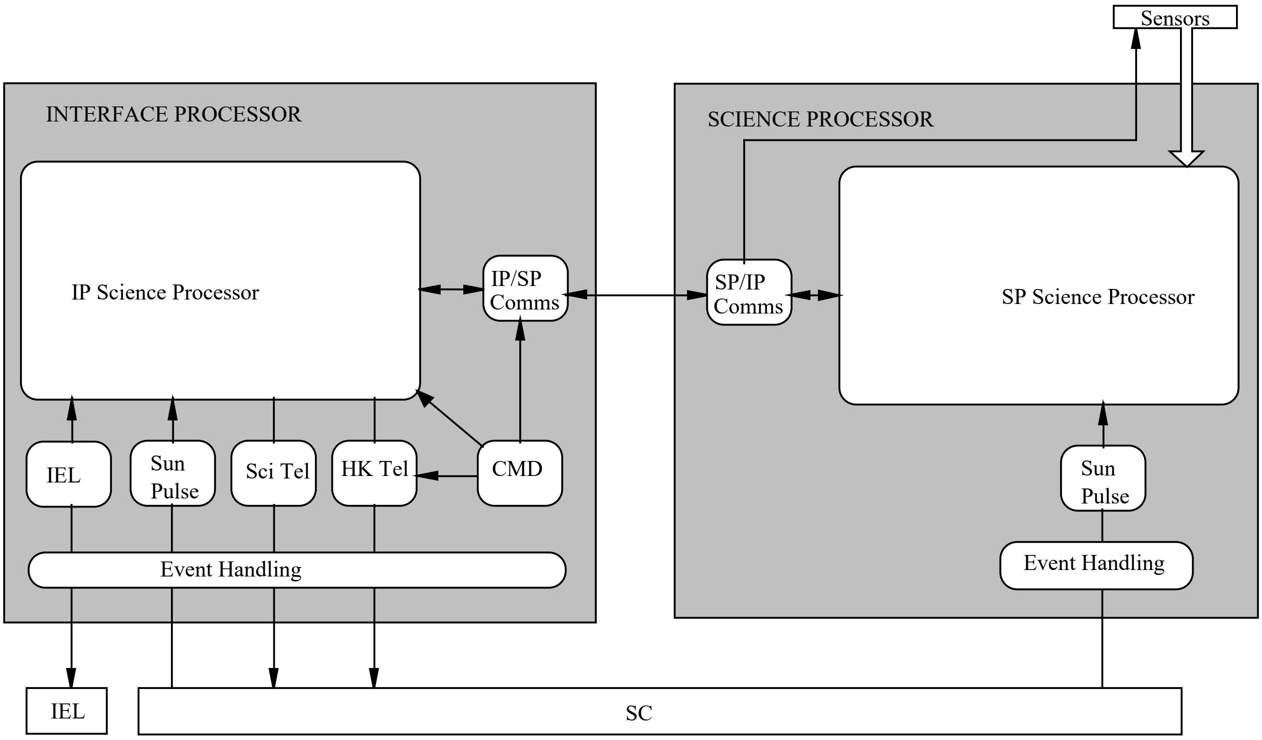


Figure 6. Basic architecture of the DPU processors

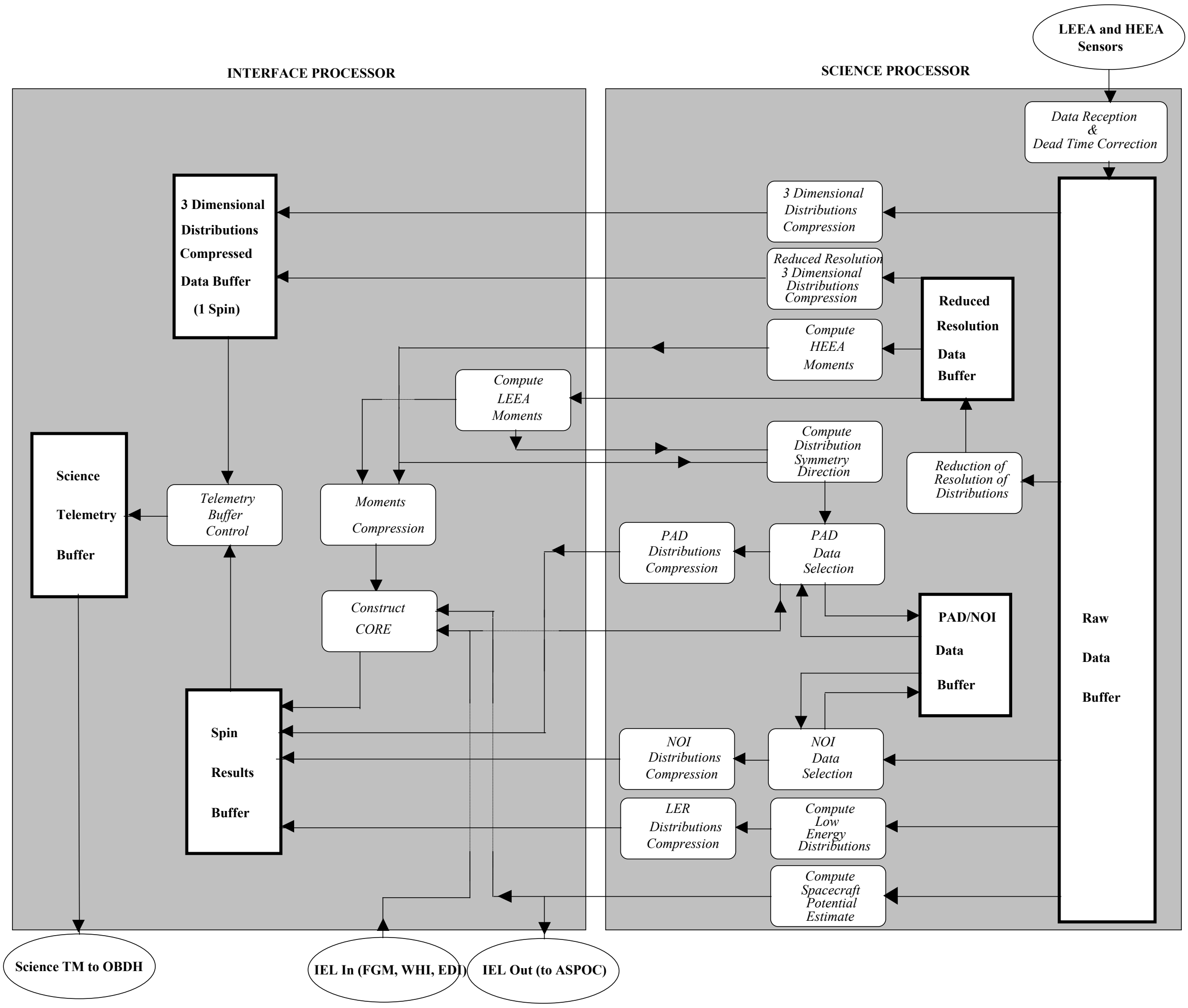


Figure 7. Distribution of the processing software between the two internal processors, in standard configuration. Single processor operations are possible on a contingency basis.

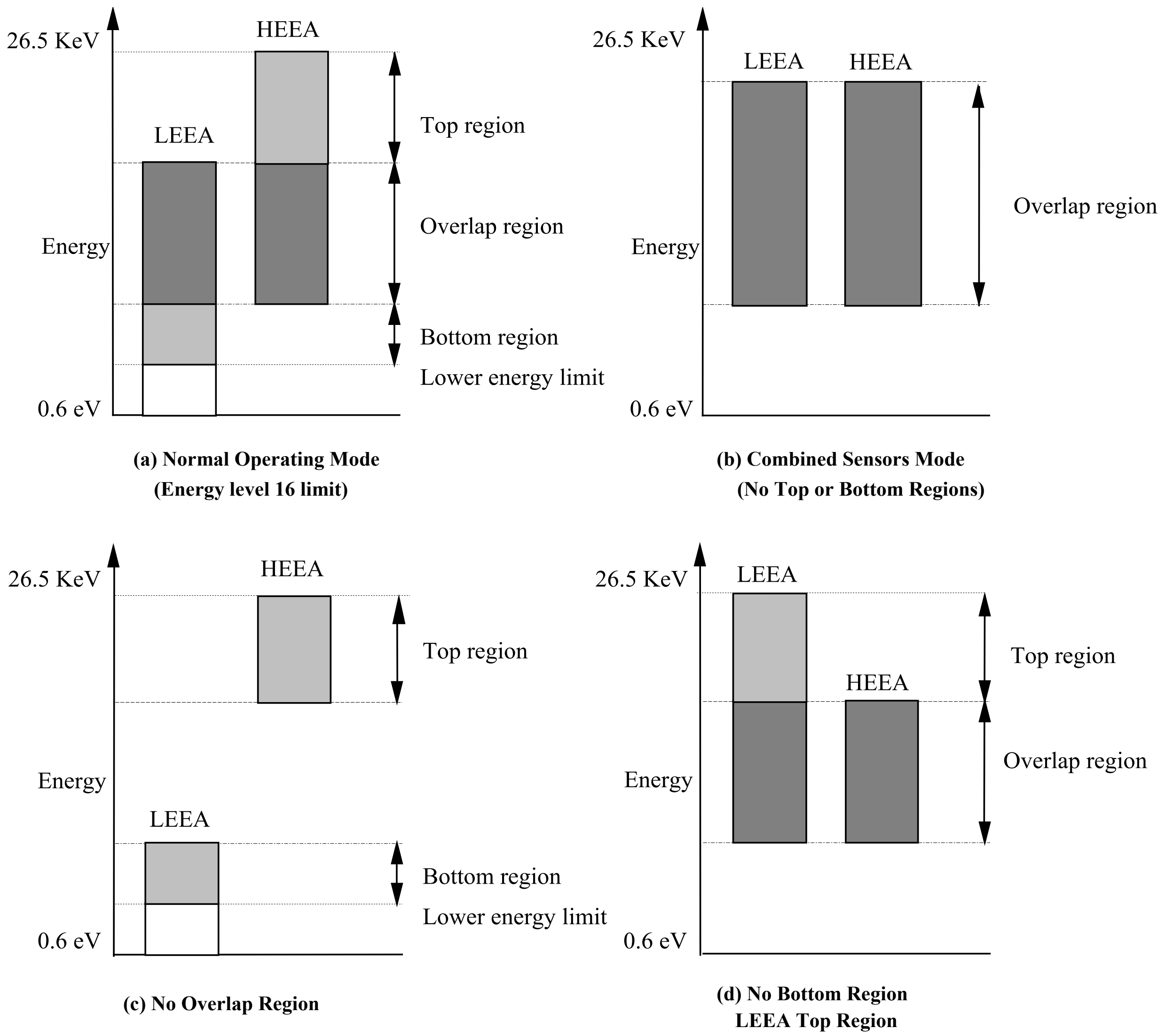


Figure 8.   Possible energy sweep schemes for the combination of two analysers

PEACE
SCIENCE TELEMETRY
PACKET

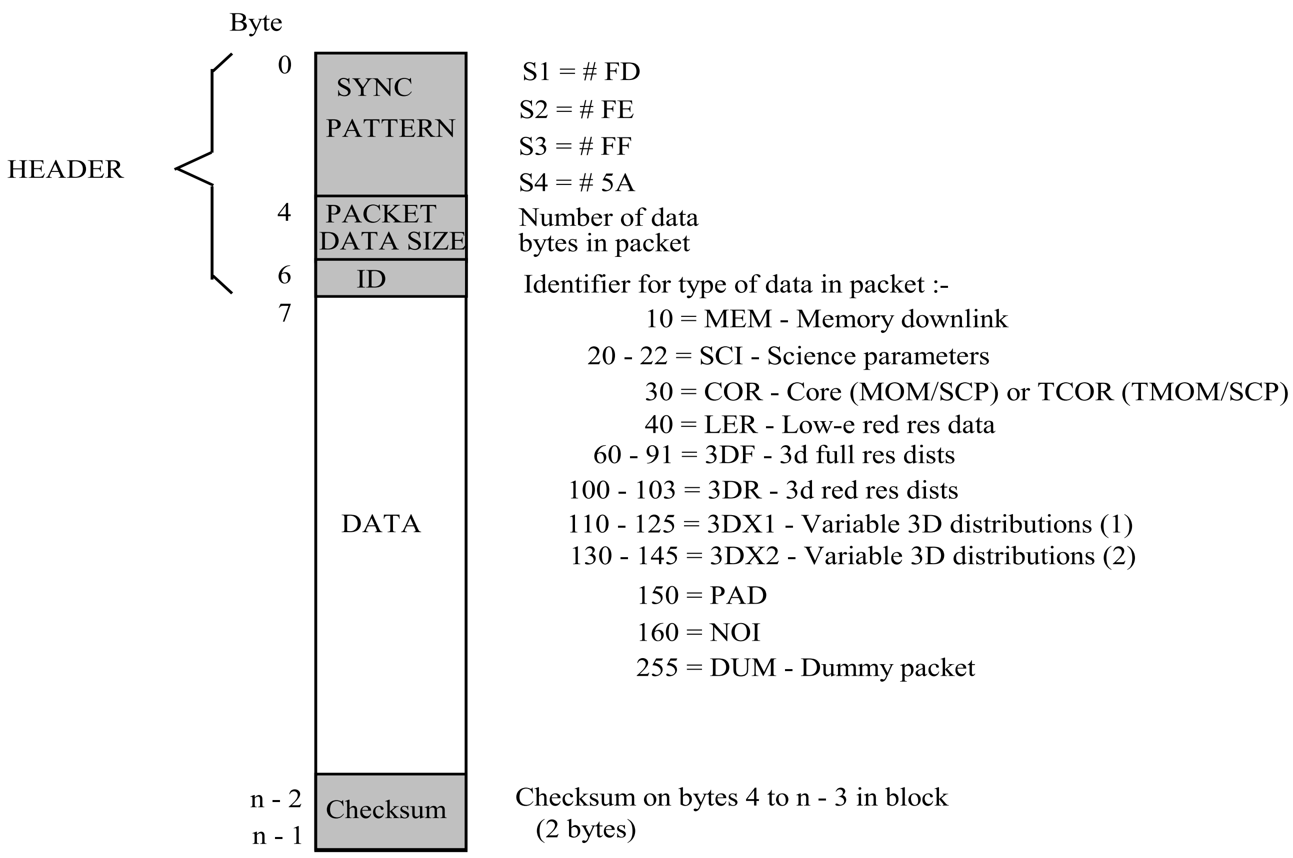


Figure 9. Structure of the science telemetry packet which floats within the spacecraft format

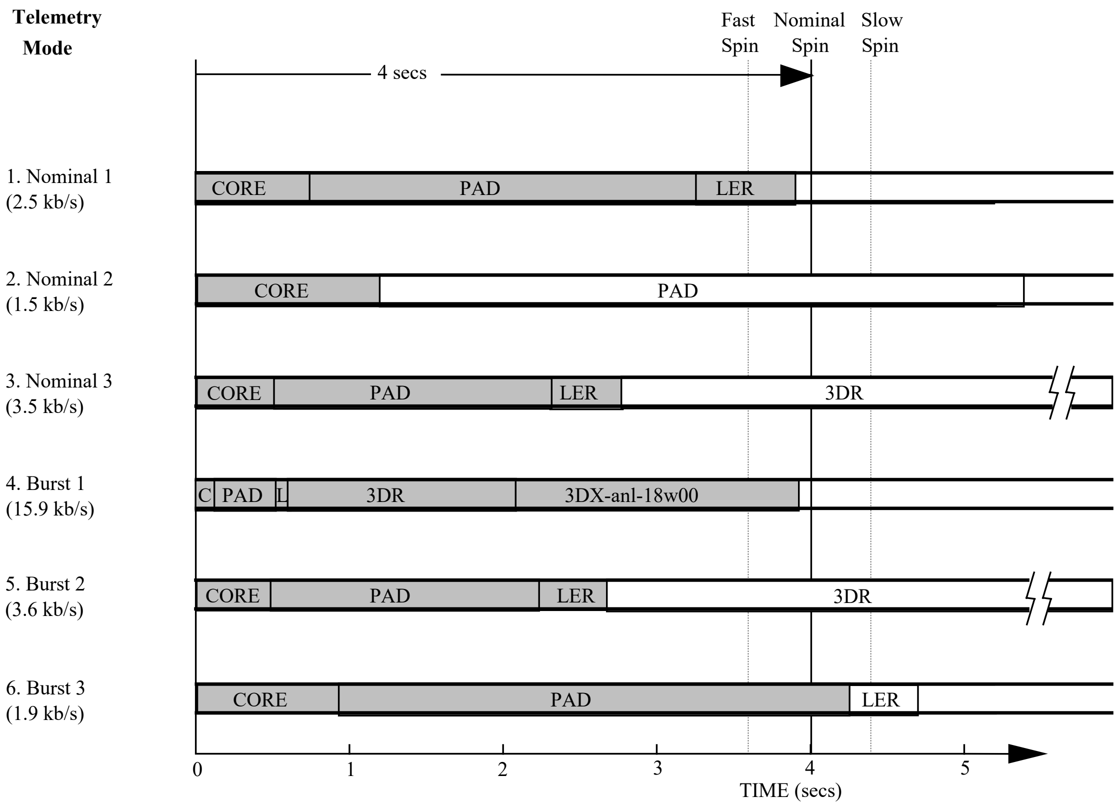


Figure 10 Transmission of distributions for the six telemetry rates. Note that NM2 and NM3 are transparent to all instruments except CIS and PEACE. NM2 takes TM from PEACE and gives it to CIS, while NM3 takes TM from CIS and gives it to PEACE. Note that these modes are not convenient for CIS and are not intended for regular use. The figure illustrates the data return for the Standard Mode. Note that 3DF-D (not shown) is very large. Even in BM1, 5 spins (about 20 seconds) are required to transmit a single 3DF-D data product.

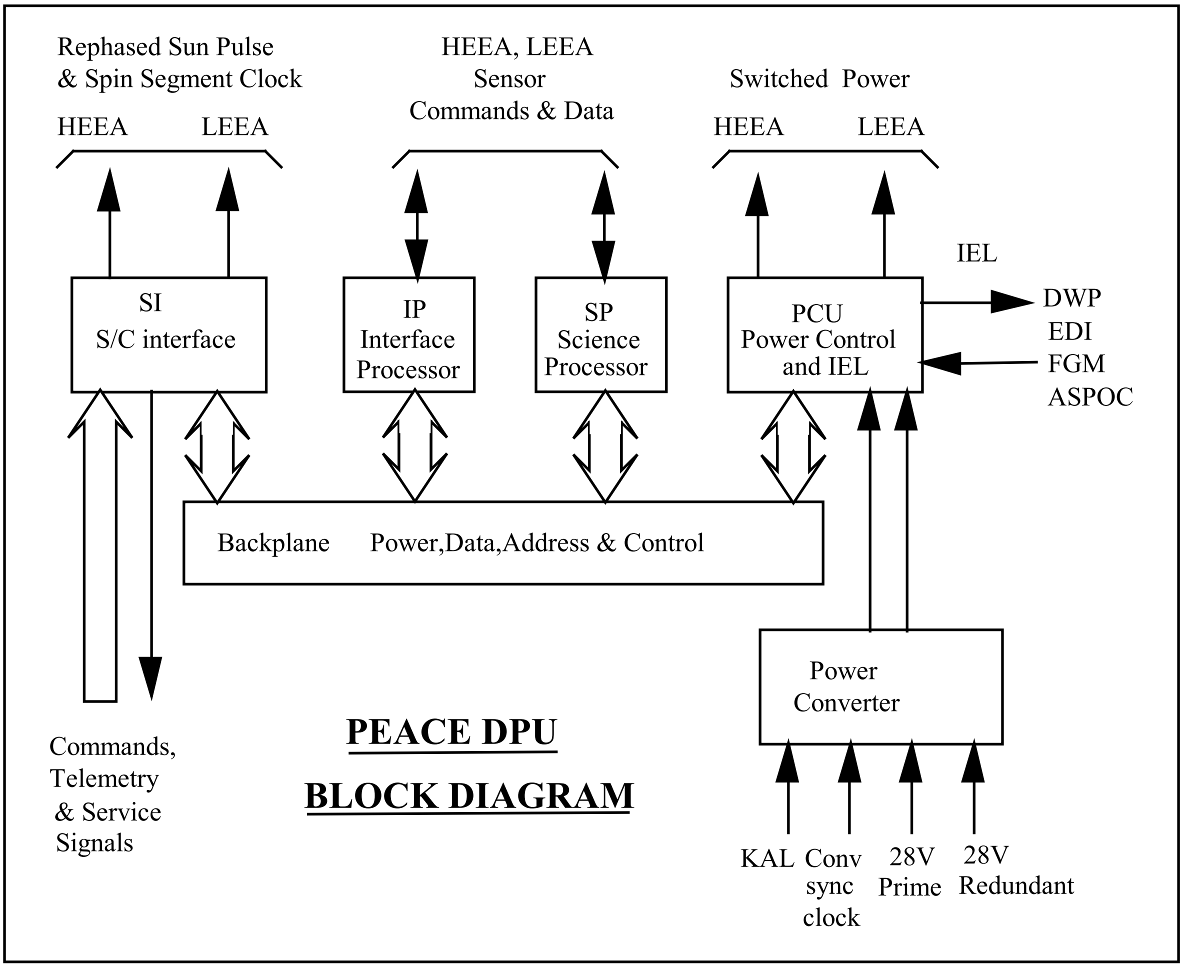


Figure 11 DPU electronics block diagram

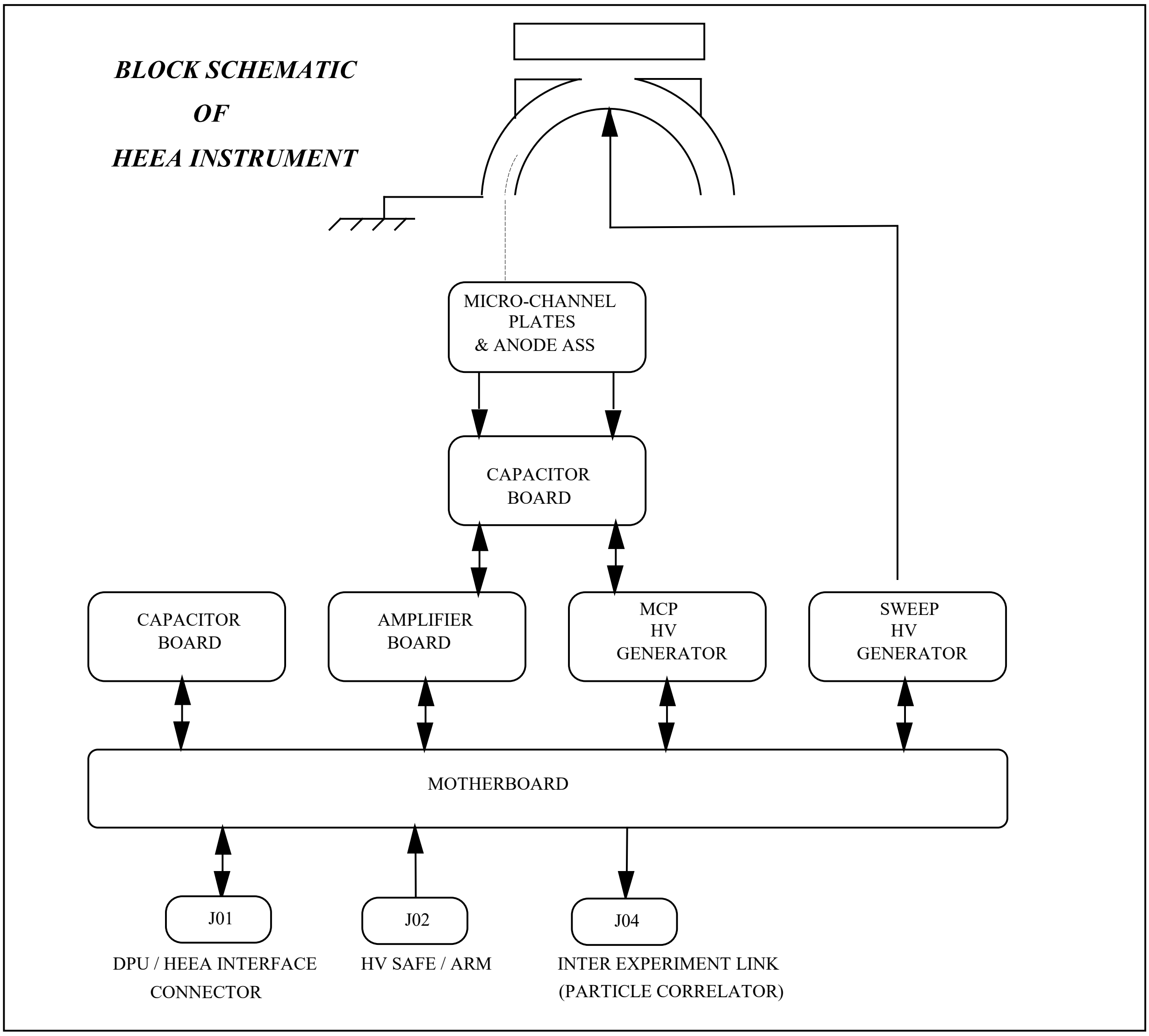


Figure 12 HEEA sensor electronics block diagram

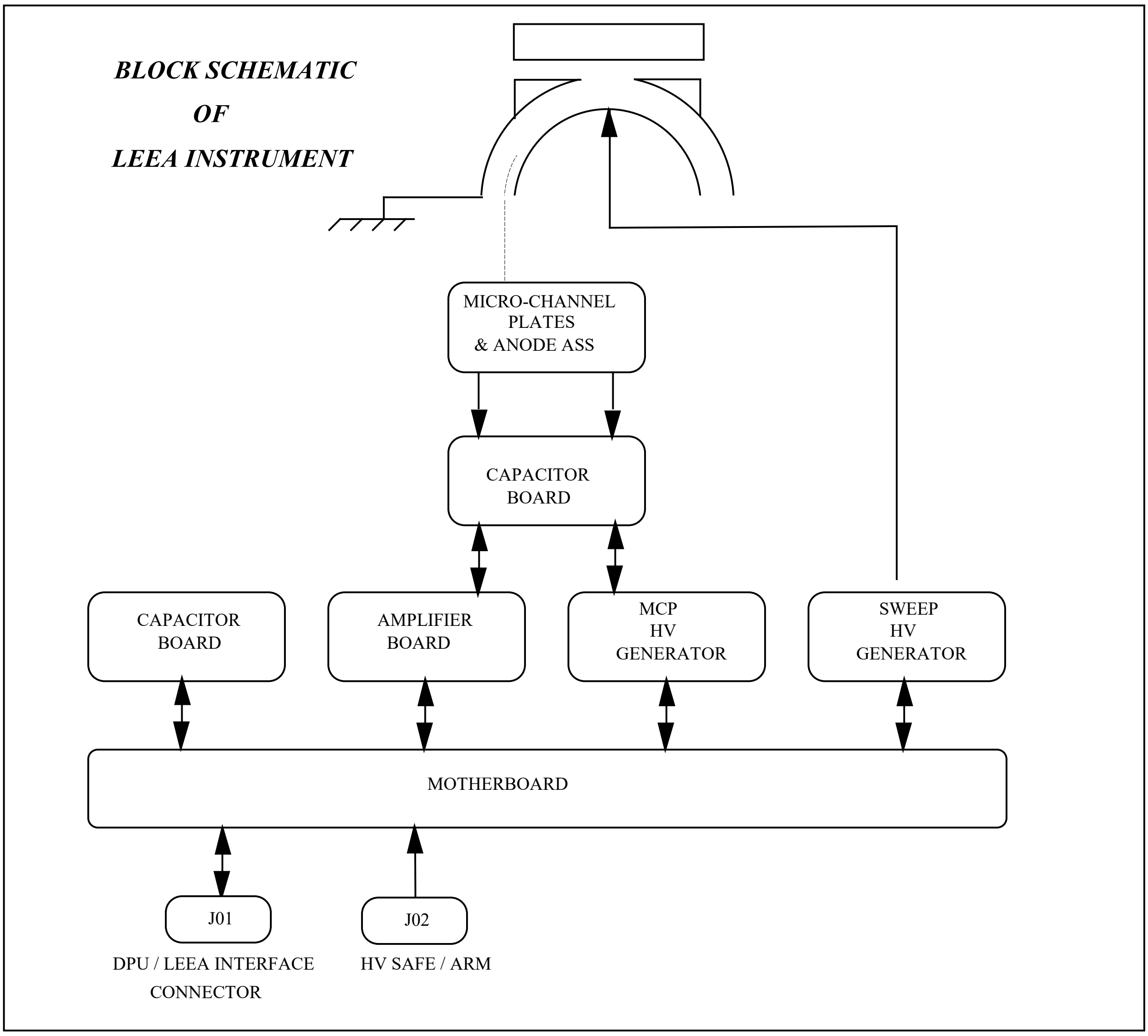


Figure 13 LEEA sensor electronics block diagram

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UNIVERSITY COLLEGE LONDON Authors: B. Hancock / G. Watson / A.Fazakerley/ P Carter/ C. Alsop

PEACE USER MANUAL CHAPTER 2

Version 3.5
01-Feb-2000

Change Sheet since Cluster 1

Description added to Housekeeping Parameters in 2.1.1

Calibration Tables Updated for Cluster II Spacecraft 1, PEACE instrument FM06, section 2.2.1
Calibration Tables Updated for Cluster II Spacecraft 2, PEACE instrument FM07, section 2.2.2
Calibration Tables Updated for Cluster II Spacecraft 3, PEACE instrument FM08, section 2.2.3
(Calibration Tables Cluster II Spacecraft 4, not yet available for section 2.2.4)

Modifcation of some text, e.g. document references updated.

Version 3.3 (23rd Aug 99):
Spacecraft numbering changed to ESOC spec and tables moved round to agree with this (ie FM06 calibrations are now found in Section 2.2.2 etc).
Input FM09 calibration data, now section 2.2.1.
Changed PEADPUF, PEAHEEF and PEALEEF numbering to agree with FM number.

Version 3.4
1.12.99 – changed mistakes after cross-checking with cal.txt files

Version 3.5

01/02/00revision of Section 2.3 : added material on limit checking
correction to document number

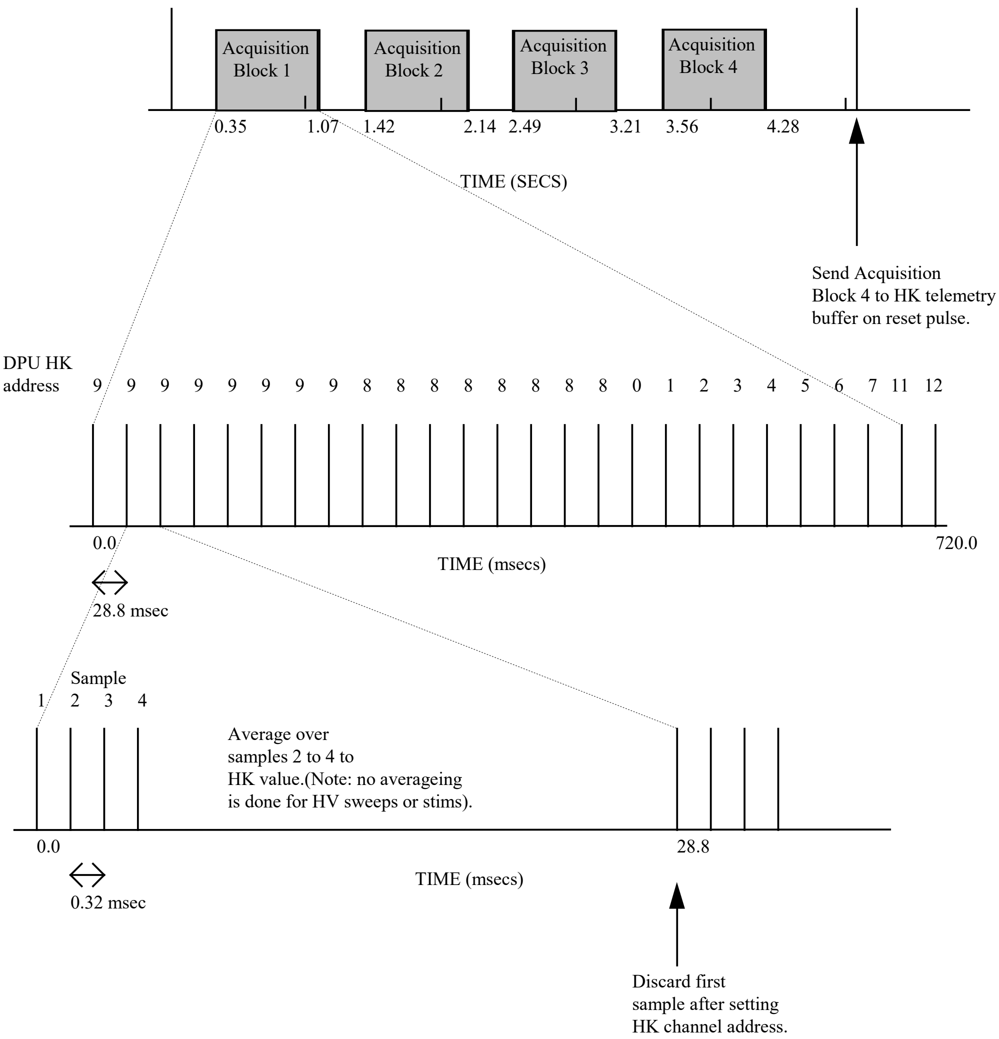
2. TELEMETRY

2.1 Housekeeping Telemetry Description

The PEACE HK telemetry consists of digital parameters and status words, command echos, single anode (one bin per spin) and total anode counts, and measured analog parameter values.

2.1.1 On-board monitoring

Analogue values can be monitored within the DPU and if an out-of-limits error occurs, the LEEA and HEEA sensor power may be shut down. The trip status is recorded in the parameters EPD_MTRP and EPD_STAT. The channel that tripped is recorded in EPD_MCHN. The value of the channel that tripped is recorded in EPD_MVAL. In order that as fast a time response as possible is achieved, the analog parameters can be checked four times between reset pulses. This is shown below. Each value with the exception of the sensor HV sweep and stim monitors are averaged over 3 samples.



2.1.2 The Housekeeping Database.

A complete listing of the "Operational Housekeeping Telemetry Database", CL/PE-MSSL-LI-0052 is contained in Appendix B. This data base is derived from the document "DPU HK Telemetry Specification", CL/PE-MSSL-DS-0853, which is included in Appendix C. The information below is a brief summary of the parameters in the data base.

2.1.2.1 List of Digital Housekeeping Parameters

EPD_BFLK	Code source select, boot from memory or from diagnostic link
EPD_HKTM	DPU telemetry mode, normal or engineering mode
EPD_IBUS	DPU IO bus controller, IP or SP
EPD_IPCL	IP processor memory boot mode, EEPROM or bipolar PROM
EPD_ISAS	ASPOC IEL status
EPD_ISDW	DWP IEL status
EPD_ISED	EDI IEL status
EPD_ISFG	FGM IEL status
EPD_LSEL	Sensor link select, IP or SP
EPD_MACT	DPU monitor on/off status
EPD_MTRP	DPU monitor ID of tripped channel
EPD_RSET	Status of low level command reset bit
EPD_SCIM	Spacecraft interface control, prime or redundant selected
EPD_SIAM	Spacecraft interface mode, auto select or manual select
EPD_SPCL	SP processor memory boot mode, EEPROM or bipolar PROM
EPD_WDST	Watchdog status, enabled or disabled

2.1.2.2 List Of Counter and Register Housekeeping Parameters

EPD_CD01	Command echo , most recent command
EPD_CD02	Command echo
EPD_CD03	Command echo
EPD_CD04	Command echo
EPD_CD05	Command echo
EPD_CD06	Command echo
EPD_CD07	Command echo
EPD_CD08	Command echo
EPD_CD09	Command echo
EPD_CD10	Command echo
EPD_CD11	Command echo

EPD_CD12	Command echo
EPD_CD13	Command echo
EPD_CD14	Command echo
EPD_FCNT	Telemetry frame counter, since main code execution
EPD_MCHN	Monitor channel trip ID
EPD_MVAL	Monitor control trip value
EPD_SCCT	Science processing spin counter, from start of science processing
EPD_SPCT	Spin counter, since main code execution
EPD_SPOS	Current sun reference pulse offset, in spin segment clocks
EPD_STAT	DPU status monitor, valid from power on

EPH_HA01	HEEA compressed counts from anode 1
EPH_HA02	HEEA compressed counts from anode 2
EPH_HA03	HEEA compressed counts from anode 3
EPH_HA04	HEEA compressed counts from anode 4
EPH_HA05	HEEA compressed counts from anode 5
EPH_HA06	HEEA compressed counts from anode 6
EPH_HA07	HEEA compressed counts from anode 7
EPH_HA08	HEEA compressed counts from anode 8
EPH_HA09	HEEA compressed counts from anode 9
EPH_HA10	HEEA compressed counts from anode 10
EPH_HA11	HEEA compressed counts from anode 11
EPH_HA12	HEEA compressed counts from anode 12
EPH_HBIN	HEEA compressed counts bin number
EPH_HTOT	HEEA total count per spin all anodes

EPL_LA01	LEEA compressed counts from anode 1
EPL_LA02	LEEA compressed counts from anode 2
EPL_LA03	LEEA compressed counts from anode 3
EPL_LA04	LEEA compressed counts from anode 4
EPL_LA05	LEEA compressed counts from anode 5
EPL_LA06	LEEA compressed counts from anode 6
EPL_LA07	LEEA compressed counts from anode 7
EPL_LA08	LEEA compressed counts from anode 8
EPL_LA09	LEEA compressed counts from anode 9
EPL_LA10	LEEA compressed counts from anode 10
EPL_LA11	LEEA compressed counts from anode 11
EPL_LA12	LEEA compressed counts from anode 12

EPL_LBIN	LEEA compressed counts bin number
EPL_LTOT	LEEA total counts per spin all anodes

2.1.2.3 List of Analogue Housekeeping Parameters

EPD_36VI	DPU 36V rail current monitor
EPD_36VV	DPU 36V rail Voltage monitor
EPD_DTMP	DPU temperature monitor
EPD_M8VI	DPU total 8V current monitor (formerly –8V monitor, but redefined)
EPD_M8VV	DPU -8V Voltage monitor
EPD_P5VI	DPU 5V current monitor
EPD_P5VV	DPU 5V Voltage monitor
EPD_P8VI	DPU 8V current monitor
EPD_P8VV	DPU 8V Voltage monitor
EPD_TELM	Spacecraft interface prime/redundant monitor

EPH_36VV	HEEA 36V monitor
EPH_HVEN	HEEA HV enable
EPH_M8VV	HEEA -8V monitor
EPH_MCP_	HEEA MCP Voltage monitor
EPH_P5VV	HEEA 5V monitor
EPH_P8VV	HEEA 8V monitor
EPH_STIM	HEEA Stim monitor
EPH_SWE _	HEEA Sweep Voltage monitor

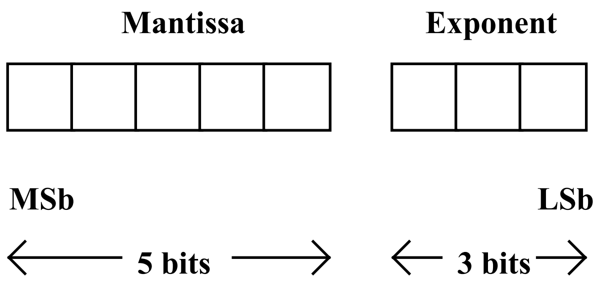
EPL_36VV	LEEA 36V monitor
EPL_HVEN	LEEA HV enable
EPL_M8VV	LEEA -8V monitor
EPL_MCP_	LEEA MCP Voltage monitor
EPL_P5VV	LEEA 5V monitor
EPL_P8VV	LEEA 8V monitor
EPL_STIM	LEEA Stim monitor
EPL_SWE _	LEEA Sweep Voltage monitor

2.1.3 Decompression of Single Bin Count Values.

The housekeeping contains the parameters EPL_LA01 to EPL_LA12 and EPH_HA01 to EPH_HA10.

These parameters are single energy bin particle count accumulations for each of the 12 anodes contained in both the LEEA and HEEA sensors. The selected bin changes every spin, and cycles through the 1024 possible bins, changing by 1 bin per spin. The counts are in a compressed form, the decompression for these parameters follows:

Structure of each byte value is



Using this the Mantissa and Exponent can be extracted from the byte value.

There is an implied bit after bit 5 of the mantissa which must be added so,

MANTISSA = MANTISSA + 0X20

The counts value can now be found by,

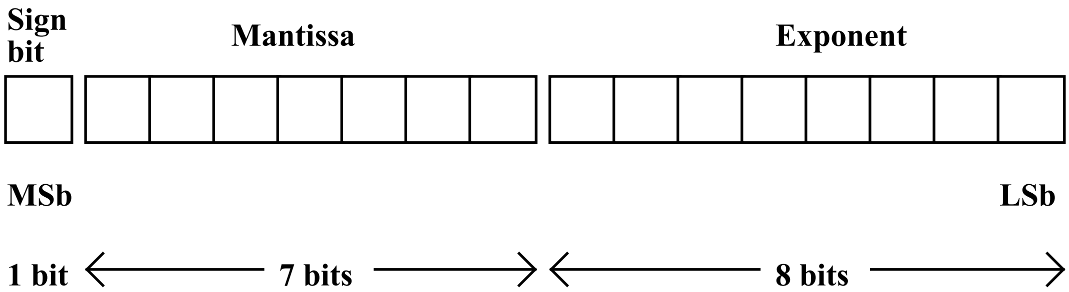
$\text{COUNT VALUE} = \text{MANTISSA} \times 2^{(\text{EXPONENT})} - 32$

The parameters EPL_LA01 to EPL_LA10 and EPH_HA01 to EPH_HA10 will be required for commissioning.

2.1.4 Decompression of Total LEEA and HEEA Counts.

The housekeeping contains the total counts received in those bins for which spacecraft moments are being calculated, collected over a complete spin, for both the LEEA and HEEA sensors. These are telemetered as 16 bit compressed real numbers. The housekeeping parameters EPH_HTOT contains HEEA total counts and EPL_LTOT contains the LEEA total counts. The decompression of these parameters is as follows:

The structure of each total counts value is,



Using this the **Sign bit, Mantissa** and **Exponent** can be extracted from the 16 bit value.

There is an implied bit at after bit 7 of the mantissa which must be added so,

MANTISSA = MANTISSA + 0X80

The format of the Sign bit is

bit = 0 value is positive
bit = 1 value is negative

For total counts the value will always be positive.
The total counts value can now be found by,

$$\text{TOTAL COUNT VALUE} = \text{SIGN} \times (\text{MANTISSA} / 256) \times 2^{(\text{EXPONENT} - 128)}$$

These parameters will be required for Commissioning.

2.2 Housekeeping Analogue Parameter Calibrations.

2.2.1 Spacecraft 1 (Dornier Spacecraft F5) Analogue Parameter Calibrations (PEACE FM09).

PARAM-ID	CAL ID	UNIT MOD	X-VALUE	Y-VALUE
EPD_36VI	CCD_36VI	PEADPUF9	0	0
			1	0.84
			255	108.63
EPD_36VV	CCD_36VV	PEADPUF9	0	0
			255	39.4
EPD_DTMP	CCD_DTMP	PEADPUF9	0	0
			1	-138
			255	112
EPD_M8VI	CCD_M8VI	PEADPUF9	0	0
			1	-2.2
			255	-114
EPD_M8VV	CCD_M8VV	PEADPUF9	0	0
			5	-0.04
			255	-9.04
EPD_P5VI	CCD_P5VI	PEADPUF9	0	0
			1	45.93
			255	1158
EPD_P5VV	CCD_P5VV	PEADPUF9	0	0
			255	5.74
EPD_P8VI	CCD_P8VI	PEADPUF9	0	0
			1	0.44
			255	115
EPD_P8VV	CCD_P8VV	PEADPUF9	0	0
			1	0.08
			255	10.29

EPD_TELM	CCD_TELM	PEADPUF9	0	0
			255	5.19
EPH_36VV	CCH_36VV	PEAHEEF9	0	0
			145	32.46
			153	34.24
			161	36.03
			169	37.88
			177	39.59
			255	56.3
EPH_HVEN	CCH_HVEN	PEAHEEF9	0	0
			255	5.233
EPH_M8VV	CCH_M8VV	PEAHEEF9	0	0
			1	-24.26
			10	-23.12
			200	0.01
			255	6.83
EPH_MCP_	CCH_MCP	PEAHEEF9	0	0
			255	5233
EPH_P5VV	CCH_P5VV	PEAHEEF9	0	0
			109	4.46
			115	4.72
			124	5.10
			127	5.21
			134	5.49
			255	10.43

EPH_P8VV	CCH_P8VV	PEAHEEF9	0	0
			177	7.28
			184	7.56
			202	8.29
			213	8.77
			255	10.39
EPH_STIM	CCH_STIM	PEAHEEF9	0	0
			255	167.7
EPH_SWE_	CCH _|SWE_	PEAHEEF9	0	0
			255	5233
EPL_36VV	CCL_36VV	PEALEEF9	0	0
			144	32.3
			153	34.1
			160	35.9
			169	37.7
			177	39.5
			255	56.08
EPL_HVEN	CCL_HVEN	PEALEEF9	0	0
			255	5.233
EPL_M8VV	CCL_M8VV	PEALEEF9	0	0
			1	-24.26
			10	-23.12
			200	0.01
			255	6.83
EPL_MCP_	CCL_MCP	PEALEEF9	0	0
			255	5233

EPL_P5VV	CCL_P5VV	PEALEEF9	0	0
			109	4.46
			115	4.71
			121	4.97
			127	5.20
			133	5.46
			255	10.45
EPL_P8VV	CCL_P8VV	PEALEEF9	0	0
			175	7.17
			185	7.59
			194	7.96
			203	8.32
			255	10.43
EPL_STIM	CCL_STIM	PEALEEF9	0	0
			255	167.7
EPL_SWE_	CCL _|SWE_	PEALEEF9	0	0
			255	5233

2.2.2 Spacecraft 2 (Dornier Spacecraft F6) Analogue Parameter Calibrations (PEACE FM06).

PARAM-ID	CAL ID	UNIT MOD	X-VALUE	Y-VALUE
EPD_36VI	CCD_36VI	PEADPUF6	0	0
			1	4.19
			255	111
EPD_36VV	CCD_36VV	PEADPUF6	0	0
			255	39.6
EPD_DTMP	CCD_DTMP	PEADPUF6	0	0
			1	-138
			255	112
EPD_M8VI	CCD_M8VI	PEADPUF6	0	0
			1	-0.88
			255	-112
EPD_M8VV	CCD_M8VV	PEADPUF6	0	0
			6	-0.036
			255	-9.14
EPD_P5VI	CCD_P5VI	PEADPUF6	0	0
			1	2.55
			255	1119
EPD_P5VV	CCD_P5VV	PEADPUF6	0	0
			255	5.74
EPD_P8VI	CCD_P8VI	PEADPUF6	0	0
			1	1.77
			255	111
EPD_P8VV	CCD_P8VV	PEADPUF6	0	0
			1	0.08
			255	10.29
EPD_TELM	CCD_TELM	PEADPUF6	0	0
			255	5.19
EPH_36VV	CCH_36VV	PEAHEEF6	0	0
			145	32.46
			153	34.24
			161	36.03

			169	37.88
			177	39.59
			255	56.3
EPH_HVEN	CCH_HVEN	PEAHEEF6	0	0
			255	5.233
EPH_M8VV	CCH_M8VV	PEAHEEF6	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPH_MCP_	CCH_MCP	PEAHEEF6	0	0
			255	5233
EPH_P5VV	CCH_P5VV	PEAHEEF6	0	0
			109	4.46
			115	4.72
			124	5.10
			127	5.21
			134	5.49
			255	10.43
EPH_P8VV	CCH_P8VV	PEAHEEF6	0	0
			177	7.28
			184	7.56
			202	8.29
			213	8.77
			255	10.39
EPH_STIM	CCH_STIM	PEAHEEF6	0	0
			255	167.7
EPH_SWE_	CCH _|SWE_	PEAHEEF6	0	0
			255	5233
EPL_36VV	CCL_36VV	PEALEEF6	0	0
			144	32.3
			153	34.1
			160	35.9
			169	37.7
			177	39.5
			255	56.08

EPL_HVEN	CCL_HVEN	PEALEEF6	0	0
			255	5.233
EPL_M8VV	CCL_M8VV	PEALEEF6	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPL_MCP_	CCL_MCP	PEALEEF6	0	0
			255	5233
EPL_P5VV	CCL_P5VV	PEALEEF6	0	0
			109	4.46
			115	4.71
			121	4.97
			127	5.20
			133	5.46
			255	10.45
EPL_P8VV	CCL_P8VV	PEALEEF6	0	0
			175	7.17
			185	7.59
			194	7.96
			203	8.32
			255	10.43
EPL_STIM	CCL_STIM	PEALEEF6	0	0
			255	167.7
EPL_SWE_	CCL _|SWE_	PEALEEF6	0	0
			255	5233

2.2.3 Spacecraft 3 (Dornier Spacecraft F7) Analogue Parameter Calibrations (PEACE FM07).

PARAM-ID	CAL ID	UNIT MOD	X-VALUE	Y-VALUE
EPD_36VI	CCD_36VI	PEADPUF7	0	0
			3	0.42
			255	106
EPD_36VV	CCD_36VV	PEADPUF7	0	0
			255	39.6
EPD_DTMP	CCD_DTMP	PEADPUF7	0	0
			1	-138
			255	112
EPD_M8VI	CCD_M8VI	PEADPUF7	0	0
			3	-0.44
			255	-111
EPD_M8VV	CCD_M8VV	PEADPUF7	0	0
			5	-0.04
			255	-9.14
EPD_P5VI	CCD_P5VI	PEADPUF7	0	0
			1	22.9
			255	1136
EPD_P5VV	CCD_P5VV	PEADPUF7	0	0
			255	5.74
EPD_P8VI	CCD_P8VI	PEADPUF7	0	0
			3	0.44
			255	110
EPD_P8VV	CCD_P8VV	PEADPUF7	0	0
			2	0.04
			255	10.29
EPD_TELM	CCD_TELM	PEADPUF7	0	0
			255	5.19
EPH_36VV	CCH_36VV	PEAHEEF7	0	0
			145	32.46
			153	34.24
			161	36.03

			169	37.88
			177	39.59
			255	56.3
EPH_HVEN	CCH_HVEN	PEAHEEF7	0	0
			255	5.233
EPH_M8VV	CCH_M8VV	PEAHEEF7	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPH_MCP_	CCH_MCP	PEAHEEF7	0	0
			255	5233
EPH_P5VV	CCH_P5VV	PEAHEEF7	0	0
			109	4.46
			115	4.72
			124	5.1
			127	5.21
			134	5.49
			255	10.43

EPH_P8VV	CCH_P8VV	PEAHEEF7	0	0
			177	7.28
			184	7.56
			202	8.29
			213	8.77
			255	10.39
EPH_STIM	CCH_STIM	PEAHEEF7	0	0
			255	167.7
EPH_SWE_	CCH _|SWE_	PEAHEEF7	0	0
			255	5233
EPL_36VV	CCL_36VV	PEALEEF7	0	0
			144	32.3
			153	34.1
			160	35.9
			169	37.7
			177	39.5
			255	56.08
EPL_HVEN	CCL_HVEN	PEALEEF7	0	0
			255	5.233
EPL_M8VV	CCL_M8VV	PEALEEF7	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPL_MCP_	CCL_MCP	PEALEEF7	0	0
			255	5233

EPL_P5VV	CCL_P5VV	PEALEEF7	0	0
			109	4.46
			115	4.71
			121	4.97
			127	5.2
			133	5.46
			255	10.45
EPL_P8VV	CCL_P8VV	PEALEEF7	0	0
			175	7.17
			185	7.59
			194	7.96
			203	8.32
			255	10.43
EPL_STIM	CCL_STIM	PEALEEF7	0	0
			255	167.7
EPL_SWE_	CCL _|SWE_	PEALEEF7	0	0
			255	5233

2.2.4 Spacecraft 4 (Dornier Spacecraft F8) Analogue Parameter Calibrations (PEACE FM08).

PARAM-ID	CAL ID	UNIT MOD	X-VALUE	Y-VALUE
EPD_36VI	CCD_36VI	PEADPUF8	0	0
			3	0.42
			255	106
EPD_36VV	CCD_36VV	PEADPUF8	0	0
			255	39.6
EPD_DTMP	CCD_DTMP	PEADPUF8	0	0
			1	-138
			255	112
EPD_M8VI	CCD_M8VI	PEADPUF8	0	0
			3	-0.44
			255	-111
EPD_M8VV	CCD_M8VV	PEADPUF8	0	0
			5	-0.04
			255	-9.14
EPD_P5VI	CCD_P5VI	PEADPUF8	0	0
			5	4.39
			255	1104
EPD_P5VV	CCD_P5VV	PEADPUF8	0	0
			255	5.74
EPD_P8VI	CCD_P8VI	PEADPUF8	0	0
			3	0.44
			255	110
EPD_P8VV	CCD_P8VV	PEADPUF8	0	0
			2	0.04
			255	10.29

EPD_TELM	CCD_TELM	PEADPUF8	0	0
			255	5.19
EPH_36VV	CCH_36VV	PEAHEEF8	0	0
			145	32.46
			153	34.24
			161	36.03
			169	37.88
			177	39.59
			255	56.3
EPH_HVEN	CCH_HVEN	PEAHEEF8	0	0
			255	5.233
EPH_M8VV	CCH_M8VV	PEAHEEF8	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPH_MCP_	CCH_MCP	PEAHEEF8	0	0
			255	5233
EPH_P5VV	CCH_P5VV	PEAHEEF8	0	0
			109	4.46
			115	4.72
			124	5.1
			127	5.21
			134	5.49
			255	10.43

EPH_P8VV	CCH_P8VV	PEAHEEF8	0	0
			177	7.28
			184	7.56
			202	8.29
			213	8.77
			255	10.39
EPH_STIM	CCH_STIM	PEAHEEF8	0	0
			255	167.7
EPH_SWE_	CCH _|SWE_	PEAHEEF8	0	0
			255	5233
EPL_36VV	CCL_36VV	PEALEEF8	0	0
			144	32.3
			153	34.1
			160	35.9
			169	37.7
			177	39.5
			255	56.08
EPL_HVEN	CCL_HVEN	PEALEEF8	0	0
			255	5.233
EPL_M8VV	CCL_M8VV	PEALEEF8	0	0
			1	-24.26
			10	-23.12
			200	.01
			255	6.83
EPL_MCP_	CCL_MCP	PEALEEF8	0	0
			255	5233

EPL_P5VV	CCL_P5VV	PEALEEF8	0	0
			109	4.46
			115	4.71
			121	4.97
			127	5.20
			133	5.46
			255	10.45
EPL_P8VV	CCL_P8VV	PEALEEF8	0	0
			175	7.17
			185	7.59
			194	7.96
			203	8.32
			255	10.43
EPL_STIM	CCL_STIM	PEALEEF8	0	0
			255	167.7
EPL_SWE_	CCL _|SWE_	PEALEEF8	0	0
			255	5233

2.3 Monitoring of Housekeeping Parameters

The following tables contain information to be used for limit checking of the analogue HK parameters. The values shown here are derived from bench tests and will be updated after instrument commissioning.

If "soft limits"are exceeded on 3 consecutive HK telemetry frames, the requested action is "inform the PI".

If "hard limits" are exceeded on 3 consecutive HK telemetry frames, the requested action is "turn off the instrument using command sequence PDP and inform the PI".

The limit values shown here supersede values in Appendix C DPU_HK_telemetry

The possibility of using OBDH monitors to trigger instrument safing is to be considered during the Commissioning Phase.

EPD_P8VI and EPD_M8VI are as transmitted by the DPU and are therefore uncorrected

Limiting values for voltage and current consumption in the "Running HV On" mode are based on the maximum load scenario achievable on the bench, in which both MCP HV Generators are set to maximum, both Sweep HV Generators are at maximum load (preset 91, HAR sweep mode) and Internal Stims are on to generate a high counting rate. It is expected that loads in orbit will rarely reach this level.

2.3.1 Instrument/ Spacecraft Interface

2.3.1.1 28Volt Primary Current (from the spacecraft)

PEACE mode		**nominal current**	**lower limit hard**	**lower limit soft**	**higher limit soft**	**higher limit hard**
PEACE On		100mA	85	90	110	115
Executive Mode		100mA	85	90	110	115
Standby Both Pro		100mA	85	90	110	115
Ready Both (HV safe)		150mA	120	130	165	175
Running HV On (HAR)		194- 227mA	150	165	250	260

2.3.2 DPU Monitors

2.3.2.1 EPD_P5VI

PEACE mode	nominal current	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	220mA	200	210	250	260
Ready Both (HV safe)	280mA	250	260	310	320
Running HV On (HAR)	292 - 462mA	220	260	500	520

Values shown for EPD_P5VI are derived using the internal stim, actual values in flight will vary as they depend on the plasma environment (i.e. on the rate of particle counting).

2.3.2.2 EPD_M8VI

PEACE mode	nominal current	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	6mA	1	2	10	14
Ready Both (HV safe)	27mA	15	18	40	45
Running HV On (HAR)	22.46 - 28.24mA	15	18	40	45

Note; it remains tbc whether ESOC use the corrected or uncorrected value for this parameter. See the HK Telemetry Format Specification Document (Appendix C) for details of how to apply the correction.

2.3.2.3 EPD_P8VI

PEACE mode	nominal current	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	9.2mA	4	6	14	18
Ready Both (HV safe)	66mA	50	58	75	85
Running HV On (HAR)	63 - 70.44mA	50	58	75	85

2.3.2.4 EPD_36VI

PEACE mode	nominal current	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	3.8mA	0.5	1	8	15
Ready Both (HV safe)	9mA	3	5	14	18
Running HV On (HAR)	30.81 - 46.84mA	8	10	55	60

2.3.2.5 EPD_P5VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	4.8	5	5.3	5.4
Ready Both (HV safe)	4.8	5	5.3	5.4
Running HV On (HAR)	4.8	5	5.3	5.4

2.3.2.6 EPD_M8VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	-7.5	-7.6	-8.2	-8.4
Ready Both (HV safe)	-7.5	-7.6	-8.2	-8.4
Running HV On (HAR)	-7.5	-7.6	-8.2	-8.4

2.3.2.7 EPD_P8VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	-7.5	-7.6	-8.2	-8.4
Ready Both (HV safe)	-7.5	-7.6	-8.2	-8.4
Running HV On (HAR)	-7.5	-7.6	-8.2	-8.4

2.3.2.8 EPD_36VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro	32	34	38	40
Ready Both (HV safe)	32	34	38	40
Running HV On (HAR)	32	34	38	40

2.3.2.9 EPD_DTMP

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Standby Both Pro				
Ready Both (HV safe)	see EID B			
Running HV On (HAR)				

2.3.3 Sensor Monitors

Values for LEEA and HEEA are identical; only LEEA monitors are explicitly referred to here, but the same values apply to their HEEA counterparts.

2.3.3.1 EPL_HVSWP

PEACE mode	**lower limit hard**	**lower limit soft**	**higher limit soft**	**higher limit hard**
Ready Both (HV safe)	0	0	50	100
Running HV On	sweep mode dependant			4300

2.3.3.2 EPL_MCP_

PEACE mode	**lower limit hard**	**lower limit soft**	**higher limit soft**	**higher limit hard**
Ready Both (HV safe)	0	0	50	100
Running HV On	MCP level dependant			3700

2.3.3.3 EPL_HVEN

PEACE mode	**lower limit hard**	**lower limit soft**	**higher limit soft**	**higher limit hard**
>=2.5V HV enabled	4.7	4.8	5.1	5.2
2.5V<HV disabled	0	2	2.2	2.5

The table applies for any instrument state above and including Ready Both (HV Safe) e.g. see 3.5.3.
(This monitor indicates whether or not the HV disable plug is in; it should be out in orbit, i.e. high values!)

2.3.3.4 EPL_STIM

PEACE mode	**lower limit hard**	**lower limit soft**	**higher limit soft**	**higher limit hard**
Ready Both (HV safe)	n/a	n/a	n/a	n/a
Running HV On	n/a	n/a	n/a	n/a

This parameter is not used for limit checking.

2.3.3.5 EPL_P5VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Ready Both (HV safe)	4.5	4.6	5.1	5.4
Running HV On	4.5	4.6	5.1	5.4

2.3.3.6 EPL_M8VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Ready Both (HV safe)	-7.2	-7.5	-8.5	-9
Running HV On	-7.2	-7.5	-8.5	-9

2.3.3.7 EPL_P8VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Ready Both (HV safe)	7.4	7.5	8.4	8.8
Running HV On	7.4	7.5	8.4	8.8

2.3.3.8 EPL_36VV

PEACE mode	lower limit hard	lower limit soft	higher limit soft	higher limit hard
Ready Both (HV safe)	32	34	38	40
Running HV On	32	34	38	40

2.4 Science Telemetry Description

The science telemetry products are described in detail in Chapters 1 and 6 of this document. A byte by byte specification and how these products are fitted into the spacecraft telemetry scheme can be found in the document "DPU Science Telemetry Format Specification" , CL/PE-MSSL-DS-0050 which is included in Appendix D.

CLUSTER-PEACE

CL/PE-MSSL-UM-0053 V5.1

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PEACE USER MANUAL CHAPTER 3

Version 5.1
04-January-2001

Change Sheet since Cluster 1

Version 3.1

Addition of discussion of Nominal Commanding via JSOC

Addition of cross referencing to Commanding Specification Document
Addition of recommended use text for command sequences
Minor correction to bit pattern in PMACHOFF
Modification of some command sequences, see "changes" shading
    New material since Cluster I
    Altered material since Cluster I

New Command Sequences
    BLVPU
    ECLIP
    GS
    MACRO
    SMAC
    UMAC
Also
    UTDCF replaced by UDTCFH and UTDCFL

Version 3.2

Corrections to "uplink dead time correction" material for LEEA and HEEA (ZEPDHDTC, ZEPDLDTC) in Sections 3.1.1, 3.1.2.1, 3.3.11.1, 3.3.11.2

Version 3.3

    Change since ver 3.2
New Command Sequence
    SORB, see 3.2, 3.3.7.5
Also
    Diagram still to be modified to show SORB

Version 3.4

ECLIP sequence command changed to account for ‘enable watchdog’ in redundant mode as well as prime mode.

Version 4.0

Doc number (should be cl/pe-mssl-um-0053)

3.0

minor change in introductory paragraphs

3.1.1.1

correction from ZEPDLEUE to ZEPDLEVE; ZEPDHEUE to ZEPDHEVE

3.1.1.2

new section; relates command names to relevant section of PEACE DPU Commanding System Specification (Appendix A)

3.1.2.1

minor change to description for ZEPDDATP and ZEPDDATS

ZEPDHDTC	fixed bit mask and pattern changed
ZEPDLDTC	fixed bit mask changed

3.1.2.2

ZEPHHVGE	fixed bit mask and pattern and valid values changed
ZEPHSTMN	valid values changed

3.1.2.3

ZEPLHVGE	fixed bit mask and pattern and valid values changed
ZEPLSTMN	valid values changed

3.2

major revision of command sequence names as follows

Renamed

BLVPU	->	LV_BOTH
HLVPU	->	LV_HEEA
LLVPU	->	LV_LEEA
PDPF	->	PDP
SO	->	LV_OFF
SORB	->	LV_SCI_OFF

Deleted

CSM
DDCNRT
HEMO
HVT
PDPS
SS
SSHO
SSLO
SC
SCSM
SCT
SMAC

Added

HS_SAFE
HV_BOTH, HV_HEEA, HV_ LEEA
HV_MEL_BOTH
HV_MOLT_BOTH, HV_MOLT_HEEA, HV_MOLT_LEEA
HV_MNT_BOTH
INTERFACE
RUNSCI_BOTH, RUNSCI_HEEA, RUNSCI_LEEA
SAFE
SETUP_0, SETUP_1 , SETUP_2 , SETUP_3, SETUP_4
SETUP_0_HEEA, SETUP_1 _HEEA, SETUP_2 _HEEA, SETUP_3_HEEA
SETUP_0_LEEA, SETUP_1 _LEEA, SETUP_2 _LEEA, SETUP_3_LEEA
STIMTEST

3.3.1.3
name change; recommended use change

3.3.1.4
removed

3.3.2; 3.3.3.1; 3.3.3.2
Caution warning added

3.3.3.2
free bit pattern change, no of input parameters changed

3.3.4.7
total bit pattern change (typo corrected), no of input parameters changed, explanatory text change

3.3.5.1; 3.3.5.2
description change

3.3.7.1-5
all command sequences renamed

3.3.8
major changes and additions; only ECLIP unaffected; MACRO explanation improved

3.3.9
major changes and additions

3.3.10.3,4
description changed

3.3.11.1
total bit pattern changed

3.3.11.12,13
description, explanatory notes changed

3.4
additional text

3.4.1.5
free and total bit patterns

3.4.2
title

3.4.4 to 7
this text was inadvertently omitted from recent iterations of the UM, but part of the Cluster UM

3.5.1,2,3
major changes
3.5.4
deleted

Version 4.1

Removed explicit grid commands from HV_MNT_BOTH
INTERFACE now uses a Henceforth parameter
Removed datasets commands from RUNSCI_BOTH, RUNSCI_LEEA and RUNSCI_HEEA

Version 4.2

Corrected LV_OFF by taking out extra command

Version 4.3 **Applicable at beginning of Commissioning**

(tbc) in sections 3.3.9.8 and 3.3.9.9 removed
Added 10 seconds delay to 3.3.8.7 Macro.
Added 10 seconds delay to 3.3.6.1 IKAL.
Change delay in LV_OFF to 120 seconds.
Change delay in LV_SCI_OFF to 120 seconds.

Version 4.4

Made 4 different macro uplinking procedures to accommodate SETUP_0, SETUP_1, SETUP_2 and SETUP_3 commands (3.3.11.12)
Corrected EMF so that the command to turn Engineering Mode off is used.
Added 3 new procedures: VAR_STIMS_ON (3.3.10.6), STIMS_OFF (3.3.10.7), and HV_MCPLEV_2 (3.3.9.12)

Version 4.5

Corrected delay times between commands in Command Sequence Definitions and added Durations of command sequences (Section 3.3).
Added ESOC sequence numbers to List of PEACE Command Sequences (Section 3.2)

Version 4.6

Added HV_MNOI_BOTH, a new HV MCP noise test procedure.
HV_MNT_BOTH (3.3.9.3) and HV_MEL_BOTH (3.3.9.7) are retained but their descriptions and recommended use have been changed.
Section 3.2 updated accordingly.

Version 4.7

Added SPA_SWITCH (3.3.10.8) and TDA (3.3.10.9), section 3.2 updated accordingly.
Corrected parameters for constant stim in sections 3.3.10.5 and 3.3.10.6, section 3.2 updated accordingly.
HV_MOLT_BOTH (3.3.9.4), HV_MOLT_HEEA (3.3.9.5), HV_MOLT_LEEA (3.3.9.6) revised.
Added HV_MLEV_HEEA (3.3.9.13) and HV_MLEV_LEEA (3.3.9.14), and moved HV_MNOI_BOTH to 3.3.9.15. Section 3.2 updated accordingly.
First diagram in 3.5.3 updated: changes are to (i) MCP NOISE and (ii) power down route from Running HV On. To view this in Word you may need to use View > Page Layout.

Version 4.8

Added note in SETUP_4 (3.3.8.6)

Version 4.9

Renamed MCPTS (3.3.10.3) to HV_MCPTS (3.3.9.16), section 3.2 updated accordingly..
Renamed HV_MCPLEV_2 to MCPLEV_2_SAFE since HVs are off (3.3.9.12) and added warning about the HVs. Note this is fixed for level 2 (i.e.no input parameters). Updated section 3.2 accordingly.
Changed the recommended time delays for, and added warnings regarding use of, HV_MLEV_HEEA (3.3.9.13) and HV_MLEV_LEEA (3.3.9.14).

Version 5.0

3.3.9.1 information regarding HV procedures added
3.3.9.4 changes as discussed with James Godfrey to make the procedure flexible enough to accommodate differences of MCP operational levels between sensors, and due to changes with time for each sensor individually.
3.3.9.17,18,19,20 added

wait times in 3.3.9.3 HV_MNT_BOTH altered, durations the same

Version 5.1

Following addition of new sequences 3.3.9.17-20, removed HV_MOLT_BOTH (3.3.9.4), HV_MOLT_HEEA (3.3.9.5), HV_MOLT_LEEA (3.3.9.6) – section numbers not reallocated to avoid confusion.
Section 3.2 updated with sequences 3.3.9.17-20.
Changed input parameter description in sections 3.3.9.17-20 from 6 to 4 parameters.
Changed spacecraft potential algorithm parameter in sections 3.3.9.17-20 from 0 to 4.
Corrected two parameters: section 3.3.9.17 mid-level LEEA for spacecraft 1 (changed from 15 to 16), and section 3.3.9.19 high-level LEEA for spacecraft 3 (changed from 18 to 19).

3. CONTROL

3.0 Introduction: Control

This chapter deals explicitly with the telecommanding and control of the PEACE instrument. It contains details of the telecommand database, the command sequences that group together telecommands and macro telecommands stored within the spacecraft OBDH.

This chapter also gives details of the PEACE "modes" as defined for JSOC, and transitions between them using IBMD's (Instrument Baseline Mode Definitions). The IBMDs are constructed from the command sequences given here. IBMDs etc are defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Details of the parameters which distinguish different nominal operations science modes are given in Chapter 6.

Details of commanding during commissioning are given in Chapter 5.

Details of commanding for contingency operations are given in Chapter 8.

Many of the commands have user definable parameters. With the exception of details of science modes that are given in Chapter 6, these are not explicitly defined and are represented by **u**'s in the bit patterns (or sometimes "0"s – the document is not fully consistent in this respect).

3.1 List of All Commands in the Telecommand Data Base

3.1.1 Commands in Relation to “DPU Commanding System Specification” Document

The commands in the telecommand database are derived from the document “DPU Commanding Specification” CL/PE-MSSL-DS-0051, or DCSS, which is included in Appendix A. Here we show the relation between telecommand names of the form ZEPxxxxx and the various commanding options as laid out in Section 7 of that document.

3.1.1.1 Document to Commands Referencing

“7.1” Low Level Commands

These are generally hardware control functions related to configuring the DPU system and are expected to be performed only at hardware turn on.

“7.1.1”	Unique command (8 functions)	**ZEPDLOWL**

“7.2” High Level Power-Up Commands

In normal operations the only relevant command is that which launches the executive program. Commands also allow different system boot options and modifications to EEPROM memory areas. Not echoed in h/k telemetry. In normal operations, only the “execute executive” command is expected to be used.

“7.2.1”	Load Peek/Poke Address LS Byte Command	**ZEPDPLSB**
“7.2.2”	Load Peek/Poke Address MS Byte Command	**ZEPDPMSB**
“7.2.3”	Poke Data Byte Command	**ZEPDPDAT****
“7.2.4”	Peek Byte Command	**ZEPDPEEK**
“7.2.5”	Execute Executive Command	**ZEPDBOOS**

“7.3” Executive Level Commands

Executive Commands are used before main applications programs are run. In normal operations, only the “run application” command is expected to be used.

“7.3.1”	Perform Memory Dump	**ZEPDEMEM**
“7.3.2”	Run Application Command	**ZEPDEAPP**

"7.3.3"	Update Directory Command	
	(control word)	**ZEPDEDR1**
	(argument word)	**ZEPDEDR2**

"7.3.4"	Uplink Software Command	
	(control word)	**ZEPDUPSO****
	(argument word(s))	**ZEPDUPAR****

Note - commands marked '**' are used in high priority software patching. They will not be incorporated in conventional command sequences. Instead, they will be used in IPCH files, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

"7.4" High Level Engineering Commands

Commands decoded (used) by the main DPU application program. Are echoed in h/k telemetry. May be one or two word commands. Can be sent either at initialisation or run-time phases.

"7.4.1"	Sun-Pulse Re-phase	
	(control word)	**ZEPDSN1S**
	(argument word(s))	**ZEPDSN2S**
	(see WARNINGS in DPU Commanding System Specification Document)	

"7.4.2"	Sensor Power & Service Signal Control	
	(LEEA control word)	**ZEPDLPCN**
	(HEEA control word)	**ZEPDHPCN**
	(see WARNINGS in DPU Commanding System Specification Document)	

"7.4.3"	Change Monitor Control Parameters	
	(alters limits used by onboard safety h/k monitoring)	
	(control word)	**ZEPDHC1S**
	(argument word)	**ZEPDHC2S**

"7.4.4"	DPU Hardware Control	**ZEPDHWCE**
	(controls Inter-Experiment Links, Watchdog, and spacecraft telemetry interface)	

"7.4.5"	Engineering Mode Select	**ZEPDENGS**
	(allows selection of a particular h/k channel for engineering mode output)	

"7.4.6"	Security Confirmer Command	**ZEPDCONF**

(use with 36V switch-on, 7.4.2, and for commanding MCP levels above 24, see WARNINGS in DPU Commanding System Specification Document)

"7.5" High Level Science Commands

Single and multi-word commands, acted on by DPU main processing applications program. Echoed in h/k.

"7.5.1" SMU Commands for LEEA and HEEA

(Single word commands which can be sent to either LEEA or HEEA. The exception are commands relating to the correlator, which have no relevance for LEEA. See IMPORTANT NOTES in DPU Commanding System Specification Document concerning sweep and MCP commanding)

NOTE: These commands must be issued only with a clear understanding of their consequences for the Science Processing activities in the DPU. The default values for the SMU card, given implicitly in 7.5.1, do not apply at the DPU level.

Grid voltage, coincidence channel	**ZEPLCISG**	**ZEPHCISG**
(Coincidencing commands have no purpose in Cluster II PEACE instrument)		
Correlator Commands (unique to HEEA)		
(disable correlator)		**ZEPHCRDI**
(enable correlator)		**ZEPHCRE0**
(enable correlator and select channel)		**ZEPHCRES**
High Voltages (Sweep and MCP)		
(disable Sweep and MCP HVs)	**ZEPLHVGD**	**ZEPHHVGD**
(enable Sweep and MCP HVs)	**ZEPLHVGE**	**ZEPHHVGE**
High Voltages (MCP commands only)		
(enable MCP HVs)	**ZEPLMCPE**	**ZEPHMCPE**
(select MCP HV level)	**ZEPLMCPS**	**ZEPHMCPS**
High Voltages (Sweep only)		
(select HV sweep mode only)	**ZEPLSMSO**	**ZEPHSMSO**
(two words, SMPS and SPSS, to select HV sweep	**ZEPLSMPS**	**ZEPHSMPS**
mode, and preset)	**ZEPLSPSS**	**ZEPHSPSS**
(enable Sweep HV only)	**ZEPLSWEE**	**ZEPHSWEE**
Stims		
(disable stims i.e. stimsoff)	**ZEPLSTMF**	**ZEPHSTMF**
(enable stims i.e. stims on; operational control)	**ZEPLSTMN**	**ZEPHSTMN**

"7.5.2" Initialise Keep Alive Memory **ZEPDKALE**

(Initialises keep-alive RAM memory with default values. To be sent after first turn-on, or to overwrite previously uplinked values with default values. If default values – stored in ROM - of dead-time factors, energy step values, software versions, calibration index etc. are not valid, there will need to be uplinking of the correct parameters.)

"7.5.3" Correlator Control **ZEPDHIPS**

(Selection of polar zone(s) connected to correlator)

"7.5.4" Select Datasets to be Telemetered

(command and parameter words; include/remove data product from transmission list, alter priority of data product within list; many options!) **ZEPDDATS** **ZEPDDATP**

"7.5.5" Select Source of Magnetic Field **ZEPDMAGS**

(select source of magnetic field direction estimate; PEACE or FGM; affects PAD data and possibly the correlator zone)

"7.5.6" Spacecraft Potential Calculation Control **ZEPDSPOT**

(use data from LEEA or HEEA or produce test pattern/constant or turn off – see NOTES in DPU Commanding System Specification Document)

"7.5.7" OBDH Telemetry Mode **ZEPDTELS**

(NOT issued by PEACE users – comes from s/c OBDH – s/c tells PEACE the TM mode. The command does not affect the operation of PEACE, but the TM mode information is down linked in the PEACE science telemetry)

"7.5.8" Start Processing **ZEPDPRCN**

(takes DPU from initialisation state to science processing state; either using LEEA, HEEA or data from both sensors; also resets science processing e.g. if alteration of science setup needed)

"7.5.9" Sensors Closedown

(controlled close-down and power down of both sensors with optional DPU reset; see NOTES in DPU Commanding System Specification Document) **ZEPDSPWF** **ZEPDRSET**

"7.5.10" Uplink Dead-Time Correction Factor

(LEEA control word)	**ZEPDLDTC**
(HEEA control word)	**ZEPDHDTC**
(parameter word)	**ZEPDDTCF**

"7.5.11" Uplink Parameter

(LEEA control word)	**ZEPDLPUE**
(HEEA control word)	**ZEPDHPUE**
(parameter word)	**ZEPDPUPS**

(controls inputs to s/c potential estimate routine; FGM/PEACE angular offset; calibration ID; optional "constant" s/c potential value; 3DX setup parameters and window limits; SP and IP KAL checksums; command block checksums)

"7.5.12" Uplink Reduced Polar Geometric Factor

(LEEA control word)	**ZEPDLGUE**
(HEEA control word)	**ZEPDHGUE**
(first parameter word)	**ZEPDG0PS**
(second parameter word)	**ZEPDG1PS**

"7.5.13" Uplink Basic Energy Step Table Value

(LEEA control word)	**ZEPDLEVE**
(HEEA control word)	**ZEPDHEVE**
(first parameter word)	**ZEPDE0PS**
(second parameter word)	**ZEPDE1PS**

"7.5.14" Uplink Energy Efficiency Factor

(LEEA control word)	**ZEPDLFVE**
(HEEA control word)	**ZEPDHFVE**
(first parameter word)	**ZEPDF0PS**
(second parameter word)	**ZEPDF1PS**

"7.5.15" Uplink FGM Calibration Value

(first parameter word)	**ZEPDFGM1**
(second parameter word)	**ZEPDFGM2**
(third parameter word)	**ZEPDFGM3**

"7.5.16" Uplink or Launch PEACE Macro

(control word)	**ZEPDMAC1**
(multiple parameter words)	**ZEPDMAC2**

(for launch of macro use control word only with "update" set to zero)

3.1.1.2 Command to Document Referencing

COMMANDS ACTING ON THE DPU

Command	Description	Section of DCSS
ZEPDUPSO**	UPLINK S/W	7.3.4
ZEPDUPAR**	UPLINK ARG	7.3.4
ZEPDBOOS	DPU BOOT OPTIONS	7.2.5
ZEPDCONF	CONFIRMER COMMAND	7.4.6
ZEPDDATP	DATASET SELECT PARAMETER	7.5.4
ZEPDDATS	DATASET SELECT CONTROL	7.5.4
ZEPDDTCF	DTC FACTOR PARAM	7.5.10
ZEPDE0PS	ENGSTEP 0 UPLINK	7.5.13
ZEPDE1PS	ENGSTEP 1 UPLINK	7.5.13
ZEPDEAPP	STARTS MAIN CODE	7.3.2
ZEPDEDR1	UPDATE DIRECTORY	7.3.3
ZEPDEDR2	DIRECTORY PARAMETER	7.3.3
ZEPDEMEM	START MEMORY DUMP	7.3.1
ZEPDENGS	ENGING MODE SELECT	7.4.5
ZEPDF0PS	EFFICIENCY 0 UPL	7.5.14
ZEPDF1PS	EFFICIENCY 1 UPL	7.5.14
ZEPDFGM1	FGM CAL FACTOR 1	7.5.15
ZEPDFGM2	FGM CAL FACTOR 2	7.5.15
ZEPDFGM3	FGM CAL FACTOR 3	7.5.15
ZEPDG0PS	GEOM 0 UPLINK	7.5.12
ZEPDGIPS	GEOM 1 UPLINK	7.5.12
ZEPDHC1S	MONIT CTRL PARA 1	7.4.3
ZEPDHC2S	MONIT CTRL PARA 2	7.4.3
ZEPDHDTC	HEEA DTC FACTOR CTRL	7.5.10
ZEPDHEVE	CTRL HEEA ENG UP	7.5.13
ZEPDHFVE	CTRL HEEA EFF UP	7.5.14
ZEPDHGUE	CTRL HEEA GEOM UP	7.5.12
ZEPDHIPS	CORRELATOR SELECTION	7.5.3
ZEPDHPCN	HEEA POWER CTRL	7.4.2
ZEPDHPUE	CTRL HEEA PARAM UPLINK	7.5.11
ZEPDHWCE	DPU HARDW CTRL	7.4.4
ZEPDKALE	INITIALISE KAL	7.5.2
ZEPDLDTC	LEEA DTC FACTOR CTRL	7.5.10

ZEPDLEVE	CTRL LEEA ENG UP	7.5.13
ZEPDLFVE	CTRL LEEA EFF UP	7.5.14
ZEPDLGUE	CTRL LEEA GEOM UP	7.5.12
ZEPDLOWL	LOW LEVEL COMMAND	7.1.1
ZEPDLPCN	LEEA POWER CONTR	7.4.2
ZEPDLPUE	CTRL LEEA PARAM UPLINK	7.5.11
ZEPDMAC1	MACRO CONTROL	7.5.16
ZEPDMAC2	MACRO DATA	7.5.16
ZEPDMAGS	MAGFIELD SELECTION	7.5.5
ZEPDPDAT	DATA TO POKE ESQ	7.2.3
ZEPDPEEK	PEEK DATA BYTE	7.2.4
ZEPDPLSB	LSB ADDR FOR ESQ	7.2.1
ZEPDPMSB	MSB ADDR FOR ESQ	7.2.2
ZEPDPRCN	START PROCESSING	7.5.8
ZEPDPUPS	PARAMETER UPLINK	7.5.11
ZEPDRSET	RESET INSTRUMENT	7.5.9
ZEPDSN1S	SUN PULSE REPH 1	7.4.1
ZEPDSN2S	SUN PULSE REPH 2	7.4.1
ZEPDSPOT	SCRAFT POT CONTROL	7.5.6
ZEPDSPWF	SENSOR POWER OFF	7.5.9
ZEPDTELS	TELEM MODE SELEC	7.5.7

COMMANDS ACTING ON THE SMU OF THE HEEA SENSOR

All these commands are related to section 7.5.1 of the DCSS

Command	**Description**
ZEPHCISG	EN COIN+SEL+GRID
ZEPHCRDI	DISABLE CORR
ZEPHCRE0	ENABL CORR
ZEPHCRES	ENABL CORR+SELEC
ZEPHHVGD	DISABLE HEEA HVG
ZEPHHVGE	ENABLE HEEA HVGS
ZEPHMCPE	ENABLE HEEA MCPHVG
ZEPHMCPS	SELECT HEEA MCPHVG
ZEPHSMPS	HEEA SWP MODE + PS
ZEPHSMSO	HEEA SWP MODE
ZEPHSPSS	HEEA SWEEP PRESET

ZEPHSTMF	HEEA STIM OFF
ZEPHSTMN	HEEA STIM ON
ZEPHSWEE	ENABL HEEA SWEHVG

COMMANDS ACTING ON THE SMU OF THE LEEA SENSOR

All these commands are related to section 7.5.1 of the DCSS

Command	**Description**
ZEPLCISG	EN COIN+SEL+GRID
ZEPLHVGD	DISABLE LEEA HVGS
ZEPLHVGE	ENABLE LEEA HVGS
ZEPLMCPE	ENABLE LEEA MCPHVG
ZEPLMCPS	SELECT LEEA MCPHVG
ZEPLSMPS	LEEA SWP MODE + PS
ZEPLSMSO	LEEA SWP MODE
ZEPLSPSS	LEEA SWEEP PRESET
ZEPLSTMF	LEEA STIM OFF
ZEPLSTMN	LEEA STIM ON
ZEPLSWEE	ENABLE LEEA SWEHVG

3.1.2 Commands with Bit Pattern Information

The commands in the telecommand database are derived from the document "DPU Commanding Specification" CL/PE-MSSL-DS-0051, which is included in Appendix A. Commands are listed in alphabetical order. Refer to 3.1.1 for a guide to which commands are used in combination.

The commands can be divided into three groups. Commands in the first group act on the instrument data processing unit (DPU). Commands in the second group act on the sensor management unit (SMU) of the HEEA sensor. Commands in the third group act on the sensor management unit (SMU) of the LEEA sensor. The HEEA SMU has the same functionality as the LEEA SMU, except for the additional role of controlling the selection of the HEEA anode for provision of signals to the Correlator subsystem in the DWP experiment.

0xnnnn numbers are in Hex format.

*Note - commands marked '**' are used in high software patching and will be included only in IPCH files (see JSOC/PI Interface Control Document) not command sequences.*

3.1.2.1 Commands Acting on the DPU

Command name	Description	Fixed bit mask	Fixed bit pattern	Valid user defined values (in decimal)
ZEPDUPSO**	UPLINK S/W	0xFFFC	0x5F00	0,1,2
ZEPDUPAR**	UPLINK ARG	0x0000	0x0000	any
ZEPDBOOS	DPU BOOT OPTIONS	0xFF00	0x4D00	0,1
ZEPDCONF	CONFIRMER COMMAND	0xFFFF	0x4F55	none
ZEPDDATP	DATASET SELECT PARAMETER	0x0000	0x0000	any
ZEPDDATS	DATASET SELECT CONTROL	0xFF00	0x4300	any
ZEPDDTCF	DTC FACTOR PARAM	0x0000	0x0000	any
ZEPDE0PS	ENGSTEP 0 UPLINK	0x0000	0x0000	any
ZEPDE1PS	ENGSTEP 1 UPLINK	0x0000	0x0000	any
ZEPDEAPP	STARTS MAIN CODE	0xFF00	0x5200	any
ZEPDEDR1	UPDATE DIRECTORY	0xFF00	0x5300	any
ZEPDEDR2	DIRECTORY PARAMETER	0x0000	0x0000	any
ZEPDEMEM	START MEMORY DUMP	0xFF00	0x5100	0,1,2
ZEPDENGS	ENGING MODE SELECT	0xFF00	0x4E00	0 to 63
ZEPDF0PS	EFFICIENCY 0 UPL	0x0000	0x0000	any
ZEPDF1PS	EFFICIENCY 1 UPL	0x0000	0x0000	any
ZEPDFGM1	FGM CAL FACTOR 1	0xFFC0	0x5B00	any
ZEPDFGM2	FGM CAL FACTOR 2	0x0000	0x0000	any
ZEPDFGM3	FGM CAL FACTOR 3	0x0000	0x0000	any
ZEPDG0PS	GEOM 0 UPLINK	0x0000	0x0000	any
ZEPDGIPS	GEOM 1 UPLINK	0x0000	0x0000	any
ZEPDHC1S	MONIT CTRL PARA 1	0xFF00	0x5400	any

ZEPDHC2S	MONIT CTRL PARA 2	0x0000	0x0000	any
ZEPDHDTC	HEEA DTC FACTOR CTRL	0xFFE0	0x5700	16 to 27
ZEPDHEVE	CTRL HEEA ENG UP	0xFF80	0x7900	0 to 92
ZEPDHFVE	CTRL HEEA EFF UP	0xFF80	0x7A00	0 to 92
ZEPDHGUE	CTRL HEEA GEOM UP	0xFFF8	0x7800	0 to 5
ZEPDHIPS	CORRELATOR SELECTION	0xFFF0	0x4200	0 to 15
ZEPDHPCN	HEEA POWER CTRL	0xFFF8	0x6B00	any
ZEPDHPUE	CTRL HEEA PARAM UPLINK	0xFFF0	0x7600	any
ZEPDHWCE	DPU HARDW CTRL	0xFF00	0x4C00	any
ZEPDKALE	INITIALISE KAL	0xFFFF	0x4000	none
ZEPDLDTC	LEEA DTC FACTOR CTRL	0xFFF0	0x5700	0 to 11
ZEPDLEVE	CTRL LEEA ENG UP	0xFF80	0x5900	0 to 92
ZEPDLFVE	CTRL LEEA EFF UP	0xFF80	0x5A00	0 to 92
ZEPDLGUE	CTRL LEEA GEOM UP	0xFFF8	0x5800	0 to 5
ZEPDLOWL	LOW LEVEL COMMAND	0xFF00	0x8000	any
ZEPDLPCN	LEEA POWER CONTR	0xFFF8	0x4B00	any
ZEPDLPUE	CTRL LEEA PARAM UPLINK	0xFFF0	0x5600	any
ZEPDMAC1	MACRO CONTROL	0xFF00	0x5E00	any
ZEPDMAC2	MACRO DATA	0x0000	0x0000	any
ZEPDMAGS	MAGFIELD SELECTION	0xFFF8	0x4400	0 to 6
ZEPDPDAT	DATA TO POKE ESQ	0xFF00	0x4100	any
ZEPDPEEK	PEEK DATA BYTE	0xFFFF	0x5000	none
ZEPDPLSB	LSB ADDR FOR ESQ	0xFF00	0x4900	any
ZEPDPMSB	MSB ADDR FOR ESQ	0xFF00	0x4A00	any
ZEPDPRCN	START PROCESSING	0xFF00	0x4700	0,1,2,255
ZEPDPUPS	PARAMETER UPLINK	0x0000	0x0000	any
ZEPDRSET	RESET INSTRUMENT	0xFFFF	0x48A5	none
ZEPDSN1S	SUN PULSE REPH 1	0xFFFF	0x5500	none
ZEPDSN2S	SUN PULSE REPH 2	0x0000	0x0000	any
ZEPDSPOT	SCRAFT POT CONTROL	0xFFF8	0x4500	0,1,2,3,4
ZEPDSPWF	SENSOR POWER OFF	0xFFFF	0x4800	none
ZEPDTELS	TELEM MODE SELEC	0xFFF0	0x4600	0 to 7

3.1.2.2 Commands Acting on the SMU of the HEEA Sensor

Command name	Description	Fixed bit mask	Fixed bit pattern	Valid user defined values (in decimal)
ZEPHCISG	EN COIN+SEL+GRID	0xFFE0	0x2000	any
ZEPHCRDI	DISABLE CORR	0xFFFF	0x202F	none
ZEPHCRE0	ENABL CORR	0xFFFF	0x2020	none
ZEPHCRES	ENABL CORR+SELEC	0xFFF0	0x2020	any
ZEPHHVGD	DISABLE HEEA HVG	0xFFFF	0x20C0	none
ZEPHHVGE	ENABLE HEEA HVGS	0xFFFF	0x20C3	none
ZEPHMCPE	ENABLE HEEA MCPHVG	0xFFFF	0x20C1	none
ZEPHMCPS	SELECT HEEA MCPHVG	0xFFE0	0x2040	any
ZEPHSMPS	HEEA SWP MODE + PS	0xFFF0	0x2060	any
ZEPHSMSO	HEEA SWP MODE	0xFFF3	0x2060	any
ZEPHSPSS	HEEA SWEEP PRESET	0xFFE0	0x2080	0 to 23
ZEPHSTMF	HEEA STIM OFF	0xFFFF	0x20E0	none
ZEPHSTMN	HEEA STIM ON	0xFFFD	0x20E1	0 or 2 only
ZEPHSWEE	ENABL HEEA SWEHVG	0xFFFF	0x20C2	none

3.1.2.3 Commands Acting on the SMU of the LEEA Sensor

Command name	Description	Fixed bit mask	Fixed bit pattern	Valid user defined values (in decimal)
ZEPLCISG	EN COIN+SEL+GRID	0xFFE0	0x0000	any
ZEPLHVGD	DISABLE LEEA HVGS	0xFFFF	0x00C0	none
ZEPLHVGE	ENABLE LEEA HVGS	0xFFFF	0x00C3	none
ZEPLMCPE	ENABLE LEEA MCPHVG	0xFFFF	0x00C1	none
ZEPLMCPS	SELECT LEEA MCPHVG	0xFFE0	0x0040	any
ZEPLSMPS	LEEA SWP MODE + PS	0xFFF0	0x0060	any
ZEPLSMSO	LEEA SWP MODE	0xFFF3	0x0060	any
ZEPLSPSS	LEEA SWEEP PRESET	0xFFE0	0x0080	0 to 23
ZEPLSTMF	LEEA STIM OFF	0xFFFF	0x00E0	none
ZEPLSTMN	LEEA STIM ON	0xFFFD	0x00E1	0 or 2 only
ZEPLSWEE	ENABLE LEEA SWEHVG	0xFFFF	0x00C2	none

3.2 List of PEACE Command Sequences

The number in the left hand column is the number of the ESOC sequence name.

57	DPS	3.3.10.2	Data Product Selection (i.e. DPU Data Control Run Time)
45	ECLIP	3.3.8.19	Set up Eclipse Mode
09	EE	3.3.3.3	Execute Executive
20	EMF	3.3.5.4	Engineering Mode ofF
19	EMO	3.3.5.3	Engineering Mode On
59	GS	3.3.10.4	Grid Switches; both sensors
56	HS	3.3.10.1	Halt Science processing
53	HS_SAFE	3.3.9.9	Halt Science processing, SAFE the High Voltages
46	HV_BOTH	3.3.9.2	High Voltage enable; BOTH sensors
54	HV_HEEA	3.3.9.10	High Voltage enable; HEEA sensor
55	HV_LEEA	3.3.9.11	High Voltage enable; LEEA sensor
80	MCPLEV_2_SAFE	3.3.9.12	Set MCPs to level 2 with HVs off
58	HV_MCPTS	3.3.9.16	MCP Test Sequence
51	HV_MEL_BOTH	3.3.9.7	High Voltage MCP Enable at Op. Level; BOTH sensors
	HV_MLEV_HEEA	3.3.9.13	Set HEEA MCP to level 2
	HV_MLEV_LEEA	3.3.9.14	Set LEEA MCP to level 2
82	HV_MNOI_BOTH	3.3.9.15	High Voltage MCP Noise Test; BOTH sensors
47	HV_MNT_BOTH	3.3.9.3	High Voltage Sweep Disable; BOTH sensors
48	HV_MOLT_BOTH	3.3.9.4	*removed*
49	HV_MOLT_HEEA	3.3.9.5	*removed*
50	HV_MOLT_LEEA	3.3.9.6	*removed*
	HV_MOLT_BOTH_SC_1	3.3.9.17	MCP operational level test, both sensors, spacecraft 1
	HV_MOLT_BOTH_SC_2	3.3.9.18	MCP operational level test, both sensors, spacecraft 2
	HV_MOLT_BOTH_SC_3	3.3.9.19	MCP operational level test, both sensors, spacecraft 3
	HV_MOLT_BOTH_SC_4	3.3.9.20	MCP operational level test, both sensors, spacecraft 4
21	IKAL	3.3.6.1	Initialise Keep Alive memory
27	INTERFACE	3.3.8.1	Spacecraft INTERFACE and watchdog
22	LV_BOTH	3.3.7.1	HEEA and LEEA sensor Low Voltage Power Up
23	LV_HEEA	3.3.7.2	HEEA sensor Low Voltage Power Up
24	LV_LEEA	3.3.7.3	LEEA sensor Low Voltage Power Up
25	LV_OFF	3.3.7.4	Low Voltage sensor power OFF
26	LV_SCI_OFF	3.3.7.5	Low Voltage sensor power and SCIence Processing OFF
33	MACRO	3.3.8.7	send (PEACE internal) Macro

18	MF	3.3.5.2	Monitor ofF
17	MO	3.3.5.1	Monitor On
03	PDP	3.3.1.3	Power Down PEACE Fast
07	PEEK	3.3.3.1	PEEK a data byte
10	PMDR	3.3.4.1	Perform Memory Dump (Ram page)
11	PMD1	3.3.4.2	Perform Memory Dump (EEPROM page 1)
12	PMD2	3.3.4.3	Perform Memory Dump (EEPROM page 2)
01	PO	3.3.1.1	28V Power On
02	POF	3.3.1.2	28V Power OFf
08	POKE	3.3.3.2	POKE a data byte
13	RA1	3.3.4.4	Run Application (Single processor)
14	RA2	3.3.4.5	Run Application (Two processor)
34	RUNSCI_BOTH	3.3.8.8	Run SCIence processing (BOTH sensors)
35	RUNSCI_HEEA	3.3.8.9	Run SCIence processing (HEEA sensors)
36	RUNSCI_LEEA	3.3.8.10	Run SCIence processing (LEEA sensors)
52	SAFE	3.3.9.8	SAFE the High Voltages
28	SETUP_0	3.3.8.2	SETUP sensors and science configuration; cseq 0
29	SETUP_1	3.3.8.3	SETUP sensors and science configuration; cseq 1
30	SETUP_2	3.3.8.4	SETUP sensors and science configuration; cseq 2
31	SETUP_3	3.3.8.5	SETUP sensors and science configuration; cseq 3
32	SETUP_4	3.3.8.6	SETUP sensors and science configuration via Macro
37	SETUP_0 _HEEA	3.3.8.11	Single sensor ops SETUP; cseq 0 for HEEA
38	SETUP_1_HEEA	3.3.8.12	Single sensor ops SETUP; cseq 1 for HEEA
39	SETUP_2 _HEEA	3.3.8.13	Single sensor ops SETUP; cseq 2 for HEEA
40	SETUP_3 _HEEA	3.3.8.14	Single sensor ops SETUP; cseq 3 for HEEA
41	SETUP_0 _LEEA	3.3.8.15	Single sensor ops SETUP; cseq 0 for LEEA
42	SETUP_1_LEEA	3.3.8.16	Single sensor ops SETUP; cseq 1 for LEEA
43	SETUP_2 _LEEA	3.3.8.17	Single sensor ops SETUP; cseq 2 for LEEA
44	SETUP_3 _LEEA	3.3.8.18	Single sensor ops SETUP; cseq 3 for LEEA
04	SPI	3.3.2.1	Swap Processor Identity
05	SPIP	3.3.2.2	Single Processor IP
06	SPSP	3.3.2.3	Single Processor SP
79	STIMS_OFF	3.3.10.7	Stimuli Off
60	STIMTEST	3.3.10.5	Stim Test
89	TDA	3.3.10.9	Telemetry mode flag
15	UD	3.3.4.6	Update Directory

61	UDTCFH	3.3.11.1	Uplink Dead Time Correction Factors for HEEA
62	UDTCFL	3.3.11.2	Uplink Dead Time Correction Factors for LEEA
67	UEEH	3.3.11.7	Uplink Energy Efficiencies for HEEA
68	UEEL	3.3.11.8	Uplink Energy Efficiencies for LEEA
70	UESH	3.3.11.10	Uplink Energy Steps for HEEA
71	UESL	3.3.11.11	Uplink Energy Steps for HEEA
69	UM	3.3.11.9	Uplink Magnetometer calibration information
74	UMAC_0	3.3.11.12.1	Uplink Macro of 4 commands
75	UMAC_1	3.3.11.12.2	Uplink Macro of 5 commands
76	UMAC_2	3.3.11.12.3	Uplink Macro of 9 commands
77	UMAC_3	3.3.11.12.4	Uplink Macro of 13 commands
65	UPGH	3.3.11.5	Uplink Geometric factors for HEEA
66	UPGL	3.3.11.6	Uplink Geometric factors for LEEA
63	UPH	3.3.11.3	Uplink Parameters for HEEA
64	UPL	3.3.11.4	Uplink Parameters for LEEA
16	US	3.3.4.7	Uplink Software
73	USO	3.3.11.13	Uplink Sunpulse Offset
78	VAR_STIMS_ON	3.3.10.6	Variable Stimuli On

3.3 Command Sequence Definitions

All command sequences used for nominal operations and for commissioning are defined in this section.

Commissioning , which is discussed in Chapter 5, uses a combination of command sequences and individual commands. (tbc)

Nominal Operations, which are discussed in Chapter 6, uses only command sequences. The order of sequences required to obtain a particular instrument mode is defined in Chapter 6.

3.3.1 28 Volt Power Control Command Sequences

3.3.1.1 PO 28V Power On

NOTE: This command sequence requires inclusion of spacecraft commands.

Description

Switch on PEACE 28V power supply.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
"Spacecraft macro to turn *on* 28 V supply to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x0081	0x8081	
delay 1 second			
ZEPDLOWL	0x0001	0x8001	
delay 20 seconds			

Duration

26 seconds

3.3.1.2 POF 28V Power OFf

NOTE: This command sequence requires spacecraft commands, but no PEACE ZEP***** commands.

Description

Switch off PEACE 28V supply.

Number of input parameters

None

Command Sequence

"Spacecraft macro to turn *off* 28 V supply to PEACE DPU"

delay 25 seconds

Duration

25 seconds

3.3.1.3 PDP Power Down PEACE

NOTE: This command sequence requires inclusion of spacecraft commands.

Description

Powers Down PEACE as soon as possible in a controlled manner.

Recommended Use

Normal shutdown from " RUNNING HV ON". Shutdown from all modes above Executive Mode (see 3.5.3)

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGD	*No parameter*	0x20C0	

delay 1 second

ZEPLHVGD	*No parameter*	0x00C0	

delay 120 seconds (allows MCP power capacitors to decay)

ZEPDRSET	*No parameter*	0x48A5	

delay 120 seconds (allows sensor power capacitor discharge)

"Spacecraft macro to turn *off* 28 V supply to PEACE DPU"

delay 25 seconds

Duration

266 seconds = 4 minutes 26 seconds

3.3.2 Low Level Command Sequences

Low Level Commands can be executed IMMEDIATELY after 28V power on. Use with caution - experts only. Low Level Commands will be disabled after a delay of 250ms, following execution of command sequence EE.

3.3.2.1 SPI Swap Processor Identity

Description

Swap control of the telemetry bus from the IP processor to the SP processor.
Swap control of the sensor interface from the SP processor to the IP processor.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLOWL	0x00E1	0x80E1	
delay 1 second			
ZEPDLOWL	0x0061	0x8061	
delay 10 seconds			

Duration

11 seconds

3.3.2.2 SPIP Single Processor IP

Description

Swap control of the sensor interface from the SP processor to the IP processor.
Confirm control of the telemetry bus with the IP processor.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLOWL	0x00C1	0x80C1	
delay 1 second			
ZEPDLOWL	0x0041	0x8041	
delay 10 seconds			

Duration

11 seconds

3.3.2.3 SPSP Single Processor SP

Description

Swap control of the telemetry bus from the IP processor to the SP processor.
Confirm control of the sensor interface with the SP processor.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLOWL	0x00A1	0x80A1	
delay 1 second			
ZEPDLOWL	0x0021	0x8021	
delay 10 seconds			

Duration

11 seconds

3.3.3 High Level Boot Up Commands

High Level Power up Commands will not be echoed in the housekeeping.

3.3.3.1 PEEK PEEK a data byte

Description

This command will peek a byte from the specified address, which will be downlinked in the second byte of housekeeping.

Recommended Use

Contingency only. Use with caution, experts only.

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPLSB	0x00uu	0x49uu	
delay 1 second			
ZEPDPMSB	0x00uu	0x4Auu	
delay 1 second			
ZEPDPEEK	*No parameter*	0x5000	
delay 10 seconds			

Duration

12 seconds

3.3.3.2 POKE POKE a data byte

****NOTE: This operation is a high priority patch and will be handled by an IPCH file as in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).***

Description

This command will poke a byte from ZEPDPDAT into the specified address.

Recommended Use

Contingency only. Use with caution, experts only.

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPLSB	0x00uu	0x49uu	
delay 1 second			
ZEPDPMSB	0x00uu	0x4Auu	
delay 1 second			
ZEPDPDAT	0x00uu	0x4100	
delay 10 seconds			

Duration

12 seconds

3.3.3.3 EE Execute Executive

Description

Executes Executive Code.

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDBOOS	0x0001	0x4D01	

delay 15 seconds

Duration

15 seconds

3.3.4 Executive Level Commands

Commands decoded by the Executive code (run by an EE) and issued before an application is run.

3.3.4.1 PMDR Perform Memory Dump (Ram page)

Description

Dumps lower and selected upper page of memory (RAM) into science telemetry stream.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEMEM	0x0000	0x5100	

delay 350 seconds

Duration

350 seconds = 5 minutes 50 seconds

3.3.4.2 PMD1 Perform Memory Dump (EEPROM page 1)

Description

Dumps lower and selected upper page of memory (EEPROM1) into science telemetry stream.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEMEM	0x0001	0x5101	

delay 350 seconds

Duration

350 seconds = 5 minutes 50 seconds

3.3.4.3 PMD2 Perform Memory Dump (EEPROM page 2)

Description

Dumps lower and selected upper page of memory (EEPROM2) into science telemetry stream.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEMEM	0x0002	0x5102	

delay 350 seconds

Duration

350 seconds = 5 minutes 50 seconds

3.3.4.4 RA1 Run Application (single processor)

Description

Starts the single processor application code on either IP processor or SP processor depending on earlier command sequences.

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEAPP	0x0002	0x5202	

delay 15 seconds

Duration

15 seconds

3.3.4.5 RA2 Run Application (two processor)

Description

Starts the two processor application code (also called the main application code).

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEAPP	0x0091	0x5291	
delay 30 seconds			

Duration

30 seconds

3.3.4.6 UD Update Directory

*NB: this is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence is used to update the directory that contains the information that is required to run an application code.

Recommended Use

Contingency only

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEDR1	0x00uu	0x53uu	
delay 1 second			
ZEPDEDR2	0xuuuu	0xuuuu	
delay 1 second			

Duration

2 seconds

3.3.4.7 US Uplink Software

****NOTE: This operation is a high priority patch and will be handled by an IPCH file as in ref DS-JSO-ID-00002***

Description

Allows software patching of the processor that is controlling the telemetry interface.

Recommended Use

Contingency only

Number of input parameters:

n + 3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDUPSO	0x00uu	0x5Fuu	Control Word
delay 1 second			
ZEPDUPAR	0xuuuu	0xuuuu	Argument Word
delay 1 second			

(For a Patch of n-1 words, where there could be between 1 and 256 words; nth word contains checksum; the other three input parameters are address, numbers of words and page).

Duration

duration in seconds equals number of words in sequence

3.3.5 High Level Engineering Commands

Decoded by the main DPU application programme and are echoed in the housekeeping, these commands may be sent at any time when a code application program is running, i.e. after RA2 or RA1.

3.3.5.1 MO Monitor On

Description

Activates DPU monitoring of the housekeeping and selects channel(s) to monitor. If out of limits are observed then the result is a sensor power down and relevant data is recorded in HK. The HK will confirm that the monitor tripped, and return the value in the channel being monitored (and the channel identity).

Recommended Use

Contingency only

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHC1S	0x00uu	0x54uu	
delay 1 second			
ZEPDHC2S	0xuuuu	0xuuuu	
delay 10 seconds			

Duration

11 seconds

3.3.5.2 MF Monitor Off

Description

Deactivates DPU monitoring of the housekeeping.

Recommended Use

Contingency only

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHC1S	0x00uu	0x54uu	
delay 1 second			
ZEPDHC2S	0xuuuu	0xuuuu	
delay 1 second			

Duration

2 seconds

3.3.5.3 EMO Engineering Mode On

Description

Allows selection of a particular housekeeping channel for engineering mode output

Recommended Use

Contingency only

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDENGS	0x00uu	0x4Euu	

delay 1 second

Duration

1 second

3.3.5.4 EMF Engineering Mode ofF

Description

Disable selection of a particular housekeeping channel for engineering mode output

Recommended Use

Contingency only

Number of input parameters

none

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDENGS	no parameter	0x4E00	

delay 1 second

Duration

1 second

3.3.6 High Level Initialisation Sequences

3.3.6.1 IKAL Initialise Keep ALive memory

Description

Set all keep alive variable to default values.

Recommended Use

Commissioning and Contingency

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDKALE	*No parameter*	0x4000	

delay 10 seconds

Duration

10 seconds

3.3.7 High Level Sensor Power Control Sequences

3.3.7.1 LV_BOTH Both Sensors Low Voltage Power Up

Description

Switches low voltage onto the HEEA sensor and then to the LEEA sensor (5V, +-8V and 36V)

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLPCN	0x0003	0x4B03	
delay 10 seconds			
ZEPDCONF	*No parameter*	0x4F55	
delay 30 seconds			
ZEPDHPCN	0x0003	0x6B03	
delay 10 seconds			
ZEPDCONF	*No parameter*	0x4F55	
delay 30 seconds			

Duration

80 seconds = 1 minute 20 seconds

3.3.7.2 LV_HEEA HEEA sensor Low Voltage Power Up

Description

Switches low voltage onto the HEEA sensor (5V, +-8V and 36V)

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHPCN	0x0003	0x6B03	
delay 10 seconds			
ZEPDCONF	*No parameter*	0x4F55	
delay 30 seconds			

Duration

40 seconds

3.3.7.3 LV_LEEA LEEA Sensor Low Voltage Power Up

Description

Switches low voltage onto the LEEA sensor (5V, +-8V and 36V)

Recommended Use

Contingency only

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLPCN	0x0003	0x4B03	
delay 10 seconds			
ZEPDCONF	*No parameter*	0x4F55	
delay 30 seconds			

Duration

40 seconds

3.3.7.4 LV_OFF Low Voltage sensor power OFF

Description

Switches low voltage off for both sensors (5V, +-8V and 36V).
Use from READY BOTH SAFE to get to STANDBY BOTH PRO.

Recommended Use

Commissioning/ Contingency . Do not use if HVs are on.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDSPWF	*No parameter*	0x4800	
delay 120 seconds			

Duration

120 seconds = 2 minutes

3.3.7.5 LV_SCI_OFF Low Voltage sensor power & SCIence processing Off

Description

Switches off science processing and then switches off low voltage off for both sensors (5V, +-8V and 36V)
Use from RUNNING SAFE to get to STANDBY BOTH PRO.

Recommended Use

Commissioning/Contingency. Do not use if HVs are on.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00FF	0x47FF	
delay 20 seconds			
ZEPDSPWF	*No parameter*	0x4800	
delay 120 seconds			

Duration

140 seconds = 2 minutes 20 seconds

3.3.8 High Level Science Sequences

3.3.8.1 INTERFACE Spacecraft INTERFACE and watchdog

Description

Controls;
- IEL links (note that Correlator is always enabled – doesn't go through DPU)
- Watchdog status
- Spacecraft Telemetry Interface (use of prime or redundant interface)

Recommended Use

Normal operations

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x00**	0x4C**	Enable IELs, Watchdog, TM i/f
delay 10 seconds			

Note: The ** indicates that the missing information is available as a henceforth parameter. See 6.7.1.

Duration

10 seconds

3.3.8.2 SETUP_0 SETUP sensors and science configuration; cseq 0

Description

Setup the LEEA and HEEA sensor sweep mode and sweep preset.

The science processing configuration is not explicitly controlled. The default science processing setup is therefore adopted. The default data products are CORE, LER-LEEA, NOI, 3DF.

Recommended Use

Normal Operations

Number of input parameters

4

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			

Note 1. It is important that the sweep mode is defined before the preset in order to avoid setting an undesirable preset in the sensor default mode of 0.

Note 2. It is important that the sweep commands are sent before the start science processing command sequence is run as the sweep setup information affects both the data processing and the sensor sweep.

Duration

4 seconds

3.3.8.3 SETUP_1 SETUP sensors and science configuration; cseq 1

Description

Setup the LEEA and HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence cannot control 3DX options. It will normally be used when the data products list includes 3DF. It is based on command sequence SETUP_0, but has five additional commands added at the end for additional control.

Recommended Use

Normal Operations

Number of input parameters

9

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 5		Datasets control
delay 1 second			
ZEPDDATP	Parameter 6		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 7		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 8		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 9		Spacecraft Potential setup
delay 1 second			

continued next page

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

9 seconds

3.3.8.4 SETUP_2 SETUP sensors and science configuration; cseq 2

Description

Setup the LEEA and HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used for the case of a data products list containing 3DX1, but not 3DX2 (and not 3DF). It is based command sequence SETUP_1, but has four additional commands added at the end for 3DX1 control.

Recommended Use

Normal Operations

Number of input parameters

13

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 5		Datasets control
delay 1 second			
ZEPDDATP	Parameter 6		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 7		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 8		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 9		Spacecraft Potential setup
delay 1 second			

continued next page

ZEPDLPUE	Parameter 10	3DX 1 control
delay 1 second		
ZEPDPUPS	Parameter 11	3DX 1 setup
delay 1 second		
ZEPDLPUE	Parameter 12	3DX 1 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 13	3DX 1 energy limits
delay 1 second		

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

13 seconds

3.3.8.5 SETUP_3 SETUP sensors and science configuration; cseq 3

Description

Setup the LEEA and HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used when both 3DX1 and 3DX2 are required (not 3DF). It is based on command sequence SETUP_2, but has four additional commands added at the end for 3DX2 control.

Recommended Use

Normal Operations

Number of input parameters

17

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 5		Datasets control
delay 1 second			
ZEPDDATP	Parameter 6		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 7		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 8		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 9		Spacecraft Potential setup
delay 1 second			

continued next page

ZEPDLPUE	Parameter 10	3DX 1 control
delay 1 second		
ZEPDPUPS	Parameter 11	3DX 1 setup
delay 1 second		
ZEPDLPUE	Parameter 12	3DX 1 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 13	3DX 1 energy limits
delay 1 second		
ZEPDLPUE	Parameter 14	3DX 2 control
delay 1 second		
ZEPDPUPS	Parameter 15	3DX 2 setup
delay 1 second		
ZEPDLPUE	Parameter 16	3DX 2 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 17	3DX 2 energy limits
delay 1 second		

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

17 seconds

3.3.8.6 SETUP_4 SETUP sensors and science configuration via Macro

Description

This launches a pair of macros which command a science mode. Specifically, the macros are used to set up a particular LEEA and HEEA sweep mode and preset, and to configure DPU science algorithms. The first macro should be defined to have the same commands as SETUP_0 (but with fixed parameters) and the second to the consist of the additional commands in SETUP_3 compared to SETUP_0 (again with fixed parameters). The input parameters for SETUP_4 are the identification numbers of the macros to be called.
The instrument must be at a state at or above STANDY BOTH PRO

Recommended Use

Normal operations (tbc) and Commissioning

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	Macro Parameter 1	0x5Euu	Configure Sensors
delay 10 seconds			
ZEPDMAC1	Macro Parameter 2	0x5Euu	Configure DPU
delay 10 seconds			

Duration

20 seconds

Note

For interference campaign a separate version of this sequence will be used with a 2 second delay after commands

3.3.8.7 MACRO send Macro

Description

This command sequence can be used to launch a single PEACE Macro. The instrument must be at a state at or above STANDY BOTH PRO. The input parameter is the identification number of the macro to be called.

Recommended Use

Normal operations

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x00uu	0x5Euu	

delay 10 seconds (A PEACE macro is executed as fast has the PEACE DPU processing will allow. This delay is to account for the DPU being non-receptive to commands for a short period.)

Duration

10 seconds

3.3.8.8 RUNSCI_BOTH Run SCIence processing (BOTH sensors)

Description

Start Science Processing

Recommended Use

Normal Operations

Number of input parameters

0

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x0000	0x4700	

delay 20 seconds

Duration

20 seconds

3.3.8.9 RUNSCI_HEEA Run SCIence processing (HEEA sensor only)

Description

Start Science Processing for HEEA data only

Recommended Use

Commissioning/Contingency

Number of input parameters

0

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x0002	0x4702	

delay 20 seconds

Duration

20 seconds

3.3.8.10 RUNSCI_LEEA Run SCIence processing (LEEA sensor only)

Description

Start Science Processing for LEEA data only

Recommended Use

Commissioning/Contingency

Number of input parameters

0

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x0001	0x4701	

delay 20 seconds

Duration

20 seconds

3.3.8.11 SETUP_0_HEEA single sensor ops SETUP; cseq 0 for HEEA

Description

Setup the HEEA sensor sweep mode and sweep preset, and define basic required dataset with minimum commands.

The science processing configuration is not explicitly controlled. The default science processing setup is therefore adopted. The default data products are CORE, LER-LEEA, NOI, 3DF, but should be altered to TCOR, LER_HEEA, 3DR_HEEA (hence additional commands).

Recommended Use

Commissioning/Contingency

Number of input parameters

4

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets sent control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets sent parameter
delay 1 second			

Note 1. It is important that the sweep mode is defined before the preset in order to avoid setting an undesirable preset in the sensor default mode of 0.

Note 2. It is important that the sweep commands are sent to before the start science processing command sequence is run as the sweep setup information affects both the data processing and the sensor sweep.

Duration

4 seconds

3.3.8.12 SETUP_1_HEEA single sensor ops SETUP; cseq 1 for HEEA

Description

Setup the HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This cannot control 3DX options. It will normally be used when the data products list includes 3DF. It is based on SETUP_0_HEEA, but has three additional commands added at the end for additional control.

Recommended Use

Commissioning/Contingency

Number of input parameters

7

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 5		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 6		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 7		Spacecraft Potential setup
delay 1 second			

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

7 seconds

3.3.8.13 SETUP_2_HEEA single sensor ops SETUP; cseq 2 for HEEA

Description

Setup the HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used for the case of a data products list containing 3DX1, but not 3DX2 (and not 3DF). It is based on command sequence SETUP_1_HEEA, but has four additional commands added at the end for 3DX1 control.

Recommended Use

Commissioning/Contingency

Number of input parameters

11

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 5		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 6		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 7		Spacecraft Potential setup
delay 1 second			
ZEPDLPUE	Parameter 8		3DX 1 control
delay 1 second			

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ZEPDPUPS	Parameter 9	3DX 1 setup
delay 1 second		
ZEPDLPUE	Parameter 10	3DX 1 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 11	3DX 1 energy limits
delay 1 second		

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

11 seconds

3.3.8.14 SETUP_3_HEEA single sensor ops SETUP; cseq 3 for HEEA

Description

Setup the HEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Correlator selection
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used when both 3DX1 and 3DX2 are required (not 3DF). It is based on command sequence SETUP_2_HEEA, but has four additional commands added at the end for 3DX2 control.

NB it remains tbc that there is a requirement for 3DX2 in single sensor ops.

Recommended Use

Commissioning/Contingency

Number of input parameters

15

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDHIPS	Parameter 5		Correlator setup
delay 1 second			
ZEPDMAGS	Parameter 6		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 7		Spacecraft Potential setup
delay 1 second			
ZEPDLPUE	Parameter 8		3DX 1 control
delay 1 second			

continued next page

ZEPDPUPS	Parameter 9	3DX 1 setup
delay 1 second		
ZEPDLPUE	Parameter 10	3DX 1 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 11	3DX 1 energy limits
delay 1 second		
ZEPDLPUE	Parameter 12	3DX 2 control
delay 1 second		
ZEPDPUPS	Parameter 13	3DX 2 setup
delay 1 second		
ZEPDLPUE	Parameter 14	3DX 2 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 15	3DX 2 energy limits
delay 1 second		

(Note - if ZEPDHIPS is set to manual control the coincidence channel can be set by a single command at any time. ie by a PMRQ.)

Duration

15 seconds

3.3.8.15 SETUP_0_LEEA single sensor ops SETUP; cseq 0 for LEEA

Description

Setup the LEEA sensor sweep mode and sweep preset.

The science processing configuration is not explicitly controlled. The default science processing setup is therefore adopted. The default data products are CORE, LER-LEEA, NOI, 3DF, but should be altered to TCOR, 3DR_LEEA (hence additional commands).

Recommended Use

Commissioning/Contingency

Number of input parameters

4

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLSMPS	Parameter 1		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 2		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets sent control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets sent parameter
delay 1 second			

Note 1. It is important that the sweep mode is defined before the preset in order to avoid setting an undesirable preset in the sensor default mode of 0.

Note 2. It is important that the sweep commands are sent to before the start science processing command sequence is run as the sweep setup information affects both the data processing and the sensor sweep.

Duration

4 seconds

3.3.8.16 SETUP_1_LEEA single sensor ops SETUP; cseq 1 for LEEA

Description

Setup the LEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:
- Dataset to be calculated (both spin based and main 3d distributions).
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence cannot control 3DX options. It will normally be used when the data products list includes 3DF. It is based on command sequence SETUP_0_LEEA, but has two additional commands added at the end for additional control.

Recommended Use

Commissioning/Contingency

Number of input parameters

6

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLSMPS	Parameter 1		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 2		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDMAGS	Parameter 5		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 6		Spacecraft Potential setup
delay 1 second			

Duration

6 seconds

3.3.8.17 SETUP_2_LEEA single sensor ops SETUP; cseq 2 for LEEA

Description

Setup the LEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:

- Dataset to be calculated (both spin based and main 3d distributions).
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used for the case of a data products list containing 3DX1, but not 3DX2 (and not 3DF). It is based on command sequence SETUP_1_LEEA, but has four additional commands added at the end for 3DX1 control.

Recommended Use

Commissioning/Contingency

Number of input parameters

10

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLSMPS	Parameter 1		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 2		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDMAGS	Parameter 5		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 6		Spacecraft Potential setup
delay 1 second			
ZEPDLPUE	Parameter 7		3DX 1 control
delay 1 second			
ZEPDPUPS	Parameter 8		3DX 1 setup
delay 1 second			
ZEPDLPUE	Parameter 9		3DX 1 energy limits control
delay 1 second			

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ZEPDPUPS	Parameter 10	3DX 1 energy limits

delay 1 second

Duration

10 seconds

3.3.8.18 SETUP_3_LEEA single sensor ops SETUP; cseq 3 for LEEA

Description

Setup the LEEA sensor sweep mode and sweep preset.

Also selects the following DPU data control options:

- Dataset to be calculated (both spin based and main 3d distributions).
- Magnetic Field Source Selection
- Spacecraft Potential Control.

This command sequence is intended to be used when both 3DX1 and 3DX2 are required (and not 3DF). It is based on command sequence SETUP_2_LEEA, but has four additional commands added at the end for 3DX2 control.

NB it remains tbc that there is a requirement for 3DX2 in single sensor ops.

Recommended Use

Commissioning/Contingency

Number of input parameters

14

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLSMPS	Parameter 1		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 2		LEEA sweep PS
delay 1 second			
ZEPDDATS	Parameter 3		Datasets control
delay 1 second			
ZEPDDATP	Parameter 4		Datasets setup
delay 1 second			
ZEPDMAGS	Parameter 5		Mag field selection
delay 1 second			
ZEPDSPOT	Parameter 6		Spacecraft Potential setup
delay 1 second			
ZEPDLPUE	Parameter 7		3DX 1 control
delay 1 second			
ZEPDPUPS	Parameter 8		3DX 1 setup
delay 1 second			

continued next page

ZEPDLPUE	Parameter 9	3DX 1 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 10	3DX 1 energy limits
delay 1 second		
ZEPDLPUE	Parameter 11	3DX 2 control
delay 1 second		
ZEPDPUPS	Parameter 12	3DX 2 setup
delay 1 second		
ZEPDLPUE	Parameter 13	3DX 2 energy limits control
delay 1 second		
ZEPDPUPS	Parameter 14	3DX 2 energy limits
delay 1 second		

Duration

14 seconds

3.3.8.19 ECLIP Set Up Eclipse Mode

Description

Changes PEACE from usual mode of operation which is synchronised to the spacecraft sun pulse, to operation synchronised to an internally generated artificial sunpulse. Used for special operations as spacecraft enters eclipse.

WARNING: Must not be used while HVs are enabled.

Recommended Use

Commissioning/Eclipse mode special operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x0012	0x4C12	disable watchdog
Wait 10 seconds			
ZEPDSN1S	0x0000	0x5500	set sunpulse offset
delay 1 second			
ZEPDSN2S	0xBFFE	0xBFFE	and activate eclipse mode
Wait 20 seconds			
ZEPDHWCE	0x0016	0x4C16	enable watchdog
Wait 10 seconds			

Duration

41 seconds

3.3.9 High Level High Voltage Control Sequences

3.3.9.1 Essential Information about High Voltage Procedures.

3.3.9.1.1 Rules of Thumb

The MCP HV Enable command should never be sent unless the MCP level is set at zero.

Increases in MCP level should be carried out after MCP HV Enable has been commanded.

If beginning at level 0 (or 1) and going to level 2 or above, allow at least 30 seconds for the voltage to reach level 2.

Do not raise the MCP voltage on the second sensor until the first has had 30 seconds to respond to its own level raise command.

The MCP turn on commands will cause a progressive increase (at the rate of two levels per spin) to the specified high voltage across the MCP. The procedure avoids the risk of damage to the instrument from a very rapid turn-on. For typical operating levels, MCP turn-on can take between one and two minutes.

3.3.9.1.2 Exceptional Cases

Although apparent exceptions occurred during the interference campaign, the reasons for which were historical, no exceptions to the above should occur.

3.3.9.1.3 Technical Information

When the DPU receives a command to raise the MCP voltage level in a sensor, it commands the sensor's SMU to send the voltage gradually to the higher level; the DPU sends a one-level raise command every 2 seconds until the selected level has been commanded. The response of the MCP voltage will be controlled by the voltage rise time intrinsic to the system, and may be many 10's of seconds for a large voltage change (the largest jump is between level 1 and level 2).

When the DPU receives a command to lower the MCP voltage level in a sensor, it commands the sensor's SMU to send the voltage immediately to the lower level. The response of the MCP voltage will be controlled by the voltage decay time intrinsic to the system, and may be many 10's of seconds for a large voltage drop (the largest jump is between level 1 and level 2).

The intended voltage associated with each MCP level, once the level has been settled at, is specified in SC-P/R-RAL-RS-90-0001 and are included here (though the reference provided is to be regarded as definitive). Note that the voltage the actual voltage across the MCPs differs from the generator output voltage.

Level	Generator Output Voltage / Volts	Level	Generator Output Voltage / Volts
0	0.0	16	2832.6
1	57.8	17	2890.4
2	2023.0	18	2948.2
3	2080.8	19	3006.0
4	2138.6	20	3063.9
5	2196.5	21	3121.7
6	2254.3	22	3179.5
7	2312.1	23	3237.3
8	2369.9	24	3295.2
9	2427.8	25	3353.0
10	2485.6	26	3410.8
11	2543.4	27	3468.6
12	2601.2	28	3526.5
13	2659.1	29	3584.3
14	2716.9	30	3642.1
15	2774.7	31	3700.0

3.3.9.2 HV_BOTH High Voltage enable; BOTH sensors.

Description

Enable all high voltages and set LEEA and HEEA MCP levels.

Recommended Use

Normal Operations

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	No parameter	0x2040	set HEEA MCP level to zero
delay 5 seconds			
ZEPLMCPS	No parameter	0x0040	set LEEA MCP level to zero
delay 5 seconds			
ZEPHHVGE	No parameter	0x20C3	Enable HEEA Sweep & MCP HVs
delay 10 seconds			
ZEPLHVGE	No parameter	0x00C3	Enable LEEA Sweep & MCP HVs
delay 10 seconds			
ZEPHMCPS	Parameter 1	0x20**	set HEEA MCP level to *henceforth*
delay 30 seconds			
ZEPLMCPS	Parameter 2	0x00**	set LEEA MCP level to *henceforth*
delay 120 seconds			

Note: ** refers a henceforth parameter which controls "MCP Level", i.e. the high voltage across the MCP. The voltage associated with each MCP level is defined in 3.3.9.1. (The henceforth value for each MCP is defined in 6.7.1)

Duration

180 seconds = 3 minutes

3.3.9.3 HV_MNT_BOTH High Voltage Sweep Disable BOTH sensors

Description

Sweep disable with MCPs left ON.

Note that the MCPs remain on at selected levels, i.e. high voltages are active.

Recommended Use

Primary use is in Commissioning.
Do NOT use in MCP noise test (see new sequence for this, 3.3.9.13 HV_MNOI_BOTH)
It is recommended that the MCPs are turned down to a non-sensitive level before running this procedure.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPE	No parameter	0x20C1	Disable Sweep, Enable MCP: HEEA
delay 30 second			
ZEPLMCPE	No parameter	0x00C1	Disable Sweep, Enable MCP: LEEA
delay 171 seconds			

Duration

201 seconds = 3 minutes 21 seconds

3.3.9.4 HV_MOLT_BOTH removed

3.3.9.5 HV_MOLT_HEEA removed

3.3.9.6 HV_MOLT_LEEA removed

3.3.9.7 HV_MEL_BOTH HV MCP Enable at op. Level; BOTH sensors

Description

To re-enable HV sweeps while the MCP HV level settings are at non-zero levels (and the MCP is ALREADY enabled).

Recommended Use

Primary use is in Commissioning.
In order to avoid MCP damage, this command sequence MUST only be used following HV_MNT_BOTH.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGE	No parameter	0x20C3	HEEA: Enable Sweep, Enable MCP
delay 10 seconds			
ZEPLHVGE	No parameter	0x00C3	LEEA: Enable Sweep, Enable MCP
Delay 60 seconds			

Duration

70 seconds = 1 minute 10 seconds

3.3.9.8 SAFE SAFE the HVs

Description

This command sequence disables the High Voltages (sweep and MCP).

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGD	No parameter	0x20C0	disable HEEA HVs
ZEPLHVGD	No parameter	0x00C0	disable LEEA HVs

Wait 120 seconds for capacitor discharge

Duration

120 seconds = 2 minutes

3.3.9.9 HS_SAFE Halt Science processing, SAFE the HVs

Description

This command sequence disables the High Voltages (sweep and MCP) and also halts the science processing algorithms and sets internal variables to their default condition.

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGD	No parameter	0x20C0	disable HEEA HVs
delay 1 second			
ZEPLHVGD	No parameter	0x00C0	disable LEEA HVs
Wait 120 seconds for capacitor discharge			
ZEPDPRCN	0x00FF	0x47FF	
delay 20 seconds			

Duration

141 seconds = 2 minutes 21 seconds

3.3.9.10 HV_HEEA High Voltage enable; HEEA sensor.

Description

Enable all high voltages and set HEEA MCP levels.

Recommended Use

Commissioning/Contingency

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x0000	0x2040	set HEEA MCP level to zero
delay 5 seconds			
ZEPHHVGE	No parameter	0x20C3	Enable HEEA Sweep & MCP HVs
delay 10 seconds			
ZEPHMCPS	Parameter 1	0x20**	set HEEA MCP level to *henceforth*
delay 120 seconds			

Note: ** refers a henceforth parameter which controls "MCP Level", i.e. the high voltage across the MCP. The voltage associated with each MCP level is defined in 3.3.9.1. (The henceforth value for each MCP is defined in 6.7.1)

Duration

135 seconds = 2 minutes 15 seconds

3.3.9.11 HV_LEEA High Voltage enable; LEEA sensor.

Description

Enable all high voltages and set LEEA MCP levels.

Recommended Use

Commissioning/Contingency

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLMCPS	0x0000	0x0040	set LEEA MCP level to zero
delay 5 seconds			
ZEPLHVGE	No parameter	0x00C3	Enable LEEA Sweep & MCP HVs
delay 10 seconds			
ZEPLMCPS	Parameter 1	0x00**	set LEEA MCP level to *henceforth*
delay 120 seconds			

Note: ** refers a henceforth parameter which controls “MCP Level”, i.e. the high voltage across the MCP. The voltage associated with each MCP level is defined in 3.3.9.1. (The henceforth value for each MCP is defined in 6.7.1)

Duration

135 seconds = 2 minutes 15 seconds

3.3.9.12 MCPLEV_2_SAFE Set MCPs to Level 2 with HVs off

Description

Change HEEA and LEEA MCP level. Default level is 2. MCP HVs are OFF.

Recommended Use

Commissioning, WHISPER 1 Interference Campaign (Electronic Noise).
It must be followed by HV_MNT_BOTH.

Warning:

Use only when MCP HVs are off; if they are on, the delays are inadequate.
For MCP level changes with MCP HVs on, use HV_MCPLEV_HEEA (3.3.9.13) and HV_MCPLEV_LEEA (3.3.9.14), or use HV_BOTH (3.3.9.2) to set MCP levels from zero.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x0002	0x2042	Set HEEA MCP level 2
delay 5 second			
ZEPLMCPS	0x0002	0x0042	Set LEEA MCP level 2
delay 5 second			

Duration

10 seconds

Note: when the HVs come on, a suitable delay time is required for the MCP voltages to reach the required levels; this must be not less than 30 seconds.

3.3.9.13 HV_MLEV_HEEA Set HEEA MCP to Level 2

Description

Change HEEA MCP level. Default is level 2, but note Warnings below.

Recommended Use

Commissioning (IFC)

Note: This sequence will be inserted by PMRQ into PIORs, and the level parameter may be edited at that time.

Warnings:

1. This sequence can only be used if the MCPs are already HV enabled, and after careful thought due to potential danger to MCPs.

2. The change must not exceed 3 MCP levels for each use of the command.

3. Do NOT set a level less than 2.

Number of input parameters

One

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x00uu	0x2040+uu	Set HEEA MCP level uu (hex)

delay 8 seconds per level changed, *i.e.* max 24 seconds.

Duration

8 seconds per level changed, *i.e.* max 24 seconds

3.3.9.14 HV_MLEV_LEEA Set LEEA MCP to Level 2

Description

Change LEEA MCP level. Default is level 2, but note Warnings below.

Recommended Use

Commissioning (IFC)

Note: This sequence will be inserted by PMRQ into PIORs, and the level parameter may be edited at that time.

Warnings:

1. This sequence can only be used if the MCPs are already HV enabled, and after careful thought due to potential danger to MCPs.

2. The change must not exceed 3 MCP levels for each use of the command.

3. Do NOT set a level less than 2.

Number of input parameters

One

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLMCPS	0x00uu	0x0040+uu	Set LEEA MCP level uu (hex)

delay 8 seconds per level changed, *i.e.* max 24 seconds

Duration

8 seconds per level changed, *i.e.* max 24 seconds

3.3.9.15 HV_MNOI_BOTH HV MCP noise test, BOTH sensors

Description

To assess MCP background noise levels. Note that the MCPs are at their operational levels: the procedure starts and ends in READY BOTH HV ON (NOTE: Halt Science is required to return to this state). The grids may need to switched on at the start of the test and off at the end (see Chapter 6).

This procedure comprises:
SETUP_2 (88h58-40f40-cx-anh-88w74)
RUNSCI_BOTH
HS
SETUP_2 (40f40-88h58-cx-anl-88w74)
RUNSCI_BOTH

Recommended Use

To be used routinely at the start of each orbit, preferably in the lobe or solar wind.

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	0x0009	0x2069	HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	0x0016	0x2096	HEEA sweep PS
delay 1 second			
ZEPLSMPS	0x0000	0x0060	LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	0x000A	0x008A	LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0281	0x0281	Datasets setup
delay 1 second			
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x000u	0x450u	S/c Potential setup
delay 1 second			

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ZEPDLPUE	0x0008	0x5608	3DX 1 control
delay 1 second			
ZEPDPUPS	0x0012	0x0012	3DX 1 setup
delay 1 second			
ZEPDLPUE	0x000F	0x560F	3DX 1 energy limits control
delay 1 second			
ZEPDPUPS	0x0108	0x0108	3DX 1 energy limits
delay 1 second			
ZEPDPRCN	0x0000	0x4700	RUNSCI_BOTH
delay 140 seconds			
ZEPDPRCN	0x00FF	0x47FF	HS
delay 20 seconds			
ZEPHSMPS	0x0000	0x2060	HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	0x000A	0x208A	HEEA sweep PS
delay 1 second			
ZEPLSMPS	0x0009	0x0069	LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	0x0016	0x0096	LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0281	0x0281	Datasets setup
delay 1 second			
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x000u	0x450u	S/c Potential setup
delay 1 second			
ZEPDLPUE	0x0008	0x5608	3DX 1 control
delay 1 second			
ZEPDPUPS	0x0012	0x0002	3DX 1 setup
delay 1 second			

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ZEPDLPUE	0x000F	0x560F	3DX 1 energy limits control
delay 1 second			
ZEPDPUPS	0x0108	0x0108	3DX 1 energy limits
delay 1 second			
ZEPDPRCN	0x0000	0x4700	RUNSCI_BOTH
delay 140 seconds			

Duration

326 seconds = 5 minute 26 seconds

(NOTE: 20s will be required for the HS to return to READY BOTH HV ON)

3.3.9.16 HV_MCPTS MCP Test Sequence

Description

This is a very abbreviated version of the MCP Operational Level Test. The MCP levels of HEEA and LEEA are varied by one level up and down and then returned to the nominal level operational level.

Recommended Use

Normal Operations (on occasional basis)

Warning: this sequence can only be used if the MCPs are already HV enabled at the operational level, and after careful thought due to potential danger to MCPs.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLMCPS	0x00ML+1	0x00ML+1	LEEA: Set MCP level
delay 300seconds			
ZEPLMCPS	0x00ML-1	0x00ML-1	LEEA: Set MCP level
delay 300 seconds			
ZEPLMCPS	0x00ML	0x00ML	LEEA: Set MCP level
delay 300seconds			
ZEPHMCPS	0x00ML+1	0x20ML+1	HEEA: Set MCP level
delay 300 seconds			
ZEPHMCPS	0x00ML-1	0x20ML-1	HEEA: Set MCP level
delay 300 seconds			
ZEPHMCPS	0x00ML	0x20ML	HEEA: Set MCP level
delay 300 seconds			

*Note: **ML** refers a henceforth parameter which controls MCP level. (see 6.7.1). Thus if ML is 04 then 0x00ML+1 is 0x0005, 0x00ML is 0x0004 and 0x00ML-1 is 0x0003

Duration

1800 seconds = 30 minutes

3.3.9.17 HV_MOLT_BOTH_SC_1 Mcp Op. Lev. Test: BOTH Sensors: Spacecraft 1

Description

Aim is to measure counts (on each anode) vs. MCP HV level in a stable plasma environment; the data provide a crude indication of the ideal MCP Operational Level at the time of the measurement.

A different version of this test is needed for each spacecraft, due to the different operational levels of the 8 orbiting sensors.

The test is carried out on one sensor while the other sensor monitors the environment (if the environment is unstable, the data from the monitoring sensor can be used to normalise the counts in the sensor which is under test). The procedure is then repeated but with the roles of the sensors exchanged. The main data product is NOI-BOTH, which is analysed to give the required information (for each anode). The 3DR-S data product is used to provide context information and is collected from the monitor sensor (not the sensor on which the MCP level is being altered). A single sensor 3DR is preferred as it arrives twice as often (about once per three spins) as a dual sensor 3DR. The Moment Sums in the CORE give some indication (every spin) of whether a sudden burst of counts is natural if it is seen only in one sensor.

Four spins are allowed after each level increment for the MCP level to settle at the new value.
Seven spins of data are collected at each MCP level, after the settling time has elapsed.

There is no science reset during this test; the sweeps are not disabled, nor are their presets altered.

Recommended Use

Warning: if this sequence is used without the Sweep HVs ON, the instrument could be endangered.

Used in Normal Operations: this test should be carried out at regular intervals, perhaps initially every orbit or two, later dropping to once per month. This assumes that the expected rapid initial gain change (associated with degree of extracted charge) occurs and then the gain settles down.

The test will be carried out in suitable plasma environments. Identification of opportunities will occur during operations.

Number of input parameters

4

Parameters:

1 HEEA sweep mode and preset lsbs (sweep mode should be LAR)
2 HEEA sweep preset msbs
3 LEEA sweep mode and preset lsbs (sweep mode should be LAR)
4 LEEA sweep preset msbs

Detailed Outline

Start in READY BOTH HV ON, i.e. with Sweep HVs on, MCP HVs On.

The MCP Science Operational Levels are expected to be 15 [decimal] for HEEA and 16 [decimal] for LEEA, for 2 million gain. In practice they may be region dependent.

Set up HEEA sweeps to monitor environment in LAR mode with suitable preset to see lots of electrons at stable fluxes (but not spacecraft photoelectrons).
Set up LEEA sweeps with the same mode and preset.

Set up science processing/telemetry options to give CORE, NOI and 3DR-BOTH data.

Start science processing.

> Reduce the LEEA MCP operational level to 2.
> Set the HEEA MCP level to the appropriate Monitoring Operational Level for HEEA on this Spacecraft, chosen to be 15 [decimal].
>
> Collect data while elevating the MCP level on LEEA according to predefined pattern. The LEEA MCP level upper limit will be 17, corresponding to 4 million electrons.
>
> Reduce HEEA MCP to level 2
> Reduce LEEA MCP to the appropriate Monitoring Operational Level for LEEA on this spacecraft., chosen to be 16 [decimal].
>
> Collect data while elevating the MCP level on HEEA according to predefined pattern. The HEEA MCP level upper limit will be 17, corresponding to 4 million electrons.
> Set the HEEA & LEEA MCP levels to the appropriate (possibly region dependent) Science Operational Levels (usual henceforth setting, as used in HV_BOTH)

A Halt Science command (not included here) is needed to return to READY BOTH HV ON.

The delay time [*lev_change_ol_to_2*] is provisionally set to 120 seconds.
The delay time [*small_lev_change*] is provisionally set to 8 spins, 32 seconds.
The delay time, [*settle and accumulate counts*], is provisionally set at 44 seconds (see above)

The grids may need to switched on at the start of the test and off at the end (see Chapter 6).

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0249	0x0249	Datasets setup
delay 1 second			(COR, NOI, 3DR-BOTH)
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x0004	0x4504	Spacecraft Potential setup
delay 1 second			
ZEPDPRCN	0x0000	0x4700	Start Science
delay 20 seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x2249	0x2249	Datasets setup
delay 1 second			(COR, NOI, 3DR-H)
ZEPLMCPS	0x0002	0x0042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPHMCPS	0x000F	0x204F	HEEA Monitoring Level (15)
delay [*small_lev_change*] seconds			

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ZEPLMCPS	0x0004	0x0044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0006	0x0046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0007	0x0047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0008	0x0048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0009	0x0049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000A	0x004A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000B	0x004B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000C	0x004C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000D	0x004D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000E	0x004E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000F	0x004F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0010	0x0050	MCP Level 16
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0011	0x0051	MCP Level 17
delay [*settle and accumulate mcp counts*] seconds			

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ZEPHMCPS	0x0002	0x2042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x1249	0x1249	Datasets setup
delay 1 second			(COR, NOI, 3DR-L)
ZEPLMCPS	0x0010	0x0050	LEEA Monitoring Level (16)
delay [*small_lev_change*] seconds			
ZEPHMCPS	0x0004	0x2044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0006	0x2046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0007	0x2047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0008	0x2048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0009	0x2049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000A	0x204A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000B	0x204B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000C	0x204C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000D	0x204D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000E	0x204E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000F	0x204F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0010	0x2050	MCP Level 16
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0011	0x2051	MCP Level 17
delay [*settle and accumulate mcp counts*] seconds			

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ZEPHMCPS	parameter 5	HEEA Operational Level

delay [*small_lev_change*] seconds

ZEPLMCPS	parameter 6	LEEA Operational Level

delay [*small_lev_change*] seconds

Duration

The duration is

= 33 + 13*2*[*settle and accumulate counts*] + 2* [*lev_change_ol_to_2*] + 4*[*small_lev_change*]

= 1545 seconds = 25 minutes 45 seconds

(note: a further 20 seconds will be needed for HS to return to Ready Both HV On)

3.3.9.18 HV_MOLT_BOTH_SC_2 Mcp Op. Lev. Test: BOTH Sensors: Spacecraft 2

Description

Aim is to measure counts (on each anode) vs. MCP HV level in a stable plasma environment; the data provide a crude indication of the ideal MCP Operational Level at the time of the measurement.

A different version of this test is needed for each spacecraft, due to the different operational levels of the 8 orbiting sensors.

The test is carried out on one sensor while the other sensor monitors the environment (if the environment is unstable, the data from the monitoring sensor can be used to normalise the counts in the sensor which is under test). The procedure is then repeated but with the roles of the sensors exchanged. The main data product is NOI-BOTH, which is analysed to give the required information (for each anode). The 3DR-S data product is used to provide context information and is collected from the monitor sensor (not the sensor on which the MCP level is being altered). A single sensor 3DR is preferred as it arrives twice as often (about once per three spins) as a dual sensor 3DR. The Moment Sums in the CORE give some indication (every spin) of whether a sudden burst of counts is natural if it is seen only in one sensor.

Four spins are allowed after each level increment for the MCP level to settle at the new value.
Seven spins of data are collected at each MCP level, after the settling time has elapsed.

There is no science reset during this test; the sweeps are not disabled, nor are their presets altered.

Recommended Use

Warning: if this sequence is used without the Sweep HVs ON, the instrument could be endangered.

Used in Normal Operations: this test should be carried out at regular intervals, perhaps initially every orbit or two, later dropping to once per month. This assumes that the expected rapid initial gain change (associated with degree of extracted charge) occurs and then the gain settles down.

The test will be carried out in suitable plasma environments. Identification of opportunities will occur during operations.

Number of input parameters

4

Parameters:

1 HEEA sweep mode and preset lsbs (sweep mode should be LAR)
2 HEEA sweep preset msbs
3 LEEA sweep mode and preset lsbs (sweep mode should be LAR)
4 LEEA sweep preset msbs

Detailed Outline

Start in READY BOTH HV ON, i.e. with Sweep HVs on, MCP HVs On.

The MCP Science Operational Levels are expected to be 15 [decimal] for HEEA and 15 [decimal] for LEEA, for 2 million gain. In practice they may be region dependent.

Set up HEEA sweeps to monitor environment in LAR mode with suitable preset to see lots of electrons at stable fluxes (but not spacecraft photoelectrons).
Set up LEEA sweeps with the same mode and preset.

Set up science processing/telemetry options to give CORE, NOI and 3DR-BOTH data.

Start science processing.

> Reduce the LEEA MCP operational level to 2.
> Set the HEEA MCP level to the appropriate Monitoring Operational Level for HEEA on this Spacecraft, chosen to be 15 [decimal].
>
> Collect data while elevating the MCP level on LEEA according to predefined pattern. The LEEA MCP level upper limit will be 17, corresponding to 4 million electrons.
>
> Reduce HEEA MCP to level 2
> Reduce LEEA MCP to the appropriate Monitoring Operational Level for LEEA on this spacecraft., chosen to be 15 [decimal].
>
> Collect data while elevating the MCP level on HEEA according to predefined pattern. The HEEA MCP level upper limit will be 17, corresponding to 4 million electrons.
> Set the HEEA & LEEA MCP levels to the appropriate (possibly region dependent) Science Operational Levels (usual henceforth setting, as used in HV_BOTH)

A Halt Science command (not included here) is needed to return to READY BOTH HV ON.

The delay time [*lev_change_ol_to_2*] is provisionally set to 120 seconds.
The delay time [*small_lev_change*] is provisionally set to 8 spins, 32 seconds.
The delay time, [*settle and accumulate counts*], is provisionally set at 44 seconds (see above)

The grids may need to switched on at the start of the test and off at the end (see Chapter 6).

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0249	0x0249	Datasets setup
delay 1 second			(COR, NOI, 3DR-BOTH)
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x0004	0x4504	Spacecraft Potential setup
delay 1 second			
ZEPDPRCN	0x0000	0x4700	Start Science
delay 20 seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x2249	0x2249	Datasets setup
delay 1 second			(COR, NOI, 3DR-H)
ZEPLMCPS	0x0002	0x0042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPHMCPS	0x000F	0x204F	HEEA Monitoring Level (15)
delay [*small_lev_change*] seconds			

continued next page

ZEPLMCPS	0x0004	0x0044	MCP Level 4

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0006	0x0046	MCP Level 6

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0007	0x0047	MCP Level 7

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0008	0x0048	MCP Level 8

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0009	0x0049	MCP Level 9

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000A	0x004A	MCP Level 10

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000B	0x004B	MCP Level 11

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000C	0x004C	MCP Level 12

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000D	0x004D	MCP Level 13

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000E	0x004E	MCP Level 14

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x000F	0x004F	MCP Level 15

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0010	0x0050	MCP Level 16

delay [*settle and accumulate mcp counts*] seconds

ZEPLMCPS	0x0011	0x0051	MCP Level 17

delay [*settle and accumulate mcp counts*] seconds

continued next page

ZEPHMCPS	0x0002	0x2042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x1249	0x1249	Datasets setup
delay 1 second			(COR, NOI, 3DR-L)
ZEPLMCPS	0x000F	0x004F	LEEA Monitoring Level (15)
delay [*small_lev_change*] seconds			
ZEPHMCPS	0x0004	0x2044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0006	0x2046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0007	0x2047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0008	0x2048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0009	0x2049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000A	0x204A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000B	0x204B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000C	0x204C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000D	0x204D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000E	0x204E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000F	0x204F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0010	0x2050	MCP Level 16
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0011	0x2051	MCP Level 17
delay [*settle and accumulate mcp counts*] seconds			

continued next page

ZEPHMCPS	parameter 5	HEEA Operational Level
delay [*small_lev_change*] seconds		
ZEPLMCPS	parameter 6	LEEA Operational Level
delay [*small_lev_change*] seconds		

Duration

The duration is

= 33 + 13*2*[*settle and accumulate counts*] + 2* [*lev_change_ol_to_2*] + 4*[*small_lev_change*]

= 1545 seconds = 25 minutes 45 seconds

(note: a further 20 seconds will be needed for HS to return to Ready Both HV On)

3.3.9.19 HV_MOLT_BOTH_SC_3 Mcp Op. Lev. Test: BOTH Sensors: Spacecraft 3

Description

Aim is to measure counts (on each anode) vs. MCP HV level in a stable plasma environment; the data provide a crude indication of the ideal MCP Operational Level at the time of the measurement.

A different version of this test is needed for each spacecraft, due to the different operational levels of the 8 orbiting sensors.

The test is carried out on one sensor while the other sensor monitors the environment (if the environment is unstable, the data from the monitoring sensor can be used to normalise the counts in the sensor which is under test). The procedure is then repeated but with the roles of the sensors exchanged. The main data product is NOI-BOTH, which is analysed to give the required information (for each anode). The 3DR-S data product is used to provide context information and is collected from the monitor sensor (not the sensor on which the MCP level is being altered). A single sensor 3DR is preferred as it arrives twice as often (about once per three spins) as a dual sensor 3DR. The Moment Sums in the CORE give some indication (every spin) of whether a sudden burst of counts is natural if it is seen only in one sensor.

Four spins are allowed after each level increment for the MCP level to settle at the new value.
Seven spins of data are collected at each MCP level, after the settling time has elapsed.

There is no science reset during this test; the sweeps are not disabled, nor are their presets altered.

Recommended Use

Warning: if this sequence is used without the Sweep HVs ON, the instrument could be endangered.

Used in Normal Operations: this test should be carried out at regular intervals, perhaps initially every orbit or two, later dropping to once per month. This assumes that the expected rapid initial gain change (associated with degree of extracted charge) occurs and then the gain settles down.

The test will be carried out in suitable plasma environments. Identification of opportunities will occur during operations.

Number of input parameters

4

Parameters:

1 HEEA sweep mode and preset lsbs (sweep mode should be LAR)
2 HEEA sweep preset msbs
3 LEEA sweep mode and preset lsbs (sweep mode should be LAR)
4 LEEA sweep preset msbs

Detailed Outline

Start in READY BOTH HV ON, i.e. with Sweep HVs on, MCP HVs On.

The MCP Science Operational Levels are expected to be 15 [decimal] for HEEA and 16 [decimal] for LEEA, for 2 million gain. In practice they may be region dependent.

Set up HEEA sweeps to monitor environment in LAR mode with suitable preset to see lots of electrons at stable fluxes (but not spacecraft photoelectrons).
Set up LEEA sweeps with the same mode and preset.

Set up science processing/telemetry options to give CORE, NOI and 3DR-BOTH data.

Start science processing.

> Reduce the LEEA MCP operational level to 2.
> Set the HEEA MCP level to the appropriate Monitoring Operational Level for HEEA on this Spacecraft, chosen to be 15 [decimal].
>
> Collect data while elevating the MCP level on LEEA according to predefined pattern. The LEEA MCP level upper limit will be 19, corresponding to 4 million electrons.
>
> Reduce HEEA MCP to level 2
> Reduce LEEA MCP to the appropriate Monitoring Operational Level for LEEA on this spacecraft., chosen to be 16 [decimal].
>
> Collect data while elevating the MCP level on HEEA according to predefined pattern. The HEEA MCP level upper limit will be 17, corresponding to 4 million electrons.
> Set the HEEA & LEEA MCP levels to the appropriate (possibly region dependent) Science Operational Levels (usual henceforth setting, as used in HV_BOTH)

A Halt Science command (not included here) is needed to return to READY BOTH HV ON.

The delay time [*lev_change_ol_to_2*] is provisionally set to 120 seconds.
The delay time [*small_lev_change*] is provisionally set to 8 spins, 32 seconds.
The delay time, [*settle and accumulate counts*], is provisionally set at 44 seconds (see above)

The grids may need to switched on at the start of the test and off at the end (see Chapter 6).

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0249	0x0249	Datasets setup
delay 1 second			(COR, NOI, 3DR-BOTH)
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x0004	0x4504	Spacecraft Potential setup
delay 1 second			
ZEPDPRCN	0x0000	0x4700	Start Science
delay 20 seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x2249	0x2249	Datasets setup
delay 1 second			(COR, NOI, 3DR-H)
ZEPLMCPS	0x0002	0x0042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPHMCPS	0x000F	0x204F	HEEA Monitoring Level (15)
delay [*small_lev_change*] seconds			

continued next page

ZEPLMCPS	0x0004	0x0044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0006	0x0046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0007	0x0047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0008	0x0048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0009	0x0049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000A	0x004A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000B	0x004B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000C	0x004C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000D	0x004D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000E	0x004E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000F	0x004F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0010	0x0050	MCP Level 16
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0011	0x0051	MCP Level 17
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0012	0x0052	MCP Level 18
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0013	0x0053	MCP Level 19
delay [*settle and accumulate mcp counts*] seconds			

continued next page

ZEPHMCPS	0x0002	0x2042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x1249	0x1249	Datasets setup
delay 1 second			(COR, NOI, 3DR-L)
ZEPLMCPS	0x0010	0x0050	LEEA Monitoring Level (16)
delay [*small_lev_change*] seconds			
ZEPHMCPS	0x0004	0x2044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0006	0x2046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0007	0x2047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0008	0x2048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0009	0x2049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000A	0x204A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000B	0x204B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000C	0x204C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000D	0x204D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000E	0x204E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000F	0x204F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0010	0x2050	MCP Level 16
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0011	0x2051	MCP Level 17
delay [*settle and accumulate mcp counts*] seconds			

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ZEPHMCPS	parameter 5	HEEA Operational Level
delay [*small_lev_change*] seconds		
ZEPLMCPS	parameter 6	LEEA Operational Level
delay [*small_lev_change*] seconds		

Duration

The duration is

= 33 + 28*[*settle and accumulate counts*] + 2* [*lev_change_ol_to_2*] + 4*[*small_lev_change*]

= 1633 seconds = 27 minutes 13 seconds

(note: a further 20 seconds will be needed for HS to return to Ready Both HV On)

3.3.9.20 HV_MOLT_BOTH_SC_4 Mcp Op. Lev. Test: BOTH Sensors: Spacecraft 4

Description

Aim is to measure counts (on each anode) vs. MCP HV level in a stable plasma environment; the data provide a crude indication of the ideal MCP Operational Level at the time of the measurement.

A different version of this test is needed for each spacecraft, due to the different operational levels of the 8 orbiting sensors.

The test is carried out on one sensor while the other sensor monitors the environment (if the environment is unstable, the data from the monitoring sensor can be used to normalise the counts in the sensor which is under test). The procedure is then repeated but with the roles of the sensors exchanged. The main data product is NOI-BOTH, which is analysed to give the required information (for each anode). The 3DR-S data product is used to provide context information and is collected from the monitor sensor (not the sensor on which the MCP level is being altered). A single sensor 3DR is preferred as it arrives twice as often (about once per three spins) as a dual sensor 3DR. The Moment Sums in the CORE give some indication (every spin) of whether a sudden burst of counts is natural if it is seen only in one sensor.

Four spins are allowed after each level increment for the MCP level to settle at the new value.
Seven spins of data are collected at each MCP level, after the settling time has elapsed.

There is no science reset during this test; the sweeps are not disabled, nor are their presets altered.

Recommended Use

Warning: if this sequence is used without the Sweep HVs ON, the instrument could be endangered.

Used in Normal Operations: this test should be carried out at regular intervals, perhaps initially every orbit or two, later dropping to once per month. This assumes that the expected rapid initial gain change (associated with degree of extracted charge) occurs and then the gain settles down.

The test will be carried out in suitable plasma environments. Identification of opportunities will occur during operations.

Number of input parameters

4

Parameters:

1 HEEA sweep mode and preset lsbs (sweep mode should be LAR)
2 HEEA sweep preset msbs
3 LEEA sweep mode and preset lsbs (sweep mode should be LAR)
4 LEEA sweep preset msbs

Detailed Outline

Start in READY BOTH HV ON, i.e. with Sweep HVs on, MCP HVs On.

The MCP Science Operational Levels are expected to be 13 [decimal] for HEEA and 13 [decimal] for LEEA, for 2 million gain. In practice they may be region dependent.

Set up HEEA sweeps to monitor environment in LAR mode with suitable preset to see lots of electrons at stable fluxes (but not spacecraft photoelectrons).
Set up LEEA sweeps with the same mode and preset.

Set up science processing/telemetry options to give CORE, NOI and 3DR-BOTH data.

Start science processing.

> Reduce the LEEA MCP operational level to 2.
> Set the HEEA MCP level to the appropriate Monitoring Operational Level for HEEA on this Spacecraft, chosen to be 13 [decimal].
>
> Collect data while elevating the MCP level on LEEA according to predefined pattern. The LEEA MCP level upper limit will be 14, corresponding to 4 million electrons.
>
> Reduce HEEA MCP to level 2
> Reduce LEEA MCP to the appropriate Monitoring Operational Level for LEEA on this spacecraft., chosen to be 13 [decimal].
>
> Collect data while elevating the MCP level on HEEA according to predefined pattern. The HEEA MCP level upper limit will be 15, corresponding to 5 million electrons.
> Set the HEEA & LEEA MCP levels to the appropriate (possibly region dependent) Science Operational Levels (usual henceforth setting, as used in HV_BOTH)

A Halt Science command (not included here) is needed to return to READY BOTH HV ON.

The delay time [*lev_change_ol_to_2*] is provisionally set to 120 seconds.
The delay time [*small_lev_change*] is provisionally set to 8 spins, 32 seconds.
The delay time, [*settle and accumulate counts*], is provisionally set at 44 seconds (see above)

The grids may need to switched on at the start of the test and off at the end (see Chapter 6).

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	Parameter 1		HEEA sweep mode + PS
delay 1 second			
ZEPHSPSS	Parameter 2		HEEA sweep PS
delay 1 second			
ZEPLSMPS	Parameter 3		LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	Parameter 4		LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x0249	0x0249	Datasets setup
delay 1 second			(COR, NOI, 3DR-BOTH)
ZEPDHIPS	0x0008	0x4208	Correlator setup
delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x0004	0x4504	Spacecraft Potential setup
delay 1 second			
ZEPDPRCN	0x0000	0x4700	Start Science
delay 20 seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x2249	0x2249	Datasets setup
delay 1 second			(COR, NOI, 3DR-H)
ZEPLMCPS	0x0002	0x0042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPHMCPS	0x000D	0x204D	HEEA Monitoring Level (13)
delay [*small_lev_change*] seconds			

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ZEPLMCPS	0x0004	0x0044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0006	0x0046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0007	0x0047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0008	0x0048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x0009	0x0049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000A	0x004A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000B	0x004B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000C	0x004C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000D	0x004D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPLMCPS	0x000E	0x004E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			

continued next page

ZEPHMCPS	0x0002	0x2042	MCP Level 2
delay [*lev_change_ol_to_2*] seconds			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x1249	0x1249	Datasets setup
delay 1 second			(COR, NOI, 3DR-L)
ZEPLMCPS	0x000D	0x004D	LEEA Monitoring Level (13)
delay [*small_lev_change*] seconds			
ZEPHMCPS	0x0004	0x2044	MCP Level 4
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0006	0x2046	MCP Level 6
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0007	0x2047	MCP Level 7
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0008	0x2048	MCP Level 8
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x0009	0x2049	MCP Level 9
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000A	0x204A	MCP Level 10
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000B	0x204B	MCP Level 11
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000C	0x204C	MCP Level 12
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000D	0x204D	MCP Level 13
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000E	0x204E	MCP Level 14
delay [*settle and accumulate mcp counts*] seconds			
ZEPHMCPS	0x000F	0x204F	MCP Level 15
delay [*settle and accumulate mcp counts*] seconds			

continued next page

ZEPHMCPS	parameter 5	HEEA Operational Level
delay [*small_lev_change*] seconds		
ZEPLMCPS	parameter 6	LEEA Operational Level
delay [*small_lev_change*] seconds		

Duration

The duration is

= 33 + 21*[*settle and accumulate counts*] + 2* [*lev_change_ol_to_2*] + 4*[*small_lev_change*]

= 1325 seconds = 22 minutes 05 seconds

(note: a further 20 seconds will be needed for HS to return to Ready Both HV On)

3.3.10 High Level Science Qualifier Sequences

3.3.10.1 HS Halt Science processing

Description

This command sequence halts the science processing algorithms and sets internal variables to their default condition.

Recommended Use

Normal operations

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00FF	0x47FF	

delay 20 seconds

Duration

20 seconds

3.3.10.2 DPS Data Product Selection

Description

- Selects datasets to be telemetered (spin based and 3d distributions) from the calculated list, and their transmission priority

Recommended Use

Normal operations
Can be used without halting science processing

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDDATS	0x00uu	0x43uu
delay 1 second		
ZEPDDATP	0xuuuu	0xuuuu
delay 1 second		

Duration

2 seconds

3.3.10.3

MCPTS has been renamed HV_MCPTS and moved to 3.3.9.16

3.3.10.4 GS Grid Switches; both sensors

Description

Turns HEEA and/or LEEA grid ON (to –8V) or OFF (to 0 V)
The grid is placed at the analyser exit. When *on*, the grid reduces the flux of particles exiting the analyser which reach the MCP. The variable u is 1 for grid *on* and 0 for grid *off*. The first command affects HEEA, the second affects LEEA.

Recommended Use

Normal operations

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHCISG	0x00u0	0x20u0
delay 1 second		
ZEPLCISG	0x00u0	0x00u0
delay 1 second		

Duration

2 seconds

3.3.10.5 STIMTEST STIM TEST

Description

Used to assess level of 'Electronic Noise', 'External Noise Pickup ', 'Change of Susceptibility Noise'. Locates the level of the Amplifier Thresholds (which is known to be temperature dependent).

Recommended Use

Normal operations; at the start of each orbit during the 15 minute period assigned to payload “calibration” .

This command sequence should only be used when the instrument is in the “RUNNING SAFE” state.

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPLSTMN	0x0000	0x00E1	Variable Stim on LEEA
delay 40 seconds			
ZEPLSTMN	0x0001	0x00E3	Constant Stim on LEEA
delay 40 seconds			
ZEPLSTMF	0x0000	0x00E0	LEEA Stim off
delay 40 seconds			
ZEPHSTMN	0x0000	0x20E1	Variable Stim on HEEA
delay 40 seconds			
ZEPHSTMN	0x0001	0x20E3	Constant Stim on HEEA
delay 40 seconds			
ZEPLSTMN	0x0001	0x00E3	Constant Stim on LEEA (too)
delay 40 seconds			
ZEPLSTMF	0x0000	0x00E0	LEEA Stim off
delay 1 second			
ZEPHSTMF	0x0000	0x20E0	HEEA Stim off
delay 1 second			

Duration

242 seconds = 4 minutes 2 seconds

3.3.10.6 VAR_STIMS_ON Variable Stimuli On

Description

Turn on PEACE variable stimuli

Recommended Use

Commissioning

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSTMN	0x0000	0x20e1	HEEA stim on
delay 1 second			
ZEPLSTMN	0x0000	0x00e1	LEEA stim on
delay 1 second			

Duration

2 seconds

3.3.10.7 STIMS_OFF Stimuli Off

Description

Turn off PEACE stimuli

Recommended Use

Commissioning

Number of input parameters

None

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSTMF	0x0000	0x20e0	HEEA stim off
delay 1 second			
ZEPLSTMF	0x0000	0x00e0	LEEA stim off
delay 1 second			

Duration

2 seconds

3.3.10.8 SPA_SWITCH Spacecraft Potential Algorithm control SWITCH

Description

Selects whether the spacecraft potential is calculated and if so, by which method.

Recommended Use

Normal operations

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDSPOT	0x000u	0x450u	Spacecraft Potential setup

delay 1 second

Duration

1 second

3.3.10.9 TDA Telemetry Mode Flag

Description

Conveys which telemetry mode the spacecraft is operating in.

Recommended Use

Normal operations

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDTELS	0x000u	0x460u	telemetry mode

delay 1 second

Duration

1 second

3.3.11 Uplink Sequences (see also Chapter 7)

3.3.11.1 UDTCFH Uplink HEEA Dead Time Correction Factors

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).
Note. This command sequence is to be confirmed.

Description

This command sequence can be used to uplink dead time correction factors. The control word specifies which HEEA anode (0 to 11, labelled 16-27) is referred to and the argument (parameter) word contains the data value to be uplinked.

Recommended Use

Commissioning

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHDTC	0x00u_1u_2	0x57u_1u_2	u_1u_2 in range 16 to 27
ZEPDDTCF	0xuuuu	0xuuuu	

3.3.11.2 UDTCFL Uplink LEEA Dead Time Correction Factors

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).
Note. This command sequence is to be confirmed.

Description

This command sequence can be used to uplink dead time correction factors. The control word specifies which LEEA anode (0 to 11) is referred to and the argument (parameter) word contains the data value to be uplinked.

Recommended Use

Commissioning

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLDTC	0x00u_1u_2	0x57u_1u_2	u_1u_2 in range 0 to 11
ZEPDDTCF	0xuuuu	0xuuuu	

3.3.11.3 UPH Uplink Parameters for HEEA

Description

This command sequence can be used to uplink HEEA parameters.

Recommended Use

Commissioning, also 3DX control in normal operations

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHPUE	0x000u	0x760u	
ZEPDPUPS	0xuuuu	0xuuuu	

3.3.11.4 UPL Uplink Parameters for LEEA

Description

This command sequence can be used to uplink LEEA parameters.

Recommended Use

Commissioning, also 3DX control in normal operations

Number of input parameters

2

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLPUE	0x000u	0x560u	
ZEPDPUPS	0xuuuu	0xuuuu	

3.3.11.5 UPGH Uplink Geometric factors for HEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink HEEA geometric factors.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHGUE	0x000u	0x780u	
ZEPDG0PS	0xuuuu	0xuuuu	
ZEPDGIPS	0xuuuu	0xuuuu	

3.3.11.6 UPGL Uplink Geometric factors for LEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink LEEA geometric factors.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLGUE	0x000u	0x580u	
ZEPDG0PS	0xuuuu	0xuuuu	
ZEPDGIPS	0xuuuu	0xuuuu	

3.3.11.7 UEEH Uplink Energy Efficiencies for HEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink HEEA energy efficiencies.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHFVE	0x00uu	0x7Auu	
ZEPDF0PS	0xuuuu	0xuuuu	
ZEPDF1PS	0xuuuu	0xuuuu	

3.3.11.8 UEEL Uplink Energy Efficiencies for LEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink LEEA energy efficiencies.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLFVE	0x00uu	0x5Auu	
ZEPDF0PS	0xuuuu	0xuuuu	
ZEPDF1PS	0xuuuu	0xuuuu	

3.3.11.9 UM Uplink Magnetometer calibration information

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink magnetometer calibrations.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDFGM1	0x00uu	0x5Buu	
ZEPDFGM2	0xuuuu	0xuuuu	
ZEPDFGM3	0xuuuu	0xuuuu	

3.3.11.10 UESH Uplink Energy Steps for HEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink HEEA energy steps.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHEVE	0x00uu	0x79uu	
ZEPDE0PS	0xuuuu	0xuuuu	
ZEPDE1PS	0xuuuu	0xuuuu	

3.3.11.11 UESL Uplink Energy Steps for LEEA

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink LEEA energy steps.

Recommended Use

Commissioning

Number of input parameters

3

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLEVE	0x00uu	0x59uu	
ZEPDE0PS	0xuuuu	0xuuuu	
ZEPDE1PS	0xuuuu	0xuuuu	

3.3.11.12.1 UMAC_0 Uplink Macro of 4 Commands

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink a PEACE Macro command. Macros can't contain time delays.

Recommended Use

Commissioning and Normal Operations

Number of input parameters:

7

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x00uu	0x5E8u	Macro number
ZEPDMAC2	0xuuuu	0xuuuu	macro position and size
ZEPDMAC2	0xuuuu	0xuuuu	1st macro command
ZEPDMAC2	0xuuuu	0xuuuu	2nd macro command
ZEPDMAC2	0xuuuu	0xuuuu	3rd macro command
ZEPDMAC2	0xuuuu	0xuuuu	4th macro command
ZEPDMAC2	0xuuuu	0xuuuu	macro checksum

delay 2 seconds

Duration

2 seconds

3.3.11.12.2 UMAC_1 Uplink Macro of 5 Commands

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink a PEACE Macro command. Macros can't contain time delays.

Recommended Use

Commissioning and Normal Operations

Number of input parameters:

8

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x00uu	0x5E8u	Macro number
ZEPDMAC2	0xuuuu	0xuuuu	macro position and size
ZEPDMAC2	0xuuuu	0xuuuu	1st macro command
ZEPDMAC2	0xuuuu	0xuuuu	2nd macro command
ZEPDMAC2	0xuuuu	0xuuuu	3rd macro command
ZEPDMAC2	0xuuuu	0xuuuu	4th macro command
ZEPDMAC2	0xuuuu	0xuuuu	5th macro command
ZEPDMAC2	0xuuuu	0xuuuu	macro checksum

delay 2 seconds

Duration

2 seconds

3.3.11.12.3 UMAC_2 Uplink Macro of 9 Commands

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink a PEACE Macro command. Macros can't contain time delays.

Recommended Use

Commissioning and Normal Operations

Number of input parameters:

12

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x00uu	0x5E8u	Macro number
ZEPDMAC2	0xuuuu	0xuuuu	macro position and size
ZEPDMAC2	0xuuuu	0xuuuu	1st macro command
ZEPDMAC2	0xuuuu	0xuuuu	2nd macro command
ZEPDMAC2	0xuuuu	0xuuuu	3rd macro command
ZEPDMAC2	0xuuuu	0xuuuu	4th macro command
ZEPDMAC2	0xuuuu	0xuuuu	5th macro command
ZEPDMAC2	0xuuuu	0xuuuu	6th macro command
ZEPDMAC2	0xuuuu	0xuuuu	7th macro command
ZEPDMAC2	0xuuuu	0xuuuu	8th macro command
ZEPDMAC2	0xuuuu	0xuuuu	9th macro command
ZEPDMAC2	0xuuuu	0xuuuu	macro checksum

delay 3 seconds

Duration

3 seconds

3.3.11.12.4 UMAC_3 Uplink Macro of 13 Commands

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink a PEACE Macro command. Macros can't contain time delays.

Recommended Use

Commissioning and Normal Operations

Number of input parameters:

16

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x00uu	0x5E8u	Macro number
ZEPDMAC2	0xuuuu	0xuuuu	macro position and size
ZEPDMAC2	0xuuuu	0xuuuu	1st macro command
ZEPDMAC2	0xuuuu	0xuuuu	2nd macro command
ZEPDMAC2	0xuuuu	0xuuuu	3rd macro command
ZEPDMAC2	0xuuuu	0xuuuu	4th macro command
ZEPDMAC2	0xuuuu	0xuuuu	5th macro command
ZEPDMAC2	0xuuuu	0xuuuu	6th macro command
ZEPDMAC2	0xuuuu	0xuuuu	7th macro command
ZEPDMAC2	0xuuuu	0xuuuu	8th macro command
ZEPDMAC2	0xuuuu	0xuuuu	9th macro command
ZEPDMAC2	0xuuuu	0xuuuu	10th macro command
ZEPDMAC2	0xuuuu	0xuuuu	11th macro command
ZEPDMAC2	0xuuuu	0xuuuu	12th macro command
ZEPDMAC2	0xuuuu	0xuuuu	13th macro command
ZEPDMAC2	0xuuuu	0xuuuu	macro checksum

delay 4 seconds

Duration

4 seconds

3.3.11.13 USO Uplink Sunpulse Offset

*NOTE: This operation is a low priority patch, as defined in the JSOC/PI Interface Control Document (DS-JSO-ID-00002).

Description

This command sequence can be used to uplink a new sunpulse offset.

Recommended Use

Commissioning

Number of input parameters

1

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDSN1S	*No parameter*	0x5500	
delay 1 second			
ZEPDSN2S	0xuuuu	0xuuuu	
delay 5 seconds			

(if sent during science processing run time then a short spin may result).

Duration

6 seconds

3.4 PEACE OBDH Macros Definitions

The OBDH used on the CLUSTERII spacecraft has the capability to launch a predefined set of commands, know as a spacecraft macro. This should not be confused with a PEACE onboard macro, which is a series of commands that resides in the DPU of the PEACE experiment. The OBDH has a limited storage of the number and size of spacecraft macros (Cluster EID-C section 7). Because of the limitations within the OBDH it was decided that for the CLUSTER mission "experimenter" defined spacecraft macros would only be used for emergency operations.

In 3.4.1 we describe spacecraft macros to provide varying degrees of shut down for PEACE. Elsewhere we will describe rules for using these power control macros (tbc)

The spacecraft macros in section 3.4.2 are an example of such a set designed to reboot the PEACE instrument and place it into a default science mode. The OBDH has the capability to assess the status of the instrument by interrogating the house keeping data. In this way it is able to track the reboot and ensure that the next spacecraft macro is only launched when the instrument is ready for it. Conditions for implementation tbd

3.4.1 Contingency Power Control Options

3.4.1.1 PMACPOFF Power off PEACE

Description

This macro is intended to switch off the 28 volt to the PEACE DPU in an emergency situation. It **will not** disable the high voltages or halt the PEACE DPU before the power is turn off.

Command Sequence

(no PEACE commands)

“Spacecraft macro to turn *off* 28 V supply to PEACE DPU”

3.4.1.2 PMACSOFF Both sensors power off

Description

This macro can be used to switch off the all LEEA and HEEA sensor power in an emergency situation. It **will not** disable the high voltages before the sensor power is turn off.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDSPWF	*No parameter*	0x4800	

3.4.1.3 PMACLOFF LEEA sensor power off

Description

This macro can be used to switch off all LEEA sensor power in an emergency situation. It **will not** disable the high voltages before the sensor power is turn off.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLPCN	0x0000	0x4B00	

3.4.1.4 PMACHOFF HEEA sensor power off

Description

This macro can be used to switch off all HEEA sensor power in an emergency situation. It **will not** disable the high voltages before the sensor power is turned off.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHPCN	*No parameter*	0x6B00	

3.4.1.5 PMACHVOF All PEACE HVs off

Description

This macro switches off all LEEA and HEEA high voltages.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGD	0x0000	0x20C0	
ZEPLHVGD	0x0000	0x00C0	

3.4.1.6 PMACMCPS MCPs to safe level

Description

This macro sets the LEEA and HEEA MCP high voltages to level zero.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x0000	0x2040	
ZEPLMCPS	0x0000	0x0040	

3.4.2 Contingency Instrument Restart

3.4.2.1 PMACRSET Reset PEACE instrument

Description

This macro will switch off all LEEA and HEEA sensor power, it **will not** disable the sensor high voltages before the sensor power is turned off. The DPU will then execute a DPU software reset provided that the DPU hardware watchdog is enabled.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDRSET	*No parameter*	0x48A5	

3.4.2.2 PMACRBOO Reboot PEACE instrument (macro 1 in reboot series)

Description

This macro will switch off all LEEA and HEEA sensor power, it **will not** disable the sensor high voltages before the sensor power is turned off. The DPU will then execute a DPU software reset provided that the DPU hardware watchdog is enabled. The next function of this macro is to setup an OBDH monitor that can be used to fire the first of a chain of macros to bring the PEACE instrument back up to a nominal operational state.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDRSET	*No parameter*	0x48A5	

"On the spacecraft, setup OBDH monitor on HK parameter EPD_STAT to fire macro 2 in reboot series if EPD_STAT = 201 for 2 formats."

3.4.2.3 PMACEXEC Run Executive code from EEPROM (macro 2 in reboot series)

Description

This macro runs the executive code. The next function of this macro is to setup an OBDH monitor that can be used to fire a macros to run the main application code.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDBOOS	0x0001	0x4D01	

"On the spacecraft, setup OBDH monitor on HK parameter EPD_STAT to fire macro 3 in reboot series if EPD_STAT = 3 for 2 formats."

3.4.2.4 PMACMAIN Run application code from EEPROM (macro 3 in reboot series)

Description

This macro runs the main application code. The next function of this macro is to setup an OBDH monitor that can be used to fire a macros to power the LEEA and HEEA sensors.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDEAPP	0x0091	0x5291	

"On the spacecraft, setup OBDH monitor on HK parameter EPD_STAT to fire macro 4 in reboot series if EPD_STAT = 100 for 2 formats".

3.4.2.5 PMACSPON Power sensors (macro 4 in reboot series)

Description

This macro powers the LEEA and HEEA sensors. The next function of this macro is to setup an OBDH monitor that can be used to fire a macros to configure and start the science processing.

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDLPCN	0x0003	0x4B03	
ZEPDCONF	*No parameter*	0x4F55	
ZEPDHPCN	0x0003	0x6B03	
ZEPDCONF	*No parameter*	0x4F55	

"On the spacecraft, setup OBDH monitor on HK parameter EPH_36VV to fire macro 5 in reboot series if EPH_36VV > 32 volts".

3.4.2.6 PMACSCIP Configure science and start science processing (macro 5 in reboot series)

Description

Set LEEA and HEEA sweep mode and preset, configure DPU science algorithms, start science processing, setup OBDH monitor to fire macro to enable high voltages when science processing starts.

This command sequence to be revised

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	0x000C	0x206C	
ZEPHSPSS	0x0017	0x2097	
ZEPLSMPS	0x000C	0x006C	
ZEPLSPSS	0x0010	0x0090	
ZEPDHIPS	0x0000	0x4200	
ZEPDMAGS	0x0000	0x4400	
ZEPDSPOT	0x0000	0x4500	
ZEPDHWCE	0x00E6	0x4CE6	
ZEPDPRCN	0x0000	0x4700	

"On the spacecraft, setup OBDH monitor on HK parameter EPD_ SCCT to fire macro 6 in reboot series if EPD_SCCT > 0".

3.4.2.7 PMACHVON Enable High Voltages and set MCP level (macro 6 in reboot series)

Description

Set MCP levels and enable high voltages

Command Sequence

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGE	No parameter	0x20C3	
ZEPLHVGE	No parameter	0x00C3	
ZEPHMCPS	The appropriate MCP level will only be known after commissioning.		
ZEPLMCPS	The appropriate MCP level will only be known after commissioning.		

3.5 PEACE Commanding via JSOC

3.5.1 JSOC Commanding Model

The JSOC approach to compiling payload-wide control files has been designed so as to encompass the different instrument control models found across the Cluster payload.

JSOC chose to describe control in terms of a model which assumes that an instrument resides at any given time in a particular state or "Mode", and that a command or sequence of commands will transfer the instrument to another state. The command or command sequence brings about a "Mode Transition".

The set of calls to command sequences which command a Mode Transition is referred to as an "Instrument Baseline Mode Definition", although it does not define a Mode (!).

The PEACE commanding philosophy for standard operations can be incorporated fairly easily into the JSOC model. The main area of difficulty is the concept of a Science Mode, which is unique within the JSOC scheme but which embraces a rich set of possibilities when seen from the PEACE perspective. Also, JSOC requires that only one IBMD should be associated with a transition between two given modes. Some rather arbitrary modes have been defined to accommodate the more flexible PEACE scheme within the JSOC model. Other actions are dealt with by PMRQ (see below).

A PEACE "science mode" is prepared using one of the command sequences SETUP_0, SETUP_1, SETUP_2 or SETUP_3 (or the command sequence SETUP_4 which calls two Macros). The choice of SETUP options depends on which data products are preferred. The instrument is thereby placed in a state of readiness to perform science processing. The science processing is usually activated using RUNSCI_BOTH, after which the instrument generates telemetry. Using DPS, the order of transmission of the calculated datasets can be varied. The HV_BOTH command turns on the High Voltage generators for the sweep and the MCP, after which the instrument is able to analyse and detect electrons. When the HVs are on and the science processing is on, the instrument can collect science data. The various combinations of telemetry generated and setup of the sweeps constitute the different science modes.

The command sequence DPS may be used to alter the choice of telemetered data products selected from the list of generated data products, once science processing is in progress. The science mode command sequences require a number of input parameters. In the JSOC model, the parameters associated with individual science modes (and used by SETUP_n and DPS) are provided by the PI team in the form of VAL files or Henceforth Parameters. Henceforth Parameters are altered using Default Parameter Value files (DEPV files).

JSOC creates PI Observation Requests (PIORs) on the basis of mission planning agreed by the SWT/SOWG combined with PI team input concerning operational modes required for various geospace regions, and models of the passage of the spacecraft through geospace. PIORs contain PI team specified command sequences, organised via the rules represented within IBMDs. PIORs are made available to the PI team for checking, and after acceptance are combined with PIORs from other teams to produce a payload-wide commanding file or Observation Request (OBRQ).

JSOC handles commanding changes that cannot be readily dealt with in the model above by using PIOR Modification Requests (PMRQs) or IPCH files according to the nature of the action.

The PEACE instrument modes for nominal operations are defined in Section 3.5.2.

The command sequences for nominal (and other) operations are defined and described in Section 3.3.

The parameters (to be entered into VAL files) to control specific science modes for nominal operations are defined in Chapter 6.

The overall command flow, changes between instrument modes and use of IBMDs and PMRQs are also presented in Figures in Section 3.5.3.

3.5.2 Instrument Modes

The following PEACE instrument modes for nominal operations have been identified for the purposes of commanding via the JSOC interface.

Commanding between the modes will be by Instrument Baseline Modes Definitions (IBMD's). These will consist of one or more of the command sequences described in Section 3.3.

3.5.2.1 PEACE Off KAL On

Scientific description.

No science data being produced.

Sensor set-up.

All sensor voltages off

DPU set-up.

Kal on, 28V power off.

3.5.2.2 PEACE On

Scientific description.

No science data being produced.

Sensor set-up.

All sensor voltages off

DPU set-up.

Kal on, 28V power on.
Required Command Sequence from mode **PEACE Off KAL On** is PO.

3.5.2.3 Executive Mode

Scientific description.

No science data being produced.

Sensor set-up.

All sensor voltages off

DPU set-up.

DPU running executive code.
Required Command Sequence from mode **PEACE On** is EE

3.5.2.4 Standby Both Pro

Scientific description.

No science data being produced.

Sensor set-up.

All sensor voltages off

DPU set-up.

DPU running main application code using both processors.
Required Command Sequence from mode **Executive Mode** is RA2.
Required Command Sequence from mode **Ready Both Safe** is LV_ OFF.
Required Command Sequence from mode **Running Safe** is LV_SCI_OFF.

3.5.2.5 LV On Both

Scientific description.

No Science data being produced.

Sensor set-up.

Low voltage (5V, ±8V, 36V) on to LEEA and HEEA

DPU set-up.

No change.
Required Command Sequence from mode **Standby Both Pro** is LV_BOTH.

3.5.2.6 Ready Both Safe

Scientific description.

No Science data being produced.

Sensor set-up.

Low voltage (5V, ±8V, 36V) on to LEEA and HEEA

DPU set-up.

IELs, watchdog and telemetry interface with spacecraft are set up.
Required Command Sequence from modes **LV On Both** is INTERFACE.

3.5.2.7 Setup Safe

Scientific description.

No Science data being produced.

Sensor set-up.

Low voltage (5V, ±8V, 36V) on to LEEA and HEEA

DPU set-up.

DPU configuration is prepared for science processing
IELs, watchdog and telemetry interface with spacecraft are set up.
Science processing is off
Required Command Sequence from mode **Ready Both Safe** is SETUP_n

3.5.2.8 Running Safe

Scientific description.

Datasets being produced, but no measurements are being made.

Sensor set-up.

LEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
HEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
No high voltages

DPU set-up.

Science Processing is running.
DPU data products as defined by relevant parameter file.
Required Command Sequence from mode **Setup Safe** is RUNSCI_BOTH.

3.5.2.9 Running HV On

Scientific description.

Science data being produced. This is the proper mode for Science Operations.

Sensor set-up.

LEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
HEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
High voltages on LEEA and HEEA

DPU set-up.

Science Processing is running.
DPU data products as defined by relevant parameter file.
Required Command Sequence from mode **Running Safe** is HV_BOTH.
Required Command Sequence from mode **MCP Noise HV On** is HV_MEL_BOTH.
Required Command Sequence from mode **Stims Done Safe** is HV_BOTH.

3.5.2.10 MCP Noise HV On

Scientific description.

Science data being produced.

Sensor set-up.

MCP high voltages on LEEA and HEEA (sweep off)

DPU set-up.

Science Processing is running.
DPU data products as defined by relevant parameter file.
Required Command Sequence from mode **Running HV On** is HV_MNT_BOTH.

3.5.2.11 Ready Both HV On

Scientific description.

No Science data being produced.

Sensor set-up.

Low voltage (5V, ±8V, 36V) on to LEEA and HEEA
High voltages on LEEA and HEEA

DPU set-up.

IELs, watchdog and telemetry interface with spacecraft are set up.
Required Command Sequence from mode **Running HV On** is HS.
Required Command Sequence from mode **MCP Op Lev HV On** is HS.

3.5.2.12 Setup HV On

Scientific description.

No Science data being produced.

Sensor set-up.

Low voltage (5V, ±8V, 36V) on to LEEA and HEEA
High voltages on LEEA and HEEA

DPU set-up.

DPU configuration is prepared for science processing
IELs, watchdog and telemetry interface with spacecraft are set up.
Science processing is off
Required Command Sequence from modes **Ready Both HV On** is SETUP_n.

3.5.2.13 Stims Done Safe

Scientific description.

Science data being produced.

Sensor set-up.

LEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
HEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
No high voltages

DPU set-up.

Science Processing is running.
DPU data products as defined by relevant parameter file.
Required Command Sequence from mode **Running Safe** is STIMTEST.

3.5.2.14 MCP Op Lev HV On

Scientific description.

Science data being produced, for test purposes.

Sensor set-up.

LEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
HEEA sensor sweep mode and sweep preset set as defined by relevant parameter file.
High voltages on LEEA and HEEA

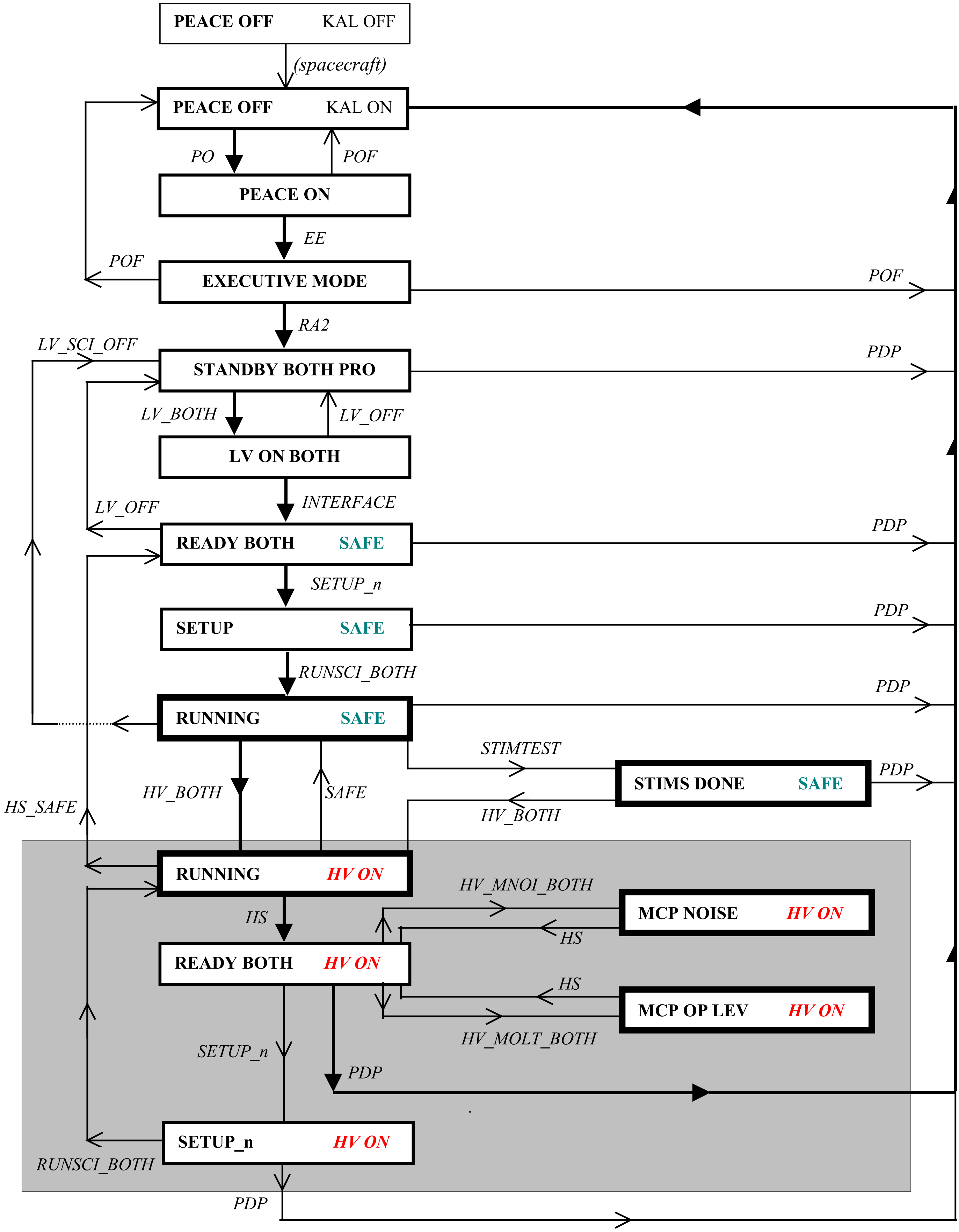
DPU set-up.

Science Processing is running.
DPU data products as defined by relevant parameter file.
Required Command Sequence from mode **Ready Both HV On** is HV_MOLT_BOTH.

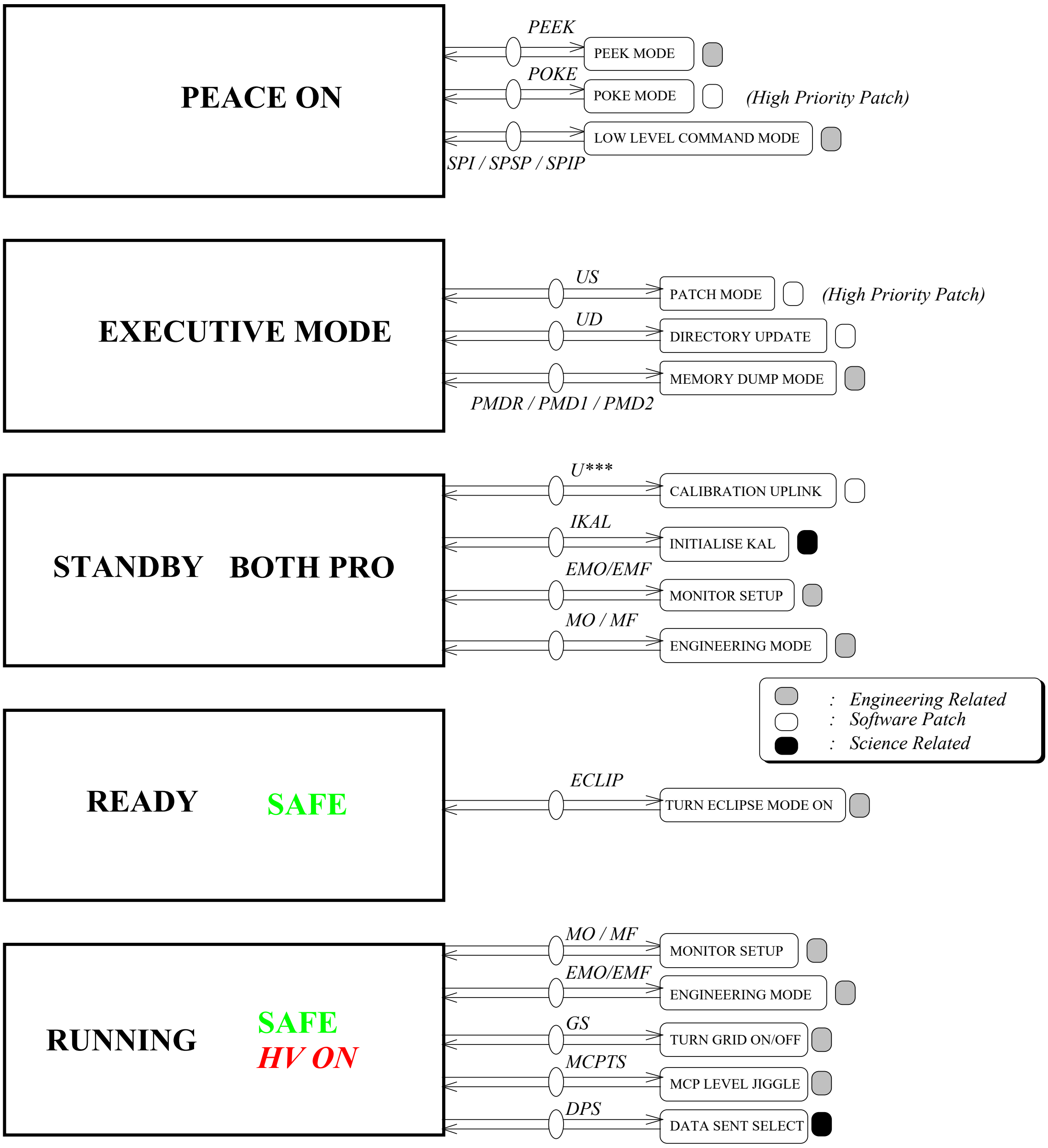
3.5.3 Command Sequence Flow Diagram

Commands sequences are described in Section 3.2 and listed in Section 3.3. Modes are described in 3.5.2.

The following is the first of two figures illustrating the correct use of command sequences.
Note:
- Heavy lined boxes indicate that the science processing is on (data is being produced).
- Boxes in the region with shaded background involve states with active HVs.
- The heavy lined solid arrows indicate the minimum chain of events needed to turn on the instrument, collect science data and turn off the instrument.


PEACE OFF KAL OFF
(spacecraft)
PEACE OFF KAL ON
PO
POF
PEACE ON
EE
POF
EXECUTIVE MODE
POF
RA2
LV_SCI_OFF
STANDBY BOTH PRO
PDP
LV_BOTH
LV_OFF
LV ON BOTH
LV_OFF
INTERFACE
READY BOTH SAFE
PDP
SETUP_n
SETUP SAFE
PDP
RUNSCI_BOTH
RUNNING SAFE
PDP
STIMTEST
STIMS DONE SAFE
PDP
HV_BOTH
HV_BOTH
SAFE
HS_SAFE
RUNNING HV ON
HV_MNOI_BOTH
MCP NOISE HV ON
HS
HS
READY BOTH HV ON
HS
MCP OP LEV HV ON
HV_MOLT_BOTH
SETUP_n
PDP
SETUP_n HV ON
RUNSCI_BOTH
PDP

The following figure shows how additional, less frequently used commands are used. Note that these commands / command sequences should only be used when the instrument is in the correct mode for the desired activity.



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PEACE USER MANUAL CHAPTER 4

Version 4.0
17-Mar-2000

Change Sheet since Cluster 1

Minor reorganisation.
Simplification of temperature section
Changes to text in 4.2 and 4.3

4. ENVIRONMENT

4.1 Thermal Environment

4.1.1 Measured Temperatures

The Sensor Temperatures are available in the Spacecraft HK Telemetry stream. They can be monitored whether or not PEACE is turned on.

The DPU Temperatures are available in the PEACE HK Telemetry stream (in EPD-DTMP). They can only be monitored while PEACE is on. (The measured DPU temperature is thought to be up to 10° C higher than that at the DPU foot, due to internal heating by the electronics).

4.1.2 Temperature Limits and Requested ESOC Actions

4.1.2.1 Non-Operating Temperature Limits

	Non-Operating Temperature Limits (°C)		
Experiment Unit	Nominal	Monitor & Warn PI	> Qual Level; Inform PI
HEEA	-30 to + 40	(-40 to -30) and (+40 to + 50)	< -40 and > +50
LEEA	-30 to + 40	(-40 to -30) and (+40 to + 50)	< -40 and > +50
DPU	-20 to + 50	(-40 to -20) and (+50 to + 60)	< -30 and > +60

4.1.2.2 Operating Temperature Limits

	Operating Temperature Limits (°C)		
Experiment Unit	Nominal	Monitor & Warn PI	Turn Off and Inform PI
HEEA	-5 to +20	(-10 to -5) and (+20 to + 30)	< -10 and > +30
LEEA	-5 to +20	(-10 to -5) and (+20 to + 30)	< -10 and > +30
DPU	-5 to +30	(-10 to -5) and (+20 to + 30)	< -10 and > +40

In general, it is desirable that the MCPs should be run at lower temperatures rather than higher temperatures, in order to reduce noise counts and to reduce the risk of thermal runaway.

These values may be altered in the light of flight experience.

4.1.2.3 OBDH Actions

It is recognised that the OBDH could be used to monitor the spacecraft HK, and could be used to turn off the instrument (e.g. using spacecraft macro PMACPOFF). However, the baseline assumption is that this possibility will not be enacted.

4.2 Radiation

The instrument is designed to withstand a total dose of 40 kRads by careful component selection, positioning of components to make best use of shielding by spacecraft and instrument hardware and, where necessary, spot shielding.

Engineering considerations recommend against frequent low altitude operations. The danger to electronic systems (i.e. SEUs) in the radiation belts is greater if they are turned on.

However, there are scientific arguments in favour of low altitude operations.

It is not clear how seriously measurements will be affected by radiation-induced noise counts in the sensor detector. This may be investigated during Commissioning.

The baseline plan is to ensure that PEACE is off when at altitudes below the L-shell L = 6. The implementation will be performed by JSOC.

It is clear that one problem is the natural variability of the radiation environment. A conservative safety limit (e.g. L = 6) may often result in no collection of data at lower altitudes which would in fact have been safe. Ideally (for science), a lower safety limit could be used, together with monitoring of the total counts in the sensors (in PEACE HK) as a check on the actual levels of radiation. This method can only be envisaged if there is either real time contact with the ability to quickly turn off PEACE, or if the OBDH is used to turn off PEACE when the total counts exceed a given limit. These approaches are not expected to be part of normal operations at the time of writing.

Operational policy will be kept under review throughout the mission. It is possible that the precautions may be gradually relaxed later in the mission.

4.3 Thruster Firing

During and shortly after thruster operation there is a risk of instrument contamination and/or an increase in gas pressure in the instrument aperture region. The instrument should be switched off before thruster firing and after firing the instrument high voltages should not be turned on until **1 hour** delay (this duration to be reviewed based on experience gained in orbit).

Command Sequences to control this aspect of operations will be incorporated into the normal operations planning.

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PEACE USER MANUAL CHAPTER 5

Version 4.8
10th April 2024

Change Sheet

To add:
Work with ASPOC
New steps 10, 11
SSR default commanding

Version 3.4

5.3.3.1 – procedure name corrected
5.3.3.2, 5.3.3.3, 5.3.3.4, 5.3.3.5 – sequence corrected
5.4.2 – description changed
5.4.2.3 – sunpulse offset changed
5.4.3 – aim changed, procedure names changed
5.4.8 – added verification table for SPOS
5.4.4, 5.4.5, 5.4.11.1, 5.4.12.1 – procedure names changed
5.4.13, 5.4.14, 5.4.15, 5.4.16, 5.4.17, 5.4.18 – procedure names changed and bit patterns altered
5.4.19 – changed procedure name
5.4.20, 5.4.23 – procedure names and command sequence changed
5.4.10 – added interference campaign macros
5.7 – added command sequences and descriptions to the interference campaign information

Changed Step 2 (uplinking) to accommodate for checking uplinked values (added checksum uplinking)

Altered sweep tests to correct presets for mode changes
Altered current/voltage check tables in Steps 1a and 1b.
Added descriptions of sequences in 5.3.3

Version 3.5

Added IEL tests and altered procedures to agree with CH3

Version 3.6

Various small errors corrected, some tbc's c'd, IEL test with WEC altered.
READY BOTH changed to READY BOTH SAFE where appropriate
Expanding WHISPER interference campaign
Expanding EDI interference campaign
Adding macros to turn PEACE back to standard mode during interference campaign

Version 3.7

Merged two versions of Ch 5, version 3.6 (on server) and 3.6 (anf)
From anf version: added
Test of spacecraft potential algorithm
Test of magnetic field estimation by symmetry direction
Test of LAR, MAR and HAR modes
Test of Interference Campaign macros
Test of unconventional data products
Added test of DWP IEL
Added macros b and c
Added macro descriptions, changed commands slightly

Version 3.8

Merged two versions of Ch 5, version 3.7 (on server) and 3.f (anf)
From anf version: added Revised Steps 10-13 (5.4.23-28)
Made corresponding modifications to 5.3

Version 3.9

5.4.10:
Changed macro 1 (EDI DPU setup) – changed command 4208 to 4202
Added macro 'd' for potential campaigns
Changed description to agree with new UMAC sequence names, changed descriptions of some macros to agree with recent ifc changes, changed STD-NM1-1e and STD-BM1-1e to STD-ALL-1e etc
Added in turning off science at end
5.4.7, 5.4.9:
Changed description of what to do if checksum uplink doesn't work, section 5.4.7.10 and 5.4.9.3
Changed information about FGM ranges
5.4.21.3 – changed name of WHISPER 1 to Electronic Noise
5.4.21.8 – changed spacecraft potential mode description and commands
5.4.10 – changed length of time to uplink macros
5.4.13 – corrected ZEP commands for HEEA part of test
5.4.20.2 – put in parameters for STD-ALL-1e and removed DPS
5.4.22.2 – put in parameters for STD-ALL-1e and removed DPS
5.4.10 – swapped commands in macro 0 with those in macro 2 and changed description
5.7.2 – swapped descriptions of HEEA and LEEA in part 1 and part 2, changed 3DX to 3DF in description, put in time of ½ an hour
5.7.3 – re-written this completely – is now called Electronic Noise campaign instead of WHISPER 1
5.7.4 – put in duration
5.7.5 – put in duration and took out ASPOC off part of test
5.7.6 – added in extra two WHISPER offsets for CIS
5.4.23 – added in commands
5.4.24 – corrected commands
5.4.13 – took out 'STIMTEST' procedure declaration
overall – decided upon some tbd times
5.4.25 – put in commands
5.4.22 – changed ending of Eclipse mode check so SPOS is reset to 176
5.4.26 – added new description and commands

5.3.28 – added new description and commands
5.4.18 – put in commands where there are 'u's and altered procedure because of this
5.4.7 – changed 'duration' description and number of telecommands
changed KAL instructions so that KAL is no longer turned on (it is always on) – but its current is checked
5.4.14.8, 5.4.15.7 – changed end here so that sensor is put into 30h00 before mode is changed to fixed
5.4.18.3 – changed fixed level to 15 for safety

Version 4.0

5.4.3.3 – corrected LEEA 36VV check
5.3.2 – corrected table

Version 4.1

corrected description of Macro 2 in 5.4.10
changed SETUP_3 to SETUP_2 in Step 9c and SETUP_2 to SETUP_3 in step 10a
step 9 – changed to BM1 throughout
5.4.28 – changed cplxt to cpltx throughout, changed ZEPDPUPS from 2940 to 293f
5.4.23.2, 5.2.24.1, 5.4.25.1,2,3,4, 5.4.28.1,2 – changed ZEPDPUPS values again for window limits and setup

Version 4.2

Changed order of steps 4 and 5 so that 'fixed' mode is checked first, then MAR, then LAR, then HAR
changed description of end of Step 13 to PEACE OFF
Took out HV_BOTH in Step 9c as HV's are already on
Added in CAL ID uplink to step 2 (5.4.7.9)
Corrected macro d last two commands

Version 4.3

Formatting Repairs to Word document, date (no change of content)
Extra headings to improve ease of reference under step 2e (macro uplink) and 3b (stim/noise check)
5.5.4.1 to 5.5.4 in titles

Version 4.4, 4.5

Amended after first two spacecraft are commissioned

Version 4.6

Added Step 14: 'Cautious MCP Turn-On in New Plasma Region'

Version 4.7

Altered 5.3.1,2 Outline Plan to improve clarity
See especially 5.4.25, 5.4.29 – 35

Version 4.8

Post commissioning tidy up, including 5.3.1 and labelling of unused sections

5. COMMISSIONING

5.1 Introduction

Commissioning of the PEACE instrument is divided into four stages:

Stage One : the instrument is cautiously commanded into a fully functional state for the first time in space and proper operation of its various modes is to be demonstrated.

Stage Two : IEL commissioning in cooperation with other instruments.

Stage Three: Instrument Characterisation to assess the scientific performance of the instrument.

Stage Four : Interference Campaigns. The detailed planning of these campaigns is dealt with elsewhere.

This chapter begins by describing the conditions which should prevail during PEACE Commissioning. Next comes an explanation of the modular approach to Stage 1 which is followed by a detailed description of Stage 1. Stages 2 and 3 will be described in a later issue of this chapter. Stage 4 will be outlined, but the detailed description is dealt with by the group responsible for the Interference Campaigns, coordinated by JSOC.

5.2 PEACE Commissioning Process

5.2.1 Required Configuration of the Spacecraft

5.2.1.1 Spacecraft Spin

The spacecraft spin period should lie within its specified range of 4 seconds ±10%. The rate of change of spin period should be ≤ 8 Spin Segment Clock Pulses per spin.

5.2.1.2 Spacecraft-generated Gases

PEACE high voltage commissioning should not begin until sufficient time has elapsed for spacecraft outgassing to be essentially complete. It has been estimated that at least 20 days are required after launch.
For the same reason, no thruster firing should occur during PEACE commissioning, and a sufficient time should be allowed between any thruster firing and the start of PEACE commissioning.

5.2.1.3 Telemetry

Some parts of PEACE Commissioning can be accomplished using only Normal Mode 1 telemetry. However, other parts will need Burst Mode 1 telemetry, since inspection of 3D distribution science data products will be required.

`NM1 Telemetry`

The instrument is in SCIENCE Mode PT (performance test) for much of Commissioning. In this mode we require spin rate transmission of CORE, LER and NOI for most tests, in common with most tests performed prior to launch. CORE contains moments data and information about the science processing setup. NOI is used to diagnose the sensor performance anode by anode.

Spacecraft telemetry mode NM1 will be sufficient for tests which need only CORE + NOI + LER every spin, for a spin rate within specification (although NM3 is typically used during pre-launch testing).

`BM1 telemetry`

Tests which allow in-flight evaluation of the data product organisation, and in particular of the onboard moments code and pitch angle distributions, will require transmission of full resolution, dual sensor three dimensional distributions (3DF) together with CORE and PAD.

The 3DF distributions are collected at a rate of about 15 in 5 minutes in BM1 (with spin rate CORE and LER and PAD).
The 3DF distributions are collected at a rate of about 1 in 5 minutes in NM1 (with spin rate CORE and NOI).
The 3DF distributions are collected at a rate of about 2 in 5 minutes in NM3 (with spin rate CORE and NOI)..

Therefore these tests should ideally be performed in spacecraft telemetry mode BM1.

5.2.2 Required Configuration of Other Instruments

5.2.2.1 During PEACE HV Sweep and MCP Commissioning

It is requested that ALL other instruments to be in 'Standby' or not powered during PEACE high voltage commissioning periods. (Note that this was not apparently the case for the first pair).

5.2.2.2 During Stage 1

ASPOC, WHISPER and EDI should be *off* during Stage 1.

5.2.3 Plasma Environment

The spacecraft orbit during commissioning is expected to have its apogee in the magnetotail throughout the allotted Commissioning interval. Near perigee the spacecraft is likely to be in an environment of high fluxes of penetrating radiation. Near apogee, the spacecraft is likely to be in the magnetotail plasmasheet. The thickness of the plasmasheet is likely to vary unpredictably between roughly 5 R_E and 1 R_E (boundary to centre). JSOC aim to predict neutral sheet crossings. It seems reasonable to expect that the spacecraft will encounter plasmasheet material for at least an hour either side of the neutral sheet (apogee speed is about 1 km/sec). At higher latitudes, but still far from Earth, the spacecraft will be in the magnetotail lobes, where the plasma is remarkably rarefied.

5.2.3.1 Magnetotail Lobes

Very low counts are expected, especially at higher (> 1 keV) energies. Significant fluxes of photoelectrons are seen below the spacecraft potential, which can reach several 10's of eV (perhaps 100 eV). The higher energy range is a good environment for measuring MCP noise.

5.2.3.2 Magnetotail Plasma Sheet

The only available environment with useful fluxes of plasma across a broad range of energy (above the spacecraft potential), which is not also in/near a penetrating radiation environment.

5.2.3.3 Below L = 8 (Auroral Zone and Radiation Belt)

There is a prohibition against PEACE being turned on below the L = 8 threshold is to ensure that PEACE is not operated while exposed to high fluxes of penetrating radiation, during Commissioning. The L = 8 limit is conservatively chosen, compared to the limit of L = 6 presently requested for normal operations. A possible test at lower altitudes (e.g. L = 6, perhaps lower) remains under consideration, but is not included in this version of the plan.

5.2.4 PEACE Inter-Experiment Link

5.2.4.1 IEL Outputs from PEACE

The IEL to ASPOC carries the

- spacecraft potential estimate data provided to ASPOC from the PEACE DPU

The statement “Until completion of Step 8, the IEL output to ASPOC from PEACE will be disabled” should carry an additional restriction as follows:
Note added 16 Oct 2000: a correction will be made to the spacecraft potential algorithm software version installed prior to launch; until then, the spacecraft potential algorithm calculations will be disabled, and feedback tests with ASPOC shall not occur. Thus the IEL to ASPOC shall not be opened until the software modification is uplinked.

The IEL to ASPOC is by default closed unless opened by command, using the INTERFACE command sequence (see 5.3.3.6).

Counts data to the Correlator part of DWP from the PEACE HEEA sensor however are always sent; this connection is hardwired open – not controllable by telecommand.

5.2.4.2 IEL Inputs to PEACE

The IEL inputs to PEACE are

- FGM field data
- EDI blanking pulse
- WHISPER mode

Until completion of the IEL tests, the PEACE DPU IEL inputs from EDI and WHISPER will be disabled at the PEACE DPU.

The FGM input is opened in Step 2d. It can also be opened following Step 8, particularly while PAD data is being collected, however it may not be open during Step 10 (or in any activity between PEACE ON and the start of Step 10).

The IELs to PEACE from EDI, WHISPER and FGM are by default closed unless opened by command, using the INTERFACE command sequence (see 5.3.3.6).

5.2.5 Operations Verification

Details to be confirmed with ESOC.

5.2.5.1 Performance Verification

Following each command in the commissioning sequence the experimenter will either confirm that the command was executed as expected or recommend that a contingency plan is executed.

5.2.5.2 Spacecraft EGSE Housekeeping Parameters

Limit checking of the housekeeping parameters will be performed using the spacecraft EGSE. Note that although the four PEACE instruments are intended to be identical, the calibration factors are unique for each instrument. See Chapter 2.

5.2.5.3 Real-time Housekeeping Parameters

Visual checking of the real time housekeeping by a PEACE team member viewing the ESOC video display. **Unless otherwise stated, each command in the commissioning sequences given should be followed by inspection of the housekeeping by a PEACE team member before the next command in the sequence is sent.**

5.2.5.4 Near Real-time PEACE EGSE Housekeeping Parameters

Visual checking of the near-real time housekeeping data by a PEACE team member viewing the PEACE EGSE display. Data will be acquired via file transfer from the DDS. The EGSE will provide a range of graphical displays for the interpretation of the PEACE housekeeping data and will have limit checking similar to that used for ground testing. Specific parameters which will be checked in this way are listed in the detailed procedures later in this chapter.

5.2.5.5 Spacecraft OBDH Checking of PEACE Housekeeping Parameters

OBDH checking of selected housekeeping parameters. 'Special' commands are issued by the experimenter to control the onboard monitor table. The policy for the use of such monitors is that they will be in place for the commissioning but not enabled (or it may be decided to have them enabled with a very wide limit set as a crude safeguard). If it is felt necessary to really use such monitors during the course of the commissioning or during the course of the rest of the mission then they will be enabled or the limit range reduced.

5.2.5.6 Assessment of PEACE Science Data

Interpretation and visualisation of Science Data will use a dedicated PEACE EGSE, both for engineering and science assessments. For example, the new-for-Cluster II data product, NOI, is designed for engineering support, but is transmitted in the science telemetry stream.

5.2.6 Order of Spacecraft Commissioning

For Cluster I it was agreed that Stage 1 Commissioning will be carried out sequentially on the first two spacecraft and in parallel for the last two spacecraft. Science operations on the first two spacecraft during the period that the second two are being commissioned were TDB (but desirable). This is not the case for Cluster II, where all spacecraft are to be commissioned separately. Cross calibration of the PEACE instruments on different spacecraft will of course have to be carried out in parallel on all four spacecraft.

5.3 Overview of Stage One Commissioning

The Commissioning should occur in the steps listed in “Outline Plan” below.

The steps are written in this way so that they are modular. This allows the Commissioning activity to be broken up into independent tasks. Some tasks may need to be repeated if all does not go well.

The Commissioning activity is divided up into a number of individual steps.

Individual Steps (including a sequence such as Step 1a, 1b and 1c) should run without interruption.

Steps should proceed in the sequence given here. Steps may be repeated if necessary.

Interruptions between Steps are anticipated, for example when the spacecraft is at low altitudes (L<8). Therefore the required state of the instrument at the beginning of each Step is identified. The final state is also specified. If an interruption is required, the instrument should be turned off. A turn off procedure from each of the final modes (which will always be one of PEACE OFF, STANDBY BOTH PRO or READY BOTH) is provided. Similarly, a turn on procedure from PEACE OFF to any start mode (which will always be one of PEACE OFF, STANDBY BOTH PRO or READY BOTH) is provided.

When the final state of the current “Step n” is the same as the start state of the next “Step n+1” (or any other step which we wish to use next) and no interruption is required, the next step can be carried out without intermediate commanding. (Where two consecutive steps both use the SCIENCE (PT) state, it is not essential to return to READY BOTH SAFE between the steps.)

The instrument should be turned off when below L = 8. However, once turned on, the spacecraft KAL power should remain on throughout Commissioning and Operations, including below L = 8.

5.3.1 Outline Plan

5.3.1. As used

`Step 0.`

PEACE KAL current check.

Check of current on spacecraft KAL to PEACE.

Inter Step State:	PEACE OFF

`Step 1.   Lobe or plasmasheet.     NM1`

DPU test, Sensors Low Voltage tests.

The instrument is gradually activated, in a step by step process culminating in the READY BOTH SAFE state, after which a basic configuration SCIENCE mode is set up, but the HVs are not turned on. PEACE is then turned off or Step 2 follows at once.

Step 1a	Power up DPU
Step 1b	LEEA and HEEA low voltage power up
Step 1c	Commence science processing – SCIENCE mode PT (HVs Off)
Optional Step 1d	Power down PEACE
Inter Step State:	PEACE OFF
Else	
Inter Step State:	READY BOTH SAFE

`Step 2.   Lobe or plasmasheet.     Real time Contact (for Uplink)`

Uplink

The instrument should be placed in the STANDBY BOTH PRO state while this activity is carried out.

Revised Step 2 a; Option 1	Off to STANDBY BOTH PRO
Revised Step 2 a; Option 2	READY BOTH SAFE to STANDBY BOTH PRO
Step 2b	Uplink of PEACE Science related Tables
Step 2c	Uplink of PEACE sunpulse offset (removed)
Step 2d	Uplink of FGM Calibration
Step 2e	Uplink of Commissioning MACROS (
Optional Step 2f	Turn PEACE Off (assumes Commissioning pauses)
Inter Step State:	PEACE OFF
Else	
Inter Step State:	STANDBY BOTH PRO

`Step 3.   Lobe NM1`

PEACE Electronics noise test.

Revised Step 3 a; Option 1	Off to READY BOTH SAFE
Revised Step 3 a; Option 2	STANDBY BOTH PRO to READY BOTH SAFE
Step 3	LEEA and HEEA Noise, Threshold and Stim test

This verifies that the sensor electronics and anode electrical connections remain intact, and checks that the amplifier thresholds are at the expected level (they are temperature dependent).

Inter Step State: READY BOTH SAFE

`Step 4.   Lobe or plasmasheet.      NM1`

LEEA HV Sweep

Sensor HV Sweep turn on. To verify that the HV sweep generators are working and that there is no breakdown across the analyser plates.

Inter Step State: READY BOTH SAFE

`Step 5.   Lobe or plasmasheet.      NM1`

HEEA HV Sweep

(same discussion as step 4)

Inter Step State: READY BOTH SAFE

`Step 6.   Lobe      NM1`

LEEA MCP Commissioning

Sensor HV MCP turn on. Sweep HVs are off. To verify that the MCP HV generators are working and that the MCPs are intact and properly outgassed. The MCP noise level should remain low as the MCP HVs are progressively raised. The duration of this process is hard to predict, based on laboratory experience. It is possible that it will be necessary to pause for longer than expected between increases in the MCP voltage level.

Inter Step State: READY BOTH SAFE

`Step 7.   Lobe      NM1`

HEEA MCP Commissioning

(same discussion as step 6)

Inter Step State: READY BOTH SAFE

`Step 8.   Plasmasheet or else Lobe      NM1`

MCP's Operational Levels Check

Revised Step 8	Operational level check

Collects data from both sensors

Inter Step State:	READY BOTH SAFE

`Step 9.   Plasmasheet and Lobe     NM1`

Confirm some operational modes

Step 9a	Demonstrate Standard Operational Mode
Step 9b	Demonstrate Interference Campaign Macros
Step 9c	Demonstrate Eclipse Mode (Mandatory turn off follows)

Inter Step State:	PEACE OFF

`Step 10.  Lobe      NM1 (ASPOC assumed Off, desire to repeat with ASPOC on)`

Solar Background

Demonstrate that the sweep synchronisation is optimised to reject solar background. Need 3D data.

Pre-step 10	Mandatory turn on from PEACE Off, with all IELs shut
Step 10	Sensor Electrons Generated near to the MCP
Post-step 10	Optional IEL switch

Inter Step State:	READY BOTH SAFE

`Step 11.  Plasmasheet NM1 (ASPOC assumed Off, desire to repeat with ASPOC on)`

Verify Data Product Selection and Moments Code

Step 11a	HEEA and LEEA Response Cross-Calibration
Step 11b	HEEA and LEEA Sweep Mode Cross-Calibration

Inter Step State:	READY BOTH SAFE

`Step 14 Magnetosheath/Solar Wind NM1`

Cautious MCP Turn On in New Plasma Region

Inter Step State: READY BOTH SAFE

5.3.2. Not in fact used due to time constraints

`Step 12 (BM1) Plasmasheet (tbd) BM1`

Optimisation of Symmetry Direction Algorithm

`Step 13 (BM1) Plasmasheet (tbd) BM1`

Optimisation of Spacecraft Potential Algorithm

This commissioning table has been split into three stages. The first stage consists of PEACE instrument checks, the second is a check of the inter-experiment links, and the third is a repeat of some Stage 1 checks but with ASPOC on.

Stage 1

Step	Step Description	Duration (hrs, mins)	Required Spacecraft Telemetry Mode	Required Magnetospheric Region	PEACE mode Start/Finish
0	PEACE KAL current check	0,05	Not Applicable	Not Applicable	Off /Off
1	DPU tests, Sensors LV tests	1,10	NM1/ Real Time	Not Applicable	Off /Off (RBS)
2	Uplink	1,00	NM1/ Real Time	Not Applicable	(RBS)Off /Off(SBB)
3	PEACE Electronics noise test.	1,05	NM1/ Real Time	Not Applicable	(SBB)Off /RBS
4	LEEA HV Sweep	2,00	NM1/ Real Time	Not Applicable	RBS /RBS
5	HEEA HV Sweep	2,00	NM1/ Real Time	Not Applicable	RBS /RBS
6	LEEA MCP Commissioning	≥ 2,00	NM1/ Real Time	Tail Lobe	RBS /RBS
7	HEEA MCP Commissioning	≥ 2,00	NM1/ Real Time	Tail Lobe	RBS /RBS
8	MCP’s Operational Levels Check	≥ 1,30	NM1/ Real Time	Tail Plasma Sheet	RBS /RBS
9	Demonstrate Modes/Macros	2,00	NM1/ Real Time	Any Region	RBS /Off
10	Solar Background	3,00	NM1/ Real Time	Tail Lobe	Off/RBS
11	HEEA/LEEA Cross Calibration	tbc	NM1/ Real Time	Tail Lobe	RBS /RBS
14	Cautious Turn On- New Region	tbc	NM1/ Real Time	Various	RBS /RBS

Stage 2

IEL tests

Step	Step Description	Duration (hrs, mins)	Required Spacecraft Telemetry Mode	Required Magnetospheric Region	PEACE mode Start/Finish
1	EDI-PEACE	0,20	NM1/ Real Time	Not Applicable	
2	Correlator-PEACE	1,00	NM1/ Real Time	Not Applicable	
3	ASPOC-PEACE	0,10	NM1/ Real Time	Not Applicable	
4	FGM-PEACE	0,05	NM1/ Real Time	Not Applicable	
5	DWP-PEACE	0,10	NM1/ Real Time	Not Applicable	
Sum		1,45			

Stage 3

Operations with ASPOC On

Step	Step Description	Duration (hrs, mins)	Required Spacecraft Telemetry Mode	Required Magnetospheric Region	PEACE mode Start/Finish
1	Solar Background (Stage 1,10)	3,00	BM1/ Real Time	Tail Lobe	Off/RBHV
2	Spacecraft Potential Algorithm (Stage 1, 13)	1,20	BM1/ Real Time or SSR	Tail Lobe	RBHV/RBHV
3	Spacecraft Potential Algorithm (Stage 1,13’)	1,20	BM1/ Real Time or SSR	Tail Plasma Sheet	RBHV/RBHV
Sum		5,40			

5.3.3 Changing Between Inter-step Modes

In order to make the PEACE Commissioning plan flexible, we need to be able to interrupt the flow of steps at any inter-step point, to resume from off at any inter-step point and to be able to repeat steps.

See Chapter 3 for full definition of the command sequences.

5.3.3.1 READY BOTH or STANDBY BOTH PRO to PEACE OFF

Duration

5 minutes

Procedure

PDP Power down PEACE

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGD	*No parameter*	0x20C0	HEEA sweep, MCP off
ZEPLHVGD	*No parameter*	0x00C0	LEEA sweep, MCP off

delay 120 seconds (allows MCP power capacitors to decay)

ZEPDRSET	No parameter	0x48A5	

delay 120 seconds (allows sensor power capacitor discharge)

"Spacecraft macro to turn off 28 V supply to PEACE DPU"

delay 25 seconds

5.3.3.2 PEACE OFF to STANDBY BOTH PRO

Do not use until Step 1 has been performed in full.

Duration

5 minutes

Procedure

PO	**Power On 28V**
EE	**Execute Executive**
RA2	**Run Application (two processor)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x8000	0x0081	0x8081
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			
ZEPDBOOS	0x4D00	0x0001	0x4D01
delay 15 seconds			
ZEPDEAPP	0x5200	0x0091	0x5291
delay 15 seconds			

5.3.3.3 PEACE OFF to READY BOTH SAFE

Do not use until Step 1 has been performed in full.

Duration

15 minutes

Procedure

PO **Power On 28V**

EE **Execute Executive**

RA2 **Run Application (two processor)**

LV_BOTH **Turn on low voltage power to both sensors**

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x8000	0x0081	0x8081
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			
ZEPDBOOS	0x4D00	0x0001	0x4D01
delay 15 seconds			
ZEPDEAPP	0x5200	0x0091	0x5291
delay 15 seconds			
ZEPDLPCN	0x4B00	0x0003	0x4B03
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDHPCN	0x6B00	0x0003	0x6B03
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16

Where the final command closes all IELs; alternatively the final command might do something else – see 5.3.3.6.

5.3.3.4 STANDBY BOTH PRO to READY BOTH SAFE

Duration

2 minutes

Procedure

LV_BOTH Turn on low voltage power to both sensors

INTERFACE Spacecraft interface and watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLPCN	0x4B00	0x0003	0x4B03
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDHPCN	0x6B00	0x0003	0x6B03
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16

Where the final command closes all IELs; alternatively the final command might do something else – see 5.3.3.6.

5.3.3.5 READY BOTH SAFE to STANDBY BOTH PRO

Duration

5 minutes

Procedure

LV_OFF Low voltage sensor power off

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDSPWF	0x4800	*no parameter*	0x4800
delay 120 seconds			

5.3.3.6 Alteration of IEL configuration while in READY BOTH SAFE

Duration

1 minutes

Procedure

INTERFACE Spacecraft Interface and Watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4c00	0x0016	0x4c16

(or – after checking 5.2.4 - other values for the free bit pattern may be selected, the options are;

0x00e6 opens all IELs;

0x0096 opens only FGM IEL;

0x0086 opens only FGM and ASP IEL;

0x0016 closes all IEL [this has the same effect as never sending a 4C** command]

in all cases the command also enables the watchdog and the default spacecraft interface setup)

5.4 Stage One Commissioning

5.4.1 Step 0: Spacecraft Power to PEACE KAL Current Check

The Keep Alive Power Line, from the spacecraft to PEACE, is permanently on to support the PEACE Keep Alive memory. The current on this line is checked on the ESOC displays.

Step 1

5.4.2 Step 1a: Activate DPU

Duration

30 minutes

Aim

Boot from EEPROM and run application program no 1.

Initial State Requirement

PEACE OFF
NM1
DPU temperature is between -10 degrees C and +40 degrees C.

Final State

STANDBY BOTH PRO

Description

PEACE OFF to STANDBY BOTH PRO
Power up DPU and check power consumption, status flags, counters etc. Initialize KAL variables.

Procedure

5.4.2.1: Switch on PEACE 28V supply

PO **Power On 28V**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x8000	0x0081	0x8081
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			

Parameter	Expected	Seen?
PEACE primary current	96 ± 10 mA	
PEACE keep alive line current (KAL)	5 ± 2 mA	
EPD_STAT	201	

delay 2 minutes

5.4.2.2: Execute DPU Executive Code

EE **Execute Executive**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDBOOS	0x4D00	0x0001	0x4D01

delay 15 seconds

Parameter	Expected	Seen?
EPD_STAT	3	

5.4.2.3: Run DPU Two Sensor Application Code

RA2 **Run Application (two processor)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDEAPP	0x5200	0x0091	0x5291

delay 15 seconds

Accumulate 30s of data and check housekeeping parameters are as expected:

Parameter	Expected	Seen?
EPD_STAT	100	
EPD_FCNT	HK format count is incrementing	
EPD_SPCT	HK sunpulse count is incrementing	
EPD_SPOS	HK sunpulse offset = 176	
EPD_TELM	interface indicator < 2.5V - prime interface	
‘DPU Status’	‘default’	
Interface Mode	AUTO	
Watchdog	ENABLED	
H/K telemetry mode	NORMAL	
FGM interface	disabled	
EDI interface	disabled	
DWP interface	disabled	
ASPOC interface	disabled	
All command echoes	‘0’	
All sensor voltage and current monitors	‘0’	

EPD_P5VV	5.0 V ± 5%	
EPD_P8VV	8.0 V ± 10%	
EPD_M8VV	-8.0 V± 10%	
EPD_36VV	36 V ± 10%	
EPD_P5VI	220mA ± 10%	
EPD_M8VI	6mA ± 10%	
EPD_P8VI	9.2mA ± 10%	
EPD_36VI	3.0mA ± 10%	
DPU Temperature	-5°C - +30°C at turn on	

Note. The table is a representative model only. The exact values for the limits of the analogue monitor values may be different for different PEACE instruments due to component tolerance variations. The actual values of the parameters expected will be in the parameter database.

5.4.2.4: Initialise Keep Alive Memory

IKAL **Initialise KAL Memory**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDKALE	0x4000	No parameter	0x4000

NOTE . It is intended that there will be an UPLINK activity to rewrite the KEEP ALIVE memory as a later step in Commissioning. This command should **not be sent** if the contents of KEEP ALIVE memory have at some point prior to the commissioning been uplinked unless it is intended that the contents of the KEEP ALIVE are overwritten by the default values in ROM.

5.4.3 Step 1b : LEEA and HEEA Low Voltage Power Up

Duration

30 minutes

Aim

To power up +5V, ±8V on LEEA, then to send confirmer command to power up 36V. Process then repeated on HEEA.

Initial State Requirement

(must follow Step 1a directly)
STANDBY BOTH PRO
NM1
Check that HEEA & LEEA s/c powered thermistors temperature is between -10 degrees C and +40 degrees C (operating acceptance levels for sensors).

Final State

READY BOTH SAFE

Description

STANDBY BOTH PRO to READY BOTH SAFE
By checking the power consumption of the low voltage electronics the integrity of the subsystems can be established.

Procedure

5.4.3.1: Switch on LEEA 5V and ± 8V supply

(Part 1 LEEA)

Switch on LEEA 5V, ± 8V and service signals. (Confirmer command not yet issued, therefore 36V remains OFF)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLPCN	0x4B00	0x0003	0x4B03

delay 25 seconds

Parameter	Expected	Seen?
EPL_P5VV	4.8 V to 5.2 V	
EPL_P8VV	7.8 V to 8.2 V	
EPL_M8VV	-7.8 V to -8.2 V	
EPL_36VV	0 V ± (TBD depending on noise)	
HEEA	Off	
EPD_P5VV	5.0 V ± 5%	
EPD_P8VV	8.0 V ± 10%	
EPD_M8VV	-8.0 V± 10%	
EPD_36VV	36 V ± 10%	
EPD_P5VI	255mA ± 10%	
EPD_M8VI	15mA ± 10%	
EPD_P8VI	36mA ± 10%	
EPD_36VI	3.0mA ± 10%	
EPL-HVEN	5 V	
HVs	0V	

5.4.3.2: Switch on LEEA 36V supply

(Part 2 LEEA)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDCONF	0x4F55	no parameter	0x4F55

delay 30 seconds

Parameter	Expected	Seen?
EPL_36VV	35 V to 37 V	
EPD_36VI	5 mA ± (TBD)	
HVs	0V	
28V current (see spacecraft EGSE)	118 mA ± (TBD)	

5.4.3.3: Switch on HEEA 5V and ± 8V supply

(Part 1 HEEA)

Switch on HEEA 5V, ± 8V and service signals. (Confirmer command not yet issued, therefore 36V remains OFF)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHPCN	0x6B00	0x0003	0x6B03

delay 25 seconds

Parameter	Expected	Seen?
EPH_P5VV	4.8 V to 5.2 V	
EPH_P8VV	7.8 V to 8.2 V	
EPH_M8VV	-7.8 V to -8.2 V	
EPH_36VV	0 V ± (TBD depending on noise)	
LEEA	On	
EPL_P5VV	4.8 V to 5.2 V	
EPL_P8VV	7.8 V to 8.2 V	
EPL_M8VV	-7.8 V to -8.2 V	
EPL_36VV	35V to 37V	
EPD_P5VV	5.0 V ± 5%	
EPD_P8VV	8.0 V ± 10%	
EPD_M8VV	-8.0 V± 10%	
EPD_36VV	36 V ± 10%	
EPD_P5VI	280mA ± 10%	
EPD_M8VI	27mA ± 10%	
EPD_P8VI	66mA ± 10%	
EPD_36VI	5mA ± 10%	
EPH-HVEN	5 V	
HVs	0V	

5.4.3.4: Switch on HEEA 36V supply

(Part 2 HEEA)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDCONF	0x4F55	no parameter	0x4F55

delay 30 seconds

Parameter	Expected	Seen?
EPH_36VV	35 V to 37 V	
EPD_36VI	7.5 mA ± (10%)	
HVs	0V	
28V current (see spacecraft EGSE)	140 mA ± (TBD)	

5.4.4 Step 1c: Commence Science Processing - PT (HVs Off)

Duration

5 minutes

Aim

Run science processing. HVs are NOT enabled.

Initial State Requirement

(must follow Step 1b directly)
READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Description

READY BOTH SAFE to RUNNING SAFE (PT mode with HVs Off)
In RUNNING SAFE mode, the "Science Processing" applications code is running. It creates a variety of data products. In the PT mode, these are CORE (which includes moments and spacecraft potential estimate) NOI, LER and 3DF. The CORE and NOI data products contain essential instrument health and performance diagnostic data to complement HK data.
Science Processing cannot function without information about sensor state, thus we must specify sensor sweep modes and sweep presets, even though the sweeps will not be enabled. In this case the selected sweep mode is HAR (sweep duration is 16 accumulation bins – "short" sweep). Preset is 32.

Procedure

`5.4.4.1:  Define sweep mode and preset for HEEA and for LEEA`

SETUP_0 Setup sensors and science configuration

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0008	0x2068
ZEPHSPSS	0x2080	0x0008	0x2088
ZEPLSMPS	0x0060	0x0008	0x0068
ZEPLSPSS	0x0080	0x0008	0x0088

`5.4.4.2: Start Science Processing`

RUNSCI_BOTH Run science processing (both sensors)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 2 minutes to collect data

Parameter	Expected	Seen?
EPD_SCCT	Incrementing	

`5.4.4.3: Halt Science (return to READY BOTH SAFE)`

HS Halt Science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

5.4.5 Step 1d (Optional): Turn PEACE Off

Duration

5 minutes

Aims

Turn PEACE Off

Initial State Requirement

READY BOTH SAFE

Final State

PEACE Off

Procedure

See 5.3.3.1 for READY BOTH SAFE to OFF Commands

Step 2

5.4.6 Step 2a (Revised): Prepare PEACE for Uplink

Duration

5 mins (but Uplinks take longer, see following sections)

Aims

Prepare PEACE for Uplink. PEACE must be in STANDBY BOTH PRO state for Uplink.

Option 1: Start from PEACE OFF

Initial State Requirement

PEACE OFF
Real-time contact interval.

Final State

STANDBY BOTH PRO

Procedure

See 5.3.3.2

Option 2: Continue from end of Step 1c

Initial State Requirement

READY BOTH SAFE
Real-time contact interval.

Final State

STANDBY BOTH PRO

Procedure

See 5.3.3.5

5.4.7 Step 2b: Uplink of PEACE Science Related Tables

Duration

The procedure may upload as many as 1500 command words, each 16 bit. Ignoring an ESA packaging overhead, this is 19904 bits, or about 19.5 k bits (binary k). At 1 kbit/sec, transmission needs less than a minute. Details TBC. All uplinked values can be checked in the 'init' science packets.

The DPU can take 100 commands at a time, however after every uplink there must be a wait time of at least 5 seconds. The parameters in this section can be uplinked in this manner, or each command can be uplinked once per second. Assuming a maximum of 1500 telecommands, sending one command per second will take about 30 mins while (to be safe) sending 50 then waiting 5 seconds will take roughly 5 minutes. Note: this is not including the times of the checksum uplinks and checks, which will take a further 5 minutes.

Aims

- Uplink LEEA and HEEA Dead Time Correction Factors (1 per anode, i.e. 24 values per instrument)
- Uplink LEEA and HEEA (reduced) Geometric Factors (1 per anode pair, i.e. 12 values per instrument)
- Uplink LEEA and HEEA Energy Efficiencies (1 per energy step, i.e. 186 values per instrument)
- Uplink LEEA and HEEA Energy Steps (1 per energy step, i.e. 186 values per instrument)
- Uplink SP KAL array checksum to account for all uplinked values
- Check SP KAL array checksum by starting science processing

Sequence Description

These Uplinks are likely to be needed to install latest calibration data into the instruments. The default values carried onboard were necessarily installed before the calibration data was available.
Total telecommand budget is up to 1500 telecommands.

Initial State Requirement

STANDBY BOTH PRO
Real-time contact interval. (Best uplink rate – effectively 1 kbit/sec)

Final State

STANDBY BOTH PRO

Procedure

`5.4.7.1: Uplink LEEA Dead Time Correction Factors`

UDTCFL Uplink LEEA dead time correction factor

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLDTC	0x5700	0x000u	0x570u

(control word; identifies reference as LEEA sensor and using "u", identifies one of the 12 anodes)

ZEPDDTCF	0x0000	0xuuuu	0xuuuu

(argument word; contains the dead-time factor)

The complete uplink of dead time factors for all twelve coarse zone anodes requires 24 telecommands.

5.4.7.2: Uplink HEEA Dead Time Correction Factors

UDTCFH Uplink HEEA dead time correction factor

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHDTC	0x5700	0x001u	0x571u

(control word; identifies reference as HEEA sensor and using “u”, identifies one of the 12 anodes)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDDTCF	0x0000	0xuuuu	0xuuuu

(argument word; contains the dead-time factor)

The complete uplink of dead time factors for all twelve coarse zone anodes requires 24 telecommands.

5.4.7.3: Uplink Geometric Factors for LEEA

UPGL Uplink LEEA geometric factor

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLGUE	0x5800	0x000u	0x580u

(control word; identifies reference as LEEA sensor and the identity of the anode)

ZEPDG0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDG1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all six parameters (the reduced geometric factors for the 12 anodes) would requires 18 telecommands.

5.4.7.4: Uplink Geometric Factors for HEEA

UPGH Uplink HEEA geometric factor

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHGUE	0x7800	0x000u	0x780u

(control word; identifies reference as HEEA sensor and the identity of the anode)

ZEPDG0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDG1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all six parameters would requires 18 telecommands.

5.4.7.5: Uplink Energy Efficiencies for LEEA

UEEL Uplink LEEA energy efficiency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLFVE	0x5A00	0x00uu	0x5Auu

(control word; identifies reference as LEEA sensor and the identity of the energy step [0 to 92])

ZEPDF0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDF1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all 93 parameters would requires 279 telecommands.

5.4.7.6: Uplink Energy Efficiencies for HEEA

UEEH Uplink HEEA energy efficiency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHFVE	0x7A00	0x00uu	0x7Auu

(control word; identifies reference as HEEA sensor and the identity of the energy step [0 to 92])

ZEPDF0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDF1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all 93 parameters would requires 279 telecommands.

5.4.7.7: Uplink Energy Steps for LEEA

UESL Uplink LEEA energy steps

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLEVE	0x5900	0x00uu	0x59uu

(control word; identifies reference as LEEA sensor and the identity of the energy step [0 to 92])

ZEPDE0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDE1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all 93 parameters would requires 279 telecommands.

5.4.7.8: Uplink Energy Steps for HEEA

UESH Uplink HEEA energy steps

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHEVE	0x7900	0x00uu	0x79uu

(control word; identifies reference as HEEA sensor and the identity of the energy step [0 to 92])

ZEPDE0PS	0x0000	0xuuuu	0xuuuu

(first argument word; contains the higher order bits of the value to be uplinked)

ZEPDE1PS	0x0000	0xuuuu	0xuuuu

(second and final argument word; contains the lower order bits of the value to be uplinked)

The complete uplink of all 93 parameters would requires 279 telecommands.

5.4.7.9: Uplink CAL ID and SP KAL array checksum

UPL Uplink parameter

UPL Uplink parameter

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLPUE	0x5600	0x0006	0x5606
ZEPDPUPS	0x0000	0xuuuu	0xuuuu

(CAL ID varies for spacecraft and calibration table)

ZEPDLPUE	0x5600	0x0009	0x5609
ZEPDPUPS	0x0000	0xuuuu	0xuuuu

(uuuu is the integer value of the checksum)

5.4.7.10: Check SP KAL array checksum

LV_BOTH **Turn on low voltage to both sensors**
SETUP_0 **Setup sensors and science configuration**
RUNSCI_BOTH **Start science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHPCN	0x6B00	0x0003	0x6B03
delay 25 seconds			
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDLPCN	0x4B00	0x0003	0x4B03
delay 25 seconds			
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPHSMPS	0x2060	0x0008	0x0068
ZEPHSPSS	0x2080	0x0008	0x2088
ZEPLSMPS	0x0060	0x0008	0x0068
ZEPLSPSS	0x0080	0x0008	0x0088
ZEPDPRCN	0x4700	0x0000	0x4700

Delay 20 seconds while science processing starts

Science processing should start: an error in the SP KAL array checksum will result in an EPD_STAT of 101 and science processing will not start. If this happens, it will be necessary to power down the instrument using the procedure **PDP**, then to repeat Sections 5.4.6, 5.4.7.9 and 5.4.7.10 with the correct checksum.

5.4.7.11: Return to STANDBY BOTH

For the rest of Step 2 it is necessary to reset the instrument to STANDBY BOTH

LV_SCI_OFF Halt Science and power off sensors

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

ZEPDSPWF	0x4800	no parameter	0x4800	

delay 120 seconds

5.4.8 Step 2c (Deleted): Uplink of PEACE Sunpulse Offset

REMOVED

Duration

1 minute

Aims

Uplink Sunpulse Offset.

Sequence Description

N/A

Initial State Requirement

STANDBY BOTH PRO
Real-time contact interval. (Best uplink rate)

Final State

STANDBY BOTH PRO

Procedure

5.4.8.1: Uplink Sunpulse Offset

USO Uplink Sunpulse offset

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDSN1S	0x5500	0x0000	0x5500

(control word; identifies purpose)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDSN2S	0x0000	0xuuuu	0xuuuu

(argument word; contains instructions on sunpulse source and value of rephase in units of 2*SSCP)

Parameter	Expected	Seen?
EPD_SPOS	uuuu (dec)	

The command uplink would requires 2 telecommands.

5.4.9 Step 2d: Uplink of FGM Calibration Information

Duration

TBD, see note in 5.4.7

Aims

Uplink FGM Calibration Data

Sequence Description

FGM values are uplinked and the IP KAL array 1 checksum changed. FGM IEL interface then opened to verify checksum.

Initial State Requirement

STANDBY BOTH PRO
Real-time contact interval. (Best uplink rate)

Final State

STANDBY BOTH PRO

Procedure

<u>`5.4.9.1: Uplink Magnetometer Calibration Data`</u>

UM Uplink magnetometer calibration information

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDFGM1	0x5B00	0x00uu	0x5Buu
(control word; identifies purpose)			
ZEPDFGM2	0x0000	0xuuuu	0xuuuu
(first argument word; contains the higher order bits of the value to be uplinked)			
ZEPDFGM3	0x0000	0xuuuu	0xuuuu
(second and final argument word; contains the lower order bits of the value to be uplinked)			

There must be one value of 'step for range', one of 'minimum value for range' and three of 'offset for range' (corresponding to the X, Y and Z axes) for each range to be uplinked, and there will be 4 ranges. This will therefore require 60 telecommands (4 x 5 x 3).

5.4.9.2: Uplink of IP KAL array 1 checksum

UPL Uplink parameter

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLPUE	0x5600	0x000a	0x560a
ZEPDPUPS	0x0000	0xuuuu	0xuuuu

(uuuu is the integer value of the checksum)

5.4.9.3: Check of IP KAL array 1 checksum

INTERFACE

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4c00	0x0096	0x4c96

If there is an error in the checksum, the interface will not be opened and an EPD_STAT of 102 will result. If this happens, it will be necessary to power down the instrument using the procedure **PDP**, then to repeat sections 5.4.6 and 5.4.9.2 and 5.4.9.3.

5.4.9.4: Close IEL

The IEL must now be closed again for the remainder of Step 2:

INTERFACE

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4c00	0x0016	0x4c16

5.4.10 Step 2e: Uplink PEACE Macro

Duration

TBD, see note in 5.4.7

Aims

Uplink PEACE Macros

Sequence Description

MACROs uplinked for interference campaigns

Initial State Requirement

STANDBY BOTH PRO
Real-time contact interval. (Best uplink rate)

Final State

STANDBY BOTH PRO

Procedure

Uplink macros number 0 to d for EDI / PEACE, WHISPER / PEACE, Electronic Noise, Spacecraft Potential, CIS-ASPOC, and EFW-Langmuir interference campaigns and for standard modes

`5.4.10.1: Uplink PEACE Macros for Interference Campaign`

UMAC_0 Uplink macro of 4 words

UMAC_1 Uplink macro of 5 words

UMAC_0 Uplink macro of 4 words

UMAC_0 Uplink macro of 4 words

UMAC_0 Uplink macro of 4 words

UMAC_0 Uplink macro of 4 words

UMAC_0 Uplink macro of 4 words

UMAC_1 Uplink macro of 5 words

UMAC_1 Uplink macro of 5 words

UMAC_0 Uplink macro of 4 words

UMAC_2 Uplink macro of 9 words

UMAC_1 Uplink macro of 5 words

UMAC_1 Uplink macro of 5 words

UMAC_2 Uplink macro of 9 words

5.4.10.2: Macro 0

Macro 0: EDI test, sensor setup (IPE-BM1-1: 58f58-60h30: for EDI-PEACE part 1)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0080	0x5E80
(control word; identifies macro number to be uplinked)			
ZEPDMAC2	0x0000	0x0400	0x0400
(first argument word; gives macro size and position)			
ZEPDMAC2	0x0000	0x2062	0x2062
(second argument word; gives first science macro command parameter word)			
ZEPDMAC2	0x0000	0x208e	0x208e
(third argument word; gives second science macro command parameter word)			
ZEPDMAC2	0x0000	0x0069	0x0069
(fourth argument word; gives third science macro command parameter word)			
ZEPDMAC2	0x0000	0x008f	0x008f
(fifth argument word; gives fourth science macro command parameter word)			
ZEPDMAC2	0x0000	0x41e8	0x41e8
(sixth and final argument word; contains the macro checksum)			

5.4.10.3: Macro 1

Macro 1: EDI test, DPU setup (IPE-BM1-1, IPE-BM1-2: cplf, T2, SP0: for EDI-PEACE parts 1 and 2)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0081	0x5E81
ZEPDMAC2	0x0000	0x0505	0x0505
ZEPDMAC2	0x0000	0x4380	0x4380
ZEPDMAC2	0x0000	0x0235	0x0235
ZEPDMAC2	0x0000	0x4202	0x4202
ZEPDMAC2	0x0000	0x4400	0x4400
ZEPDMAC2	0x0000	0x4500	0x4500
ZEPDMAC2	0x0000	0x10b7	0x10b7

5.4.10.4: Macro 2

Macro 2: EDI test, sensor setup (IPE-BM1-2: 60h30-58f58: for EDI-PEACE part 1)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0082	0x5E82
ZEPDMAC2	0x0000	0x040b	0x040b
ZEPDMAC2	0x0000	0x2069	0x2069
ZEPDMAC2	0x0000	0x208f	0x208f
ZEPDMAC2	0x0000	0x0062	0x0062
ZEPDMAC2	0x0000	0x008e	0x008e
ZEPDMAC2	0x0000	0x41e8	0x41e8

5.4.10.5: Macro 3

Macro 3: WHISPER test, sensor setup (IPW-BM1-1: 30h00-30h00: for WHISPER 2,3)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0083	0x5E83
ZEPDMAC2	0x0000	0x0410	0x0410
ZEPDMAC2	0x0000	0x206b	0x206b
ZEPDMAC2	0x0000	0x2087	0x2087
ZEPDMAC2	0x0000	0x006b	0x006b
ZEPDMAC2	0x0000	0x0087	0x0087
ZEPDMAC2	0x0000	0x41e4	0x41e4

5.4.10.6: Macro 4

Macro 4: WHISPER test, sensor setup (IPW-BM1-2: 59h29-59h29: for WHISPER 2,3)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0084	0x5E84
ZEPDMAC2	0x0000	0x0415	0x0415
ZEPDMAC2	0x0000	0x2068	0x2068
ZEPDMAC2	0x0000	0x208f	0x208f
ZEPDMAC2	0x0000	0x0068	0x0068
ZEPDMAC2	0x0000	0x008f	0x008f
ZEPDMAC2	0x0000	0x41ee	0x41ee

5.4.10.7: Macro 5

Macro 5: WHISPER test, sensor setup (IPW-BM1-3: 88h58-88h58: for WHISPER 2,3)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0085	0x5E85
ZEPDMAC2	0x0000	0x041a	0x041a
ZEPDMAC2	0x0000	0x2069	0x2069
ZEPDMAC2	0x0000	0x2096	0x2096
ZEPDMAC2	0x0000	0x0069	0x0069
ZEPDMAC2	0x0000	0x0096	0x0096
ZEPDMAC2	0x0000	0x41fe	0x41fe

5.4.10.8: Macro 6

Macro 6: WHISPER test, sensor setup (IPW-BM1-4: 60m00-60m00: for WHISPER 4)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0086	0x5E86
ZEPDMAC2	0x0000	0x041f	0x041f
ZEPDMAC2	0x0000	0x206f	0x206f
ZEPDMAC2	0x0000	0x208f	0x208f
ZEPDMAC2	0x0000	0x006f	0x006f
ZEPDMAC2	0x0000	0x008f	0x008f
ZEPDMAC2	0x0000	0x41fc	0x41fc

5.4.10.9: Macro 7

Macro 7: ENL test, DPU setup (INL-NM1-1: cnlf, T1, SP0: for Electronic noise)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0087	0x5E87
ZEPDMAC2	0x0000	0x0524	0x0524
ZEPDMAC2	0x0000	0x4300	0x4300
ZEPDMAC2	0x0000	0x0221	0x0239
ZEPDMAC2	0x0000	0x4208	0x4208
ZEPDMAC2	0x0000	0x4400	0x4400
ZEPDMAC2	0x0000	0x4500	0x4500
ZEPDMAC2	0x0000	0x1041	0x1041

5.4.10.10: Macro 8

Macro 8: WHISPER test, DPU setup (IPW-BM1-1,2,3,4; ISC-BM1-1: cplf, T1, SP0: for WHISPER 2,3,4)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0088	0x5E88
ZEPDMAC2	0x0000	0x052a	0x052a
ZEPDMAC2	0x0000	0x4300	0x4300
ZEPDMAC2	0x0000	0x0235	0x0235
ZEPDMAC2	0x0000	0x4208	0x4208
ZEPDMAC2	0x0000	0x4400	0x4400
ZEPDMAC2	0x0000	0x4500	0x4500
ZEPDMAC2	0x0000	0x103d	0x103d

5.4.10.11: Macro 9

Macro 9: Return to DIS, sensors setup (STD-ALL-1(a-e), INL-NM1-1: 88m28-60m00: for standard mode (MAR) and Electronic Noise)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x0089	0x5E89
ZEPDMAC2	0x0000	0x0430	0x0430
ZEPDMAC2	0x0000	0x206f	0x206f
ZEPDMAC2	0x0000	0x2096	0x2096
ZEPDMAC2	0x0000	0x006f	0x006f
ZEPDMAC2	0x0000	0x008f	0x008f
ZEPDMAC2	0x0000	0x4203	0x4203

5.4.10.12: Macro a

Macro a: Return to DIS, DPU setup (STD-ALL-1e, STD-ALL-2e: cplrx-anl-16w02: for standard mode where the variable parameters will be determined by the spin period)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x008a	0x5E8a
ZEPDMAC2	0x0000	0x0935	0x0935
ZEPDMAC2	0x0000	0x4300	0x4300
ZEPDMAC2	0x0000	0x02d5	0x02d5
ZEPDMAC2	0x0000	0x4208	0x4208
ZEPDMAC2	0x0000	0x4400	0x4400
ZEPDMAC2	0x0000	0x4500	0x4500
ZEPDMAC2	0x0000	0x5608	0x5608
ZEPDMAC2	0x0000	0x0002	0x0002
ZEPDMAC2	0x0000	0x560f	0x560f
ZEPDMAC2	0x0000	0x181e	0x181e
ZEPDMAC2	0x0000	0xd514	0xd514

5.4.10.13: Macro b

Macro b: Spacecraft Potential Campaign, sensor setup (ISC-BM1-1: 30h00-30h00)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x008b	0x5E8b
ZEPDMAC2	0x0000	0x043f	0x043f
ZEPDMAC2	0x0000	0x206b	0x206b
ZEPDMAC2	0x0000	0x2087	0x2087
ZEPDMAC2	0x0000	0x006b	0x006b
ZEPDMAC2	0x0000	0x0087	0x0087
ZEPDMAC2	0x0000	0x41e4	0x41e4

5.4.10.14: Macro c

Macro c: Return to DIS, sensor setup (STD-ALL-2(a-e), ISC-BM1-2 : 88l28-60l00: for standard mode (LAR), Spacecraft Potential Campaign, CIS-ASPOC, and EFW-Langmuir)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x008c	0x5E8c
ZEPDMAC2	0x0000	0x0444	0x0444
ZEPDMAC2	0x0000	0x2067	0x2067
ZEPDMAC2	0x0000	0x2096	0x2096
ZEPDMAC2	0x0000	0x0067	0x0067
ZEPDMAC2	0x0000	0x008f	0x008f
ZEPDMAC2	0x0000	0x41f3	0x41f3

5.4.10.15: Macro d

Macro d: Potential campaigns, DPU setup (ISC-BM1-2: ctx-apl-40w00: for Spacecraft Potential campaign, CIS-ASPOC and EFW-Langmuir)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDMAC1	0x5E00	0x008d	0x5E8d
ZEPDMAC2	0x0000	0x0949	0x0949
ZEPDMAC2	0x0000	0x4300	0x4300
ZEPDMAC2	0x0000	0x22c1	0x22c1
ZEPDMAC2	0x0000	0x4208	0x4208
ZEPDMAC2	0x0000	0x4400	0x4400
ZEPDMAC2	0x0000	0x4500	0x4500
ZEPDMAC2	0x0000	0x5608	0x5608
ZEPDMAC2	0x0000	0x000e	0x000e
ZEPDMAC2	0x0000	0x560f	0x560f
ZEPDMAC2	0x0000	0x183f	0x183f
ZEPDMAC2	0x0000	0xf52d	0xf52d

It is possible to store a total of 100 words in the macro buffer. These can be over-written when macros are no longer needed.

5.4.11 Step 2f (Optional): Turn PEACE Off after Uplink

Duration

5 minutes

Aims

Turn PEACE Off

Initial State Requirement

READY BOTH SAFE

Final State

PEACE Off

Procedure

See 5.3.3.1 for READY BOTH SAFE to OFF Commands

TBC that this is optional!

Step 3

5.4.12 Step 3a (Revised): Prepare for Step 3

Duration

5 mins

Aims

Put PEACE in to READY BOTH SAFE

Option 1: Start from PEACE OFF

Initial State Requirement

PEACE OFF
Real-time contact interval.

Final State

READY BOTH SAFE

Procedure

See 5.3.3.3, but close IELS

Option 2: Continue from end of Step 2f

Initial State Requirement

STANDBY BOTH PRO
Real-time contact interval.

Final State

READY BOTH SAFE

Procedure

See 5.3.3.4, but close IELS

5.4.13 Step 3: LEEA and HEEA Noise, Threshold and Stim check.

Duration

1 hour

Aim

- To establish background electronic noise level.
- To establish functionality of the internal stim generator.
- To establish threshold settings on amplifiers (n.b. possible temperature dependence).
- To establish functionality of data reduction by comparing processed stim pattern with expected values.

Initial State Requirement

READY BOTH SAFE
KAL previously initalised
NM1
Magnetotail Lobe

Final State

READY BOTH SAFE

Description

- Select SCIENCE (PT Mode with no HVs)
- By observing the total counts in the housekeeping (with the science processing running) and the anode level data in the NOI data product, the background electronics noise in the system is measured.
- By running the internal stim generator in "variable amplitude, variable frequency" mode, the functionality of each sensor data channel can be established and an estimate of the amplifier thresholds carried out. The amplitude alters each 1/16 of a spin.
- By running the stim generator in constant amplitude mode a known data set is transmitted to the DPU which will allow the integrity of the DPU data flow and processing to be checked.

Procedure

5.4.13.1: From READY BOTH SAFE to SCIENCE (PT with no HVs)

SETUP_0 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both processors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0008	0x2068
ZEPHSPSS	0x2080	0x0008	0x2088
ZEPLSMPS	0x0060	0x0008	0x0068
ZEPLSPSS	0x0080	0x0008	0x0088
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	0	
EPH-HTOT	0	

5.4.13.2: LEEA test part 1: variable amplitude, variable frequency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLSTMN	0x00E1	0x0000	0x00E1

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	10^5	
EPH-HTOT	0	
Point in stim pattern where amplifiers trigger	See NOI data - counts in steps 10 to 15 – varies by sensor	

5.4.13.3: LEEA test part 2: constant amplitude, variable frequency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLSTMN	0x00E1	0x0002	0x00E3

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	1.7 x 10^6	
EPH-HTOT	0	

A known data input to the DPU is produced and the total count values in the h/k and the science data are therefore checkable. The expected values in the core science will be available from archived laboratory data.

5.4.13.4: End LEEA Test

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLSTMF	0x00E0	no parameter	0x00E0

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	0	
EPH-HTOT	0	

5.4.13.5: HEEA test part 1: variable amplitude, variable frequency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSTMN	0x20E1	0x0000	0x20E1

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	0	
EPH-HTOT	10^5	
Point in stim pattern where amplifiers trigger	See NOI data - counts in steps 10 to 15 – varies by sensor	

5.4.13.6: HEEA test part 2: constant amplitude, variable frequency

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSTMN	0x20E1	0x0002	0x20E3

Wait 1 minute to accumulate data

Parameter	Expected	Seen?
EPL-LTOT	0	
EPH-HTOT	2.33×10^6	

A known data input to the DPU is produced in this case and the total count value in the h/k and the science data are therefore determinable and can be checked. The expected values in the core science will be available from archived laboratory data.

5.4.13.7: End HEEA Test

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSTMF	0x20E0	no parameter	0x20E0

Wait 1 minute to accumulate data

5.4.13.8: Halt Science (return to READY BOTH SAFE)

HS Halt Science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

Step 4

5.4.14 Step 4: LEEA HV Sweep

Duration

2 hours

Aim

To demonstrate correct function of the HV Sweep generator, while ensuring that if a problem is discovered, it is found at the lowest possible HV level and so in the least damaging way possible. Correct operation of all sweep modes should be verified.

Initial State Requirement

READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Description

The procedure is to switch on the HV Sweep supply to LEEA in FIX mode first so that voltage levels up to 63 can be checked. Then MAR and LAR sweeping modes are demonstrated to the peak preset level, and finally HAR is demonstrated across a range of levels. The housekeeping data, counts data and power consumption are monitored for signs of breakdown – if a breakdown is suspected the test may be immediately terminated.

The activity has four stages. A science reset is required when sweep modes are changed, but not for alteration of sweep preset.

- First stage: the sweep generator is in FIX mode and the preset is set to 31, then raised to level 63.
- Second stage: the sweep generator is run in MAR mode and the preset is raised from 63 to 91 (highest preset level for MAR or LAR mode). The preset is then lowered to 63 for the next test.
- Third stage: the sweep generator is run in LAR mode and the preset is raised to 91 in one step. The preset is then lowered to 63 for the next test.
- Fourth stage: the sweep generator is run in HAR mode at preset 31, 59 and 89.

The test involves progressive incrementing of the sweep level while the DPU is in the Science Processing state, which is not normally advised. Although a safe procedure, the problem is that the Moments data product will rely on the preset values provided when Science Processing is initiated, and will therefore be corrupted if the preset is changed without a reset of Science Processing. Other data products are unaffected. The altered sweep presets will not be shown in the science data packets – confirmation of the new presets can only be found in the HK command echoes (and by observing the 28V and 36V currents).

Procedure

5.4.14.1: Set LEEA Sweep Mode and Preset to Fixed Mode, level 31 and start Science Processing

SETUP_0
LEEA: Select Fixed mode, preset 31
HEEA: Select Fixed mode, preset 0

RUNSCI_BOTH **Start Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPHSMPS	0x2060	0x0000	0x2060	
ZEPHSPSS	0x2080	0x0000	0x2080	0
ZEPLSMPS	0x0060	0x0003	0x0063	
ZEPLSPSS	0x0080	0x0007	0x0087	31
ZEPDPRCN	0x4700	0x0000	0x4700	

delay 20 seconds for Science Processing to start

5.4.14.2: Enable LEEA Sweep (preset is 31)

Enable LEEA Sweep

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLSWEE	0x00C2	no parameter	0x00C2

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 7.5 V).

Parameter	Expected	Seen?
EPL-LTOT	0	

5.4.14.3: Progressively Increase LEEA Preset to 63, in fixed mode

Raise LEEA PS

Increase Preset Voltage up to level 63 while still in fixed mode. Steps chosen so that increment of inter-hemisphere potential is always less than or equal to 50 V.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPLSMPS	0x0060	0x0000	0x0060	
ZEPLSPSS	0x0080	0x000B	0x008B	44

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 31.9 V).

ZEPLSMPS	0x0060	0x0003	0x0063	
ZEPLSPSS	0x0080	0x000C	0x008C	51

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 69.3 V).

ZEPLSMPS	0x0060	0x0000	0x0060	
ZEPLSPSS	0x0080	0x000E	0x008E	56

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 121 V).

ZEPLSMPS	0x0060	0x0003	0x0063	
ZEPLSPSS	0x0080	0x000E	0x008E	59

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 168 V).

ZEPLSMPS	0x0060	0x0001	0x0061	
ZEPLSPSS	0x0080	0x000F	0x008F	61

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 210 V).

ZEPLSMPS	0x0060	0x0003	0x0063	
ZEPLSPSS	0x0080	0x000F	0x008F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

5.4.14.4: Reset LEEA to MAR mode, same preset

Reset LEEA sweep mode

Change to MAR mode (medium sweep) at preset 63. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	
delay 20 seconds while processing shuts down				
ZEPLSMPS	0x0060	0x000F	0x006F	
ZEPLSPSS	0x0080	0x000F	0x008F	63
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

5.4.14.5: Progressively Increase LEEA Preset to 91, in MAR mode

Raise LEEA PS

Progressively increase Preset Voltage up to preset level 91. Every step to be used so as to minimise the increment of inter-hemisphere potential. Less time is spent, per sweep, at the highest voltage in MAR, so we use it in preference to LAR mode.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPLSMPS	0x0060	0x000C	0x006C	
ZEPLSPSS	0x0090	0x0010	0x0090	64

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 293 V).

ZEPLSMPS	0x0060	0x000D	0x006D	
ZEPLSPSS	0x0090	0x0010	0x0090	65

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 328 V).

ZEPLSMPS	0x0060	0x000E	0x006E	
ZEPLSPSS	0x0090	0x0010	0x0090	66

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 366 V).

ZEPLSMPS	0x0060	0x000f	0x006f	
ZEPLSPSS	0x0090	0x0010	0x0090	67

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 409 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0011	0x0091	68

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 457 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0011	0x0091	69

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 510 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0011	0x0091	70

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 570 V).

ZEPLSMPS	0x0060	0x000f	0x006f	
ZEPLSPSS	0x0090	0x0011	0x0091	71

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 637 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0012	0x0092	72

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 712 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0012	0x0092	73

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 795 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0012	0x0092	74

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 890 V).

ZEPLSMPS	0x0060	0x000f	0x006f	
ZEPLSPSS	0x0090	0x0012	0x0092	75

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 993 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0013	0x0093	76

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1110 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0013	0x0093	77

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1241 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0013	0x0093	78

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1387 V).

ZEPLSMPS	0x0060	0x000f	0x006f	
ZEPLSPSS	0x0090	0x0013	0x0093	79

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1548 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0014	0x0094	80

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1731 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0014	0x0094	81

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1934 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0014	0x0094	82

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2158 V).

ZEPLSMPS	0x0060	0x000f	0x006f

ZEPLSPSS	0x0090	0x0014	0x0094	83

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2413 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0015	0x0095	84

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2697 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0015	0x0095	85

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3012 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0015	0x0095	86

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3369 V).

ZEPLSMPS	0x0060	0x000f	0x006f	
ZEPLSPSS	0x0090	0x0015	0x0095	87

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3761 V).

ZEPLSMPS	0x0060	0x000c	0x006c	
ZEPLSPSS	0x0090	0x0016	0x0096	88

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPLSMPS	0x0060	0x000d	0x006d	
ZEPLSPSS	0x0090	0x0016	0x0096	89

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPLSMPS	0x0060	0x000e	0x006e	
ZEPLSPSS	0x0090	0x0016	0x0096	90

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPLSMPS	0x0060	0x000F	0x006f	
ZEPLSPSS	0x0090	0x0016	0x0096	91

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

It is now necessary to set the preset back to 63 for the next test:

ZEPLSMPS	0x0060	0x000F	0x006F	
ZEPLSPSS	0x0080	0x000F	0x008F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

5.4.14.6: Reset LEEA to LAR mode, using preset at 63 and then 91, then put into safe state for next test

Reset LEEA sweep mode

Change to LAR mode (long sweep) at preset level 63. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

More time is spent, per sweep, at the highest voltage in LAR, so this is the mode with the longest interval of sustained high voltage across the analyser hemispheres. Then increase to 91.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

ZEPLSMPS	0x0060	0x0007	0x0067	
ZEPLSPSS	0x0080	0x000F	0x008F	63
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

ZEPLSMPS	0x0060	0x0007	0x0067	
ZEPLSPSS	0x0090	0x0016	0x0096	91

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

It is now necessary to set the preset back to 63 in LAR for next test:

ZEPLSMPS	0x0060	0x0007	0x0067	
ZEPLSPSS	0x0080	0x000F	0x008F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

5.4.14.7:   LEEA Preset at 31, 59, 89 in HAR mode

Change LEEA sweep mode

Reset to HAR mode at preset level 31. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

ZEPLSMPS	0x0060	0x000b	0x006b	
ZEPLSPSS	0x0080	0x0007	0x0087	31
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

ZEPLSMPS	0x0060	0x000b	0x006b	
ZEPLSPSS	0x0080	0x000e	0x008e	59

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

ZEPLSMPS	0x0060	0x0009	0x0069	
ZEPLSPSS	0x0080	0x0016	0x0096	89

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

5.4.14.8:   Disable MCP and sweep, Halt Science (return to READY BOTH SAFE)

Disable MCP and sweep

HS   Halt science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHHVGD	0x00C0	no parameter	0x00C0
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 120 seconds

Step 5

5.4.15 Step 5: HEEA HV Sweep

Duration

2 hours

Aim

To demonstrate correct function of the HV Sweep generator, while ensuring that if a problem is discovered, it is found at the lowest possible HV level and so in the least damaging way possible. Correct operation of all sweep modes should be verified.

Initial State Requirement

READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Description

The procedure is to switch on the HV Sweep supply to LEEA in FIX mode first so that voltage levels up to 63 can be checked. Then MAR and LAR sweeping modes are demonstrated to the peak preset level, and finally HAR is demonstrated across a range of levels. The housekeeping data, counts data and power consumption are monitored for signs of breakdown – if a breakdown is suspected the test may be immediately terminated.

The activity has four stages. A science reset is required when sweep modes are changed, but not for alteration of sweep preset.

- First stage: the sweep generator is in FIX mode and the preset is set to 31, then raised to level 63.
- Second stage: the sweep generator is run in MAR mode and the preset is raised from 63 to 91 (highest preset level for MAR or LAR mode). The preset is then lowered to 63 for the next test.
- Third stage: the sweep generator is run in LAR mode and the preset is raised to 91 in one step. The preset is then lowered to 63 for the next test.
- Fourth stage: the sweep generator is run in HAR mode at preset 31, 59 and 89.

The test involves progressive incrementing of the sweep level while the DPU is in the Science Processing state, which is not normally advised. Although a safe procedure, the problem is that the Moments data product will rely on the preset values provided when Science Processing is initiated, and will therefore be corrupted if the preset is changed without a reset of Science Processing. Other data products are unaffected. The altered sweep presets will not be shown in the science data packets – confirmation of the new presets can only be found in the HK command echoes (and by observing the 28V and 36V currents).

Procedure

5.4.15.1: Set HEEA to fixed mode, preset 31

SETUP_0
LEEA: Select Fixed mode, preset 0
HEEA: Select Fixed mode, preset 31

RUNSCI_BOTH **Start Science**

Set to FIXED mode (no sweep) at preset 31. It is necessary to halt and restart science processing in order that the data products are correctly organised (Moments are not produced in this mode).
LEEA in fixed mode, preset 0.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
Halt science removed				
ZEPHSMPS	0x2060	0x0003	0x2063	
ZEPHSPSS	0x2080	0x0007	0x2087	31
ZEPLSMPS	0x0060	0x0000	0x0060	
ZEPLSPSS	0x0080	0x0000	0x0080	0
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

5.4.15.2: Enable HEEA Sweep

Enable HEEA Sweep

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSWEE	0x20C2	no parameter	0x20C2

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 7.5 V).

Parameter	Expected	Seen?
EPH-HTOT	0	

5.4.15.3: Progressively Increase HEEA Preset to 63, in Fixed mode

Raise HEEA PS

Increase Preset Voltage up to level 63 while still in fixed mode. Steps chosen so that increment of inter-hemisphere potential is always less than or equal to 50 V.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPHSMPS	0x2060	0x0000	0x2060	
ZEPHSPSS	0x2080	0x000B	0x208B	44

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 31.9 V).

ZEPHSMPS	0x2060	0x0003	0x2063	
ZEPHSPSS	0x2080	0x000C	0x208C	51

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 69.3 V).

ZEPHSMPS	0x2060	0x0000	0x2060	
ZEPHSPSS	0x2080	0x000E	0x208E	56

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 121 V).

ZEPHSMPS	0x2060	0x0003	0x2063	
ZEPHSPSS	0x2080	0x000E	0x208E	59

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 168 V).

ZEPHSMPS	0x2060	0x0001	0x2061	
ZEPHSPSS	0x2080	0x000F	0x208F	61

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 210 V).

ZEPHSMPS	0x2060	0x0003	0x2063	
ZEPHSPSS	0x2080	0x000F	0x208F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

`5.4.15.4: Reset HEEA to MAR mode, same preset`

Reset HEEA sweep mode

Change to MAR mode (medium sweep) at preset 63. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	
delay 20 seconds while processing shuts down				
ZEPHSMPS	0x2060	0x000F	0x206F	
ZEPHSPSS	0x2080	0x000F	0x208F	63
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

`5.4.15.5: Progressively Increase HEEA Preset to 91, in MAR mode`

Raise HEEA PS

Progressively increase Preset Voltage up to preset level 91. Every step to be used so as to minimise the increment of inter-hemisphere potential. Less time is spent, per sweep, at the highest voltage in MAR, so we use it in preference to LAR mode.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPHSMPS	0x2060	0x000C	0x206C	
ZEPHSPSS	0x2090	0x0000	0x2090	64

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 293 V).

ZEPHSMPS	0x2060	0x000D	0x206D	
ZEPHSPSS	0x2090	0x0000	0x2090	65

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 328 V).

ZEPHSMPS	0x2060	0x000E	0x206E	
ZEPHSPSS	0x2090	0x0000	0x2090	66

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 366 V).

ZEPHSMPS	0x2060	0x000f	0x206f	
ZEPHSPSS	0x2090	0x0010	0x2090	67

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 409 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0011	0x2091	68

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 457 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0011	0x2091	69

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 510 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0011	0x2091	70

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 570 V).

ZEPHSMPS	0x2060	0x000f	0x206f	
ZEPHSPSS	0x2090	0x0011	0x2091	71

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 637 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0012	0x2092	72

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 712 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0012	0x2092	73

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 795 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0012	0x2092	74

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 890 V).

ZEPHSMPS	0x2060	0x000f	0x206f	
ZEPHSPSS	0x2090	0x0012	0x2092	75

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 993 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0013	0x2093	76

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1110 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0013	0x2093	77

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1241 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0013	0x2093	78

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1387 V).

ZEPHSMPS	0x2060	0x000f	0x206f	
ZEPHSPSS	0x2090	0x0013	0x2093	79

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1548 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0014	0x2094	80

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1731 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0014	0x2094	81

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 1934 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0014	0x2094	82

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2158 V).

ZEPHSMPS	0x2060	0x000f	0x206f

ZEPHSPSS	0x2090	0x0014	0x2094	83

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2413 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0015	0x2095	84

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 2697 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0015	0x2095	85

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3012 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0015	0x2095	86

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3369 V).

ZEPHSMPS	0x2060	0x000f	0x206f	
ZEPHSPSS	0x2090	0x0015	0x2095	87

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 3761 V).

ZEPHSMPS	0x2060	0x000c	0x206c	
ZEPHSPSS	0x2090	0x0016	0x2096	88

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPHSMPS	0x2060	0x000d	0x206d	
ZEPHSPSS	0x2090	0x0016	0x2096	89

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPHSMPS	0x2060	0x000e	0x206e	
ZEPHSPSS	0x2090	0x0016	0x2096	90

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

ZEPHSMPS	0x2060	0x000F	0x206F	
ZEPHSPSS	0x2090	0x0006	0x2096	91

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

It is now necessary to set the preset back to 63 for the next test:

ZEPHSMPS	0x2060	0x000F	0x206F	
ZEPHSPSS	0x2080	0x000F	0x208F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

5.4.15.6: Reset HEEA to LAR mode, using preset at 63 and then 91, then put into safe state for next test

Reset HEEA sweep mode

Change to LAR mode (long sweep) at preset level 63. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

More time is spent, per sweep, at the highest voltage in LAR, so this is the mode with the longest interval of sustained high voltage across the analyser hemispheres. Then increase to 91.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

ZEPHSMPS	0x2060	0x0007	0x2067	
ZEPHSPSS	0x2080	0x000F	0x208F	63
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 263 V).

ZEPHSMPS	0x2060	0x0007	0x2067	
ZEPHSPSS	0x2090	0x0016	0x2096	91

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 4200 V).

It is now necessary to set the preset back to 63 in LAR for the next test:

ZEPHSMPS	0x2060	0x0007	0x2067	
ZEPHSPSS	0x2080	0x000F	0x208F	63

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

5.4.15.7: HEEA Preset at 31, 59, 89 in HAR mode

Change HEEA sweep mode

Reset to HAR mode at preset level 31. It is necessary to halt and restart science processing in order that the data products are correctly organised (although Moments will become invalid when the preset is altered).

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	PRESET
ZEPDPRCN	0x4700	0x00FF	0x47FF	

delay 20 seconds while processing shuts down

ZEPHSMPS	0x2060	0x000b	0x206b	
ZEPHSPSS	0x2080	0x0007	0x2087	31
ZEPDPRCN	0x4700	0x0000	0x4700	

(no new commands for 20 seconds while processing restarts)

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition. (actual peak voltage across plates is 7.5 V).

ZEPHSMPS	0x2060	0x000b	0x206b	
ZEPHSPSS	0x2080	0x000e	0x208e	59

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

ZEPHSMPS	0x2060	0x0009	0x2069	
ZEPHSPSS	0x2080	0x0016	0x2096	89

Observe housekeeping data for 15 formats before proceeding to allow time for malfunction recognition.

5.4.15.8: Disable MCP and sweep, Halt Science (return to READY BOTH SAFE)

Disable MCP and sweep

HS

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHHVGD	0x20C0	no parameter	0x20C0
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 120 seconds

Step 6

5.4.16 Step 6: LEEA MCP Commissioning

Duration

2 hours (3?)
(Note that the duration of this test is likely to vary from sensor to sensor. The value given here is a conservative estimate, but longer durations cannot be ruled out).

Aim

To switch on the high voltage supply of LEEA MCP and gradually increase the high voltage to establish:

- That there has been sufficient outgassing time
- That the integrity of the high voltage supply has been maintained
- That the integrity of the MCP has been maintained

Initial State Requirement

READY BOTH SAFE
NM1
Magnetotail Lobe

Final State

READY BOTH SAFE

Description

- The exercise is carried out in the Lobe, with Sweep HVs On, to minimise non-noise counts.
- The MCP voltage is gradually increased with the sweep voltage on and the noise counts observed. If the noise count accumulated over a 4 second spin is less than the maximum noise count allowable for each particular sensor, allowing for a 5 minutes settle time, then the voltage will be increased.
- The maximum noise count allowed for a particular sensor will be assessed during calibration. The general target is for less than 100 counts per spin summed over all anodes (tbc).
- The grid is set to –8V to reduce the level of any contribution to counts from photons, or from either photoelectrons or secondary electrons which may be generated within the analyser. At the end of the test, the grid is deactivated – an increase in noise counts may be seen.
- For the initial commissioning the MCP level will be increased to a predefined value as determined during the calibration; as follows

Sensor	LEEA 6	LEEA 7	LEEA 8	LEEA 9	LEEA 10
Level (Dec)	17	19	14	17	18
Level (Hex)	11	13	E	11	12

Procedure

5.4.16.1: From READY BOTH SAFE to SCIENCE

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Start science processing (both sensors)**

HAR 89 on both sensors (DO NOT enable both HV sweeps)
COR, NOI, 3DR-LEEA
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0009	0x2069
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x0009	0x0069
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x1249	0x1249
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

5.4.16.2: LEEA grid to -8 Volts

LEEA grid on

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLCISG	0x0000	0x0010	0x0010

5.4.16.3: LEEA MCP Commissioning

LEEA only; MCP Commissioning

This example is for the case of an operating level of 19. Every level, starting from level 0, is commanded in turn, and a pause for noise assessment before proceeding is required for each step.

The delay time, *[observe mcp noise]*, will be decided by the PI for each level during the test. A value of 5 minutes is suggested as the default, and as the basis for the duration estimate above. However, experience suggests that while a minimum time for this procedure is easily established, the true time may vary from sensor to sensor.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	0
ZEPLHVGE	0x00C3	no parameter	0x00C3	
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0001	0x0041	1
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0002	0x0042	2
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0003	0x0043	3
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0004	0x0044	4
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0005	0x0045	5
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0006	0x0046	6
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0007	0x0047	7
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0008	0x0048	8
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0009	0x0049	9
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000A	0x004A	10
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000B	0x004B	11
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000C	0x004C	12
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000D	0x004D	13
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000E	0x004E	14
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x000F	0x004F	15
delay [observe mcp noise] seconds				
ZEPLMCPS	0x0040	0x0010	0x0050	16

delay [observe mcp noise] seconds

ZEPLMCPS	0x0040	0x0011	0x0051	17

delay [observe mcp noise] seconds

ZEPLMCPS	0x0040	0x0012	0x0052	18

delay [observe mcp noise] seconds

ZEPLMCPS	0x0040	0x0013	0x0053	19

delay [observe mcp noise] seconds

5.4.16.4: LEEA grid to 0 Volts

LEEA grid off

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPLCISG	0x0000	0x0000	0x0000

delay [observe mcp noise] seconds

5.4.16.5: LEEA MCP and Sweep HV Turn Off

LEEA only; MCP Turn Off

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	

(set the MCP level back to 0)

ZEPLHVGD	0x00C0	no parameter	0x00C0

(disable the MCP)

delay 120 seconds

5.4.16.6: Halt Science (return to READY BOTH SAFE)

HS

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

Step 7

5.4.17 Step 7: HEEA MCP Commissioning

Duration

2 hours (3?)
(Note that the duration of this test is likely to vary from sensor to sensor. The value given here is a conservative estimate, but longer durations cannot be ruled out).

Aim

To switch on the high voltage supply of HEEA MCP and gradually increase the high voltage to establish:

- That there has been sufficient outgassing time
- That the integrity of the high voltage supply has been maintained
- That the integrity of the MCP has been maintained

Initial State Requirement

READY BOTH SAFE
NM1
Magnetotail Lobe

Final State

READY BOTH SAFE

Description

- The exercise is carried out in the Lobe, with HV sweeps on, to minimise non-noise counts.
- The MCP voltage is gradually increased with the sweep voltage on and the noise counts observed. If the noise count accumulated over a 4 second spin is less than the maximum noise count allowable for each particular sensor, allowing for a 5 minutes settle time, then the voltage will be increased.
- The maximum noise count allowed for a particular sensor will be assessed during calibration. The general target is for less than 100 counts per spin over all anodes (tbc).
- The grid is set to –8V to reduce the level of any contribution to counts from photons, or from either phtoelectrons or secondary electrons which may be generated within the analyser. At the end of the test, the grid is deactivated – an increase in noise counts may be seen.
- For the initial commissioning the MCP level will be increased to a predefined value as determined during the calibration; as follows

Sensor	HEEA 6	HEEA 7	HEEA 8	HEEA 9	HEEA 10
Level (Dec)	17	17	15	17	17
Level (Hex)	11	11	F	11	11

Procedure

5.4.17.1:   From READY BOTH SAFE to SCIENCE

SETUP_1   **Sensor setup and science configuration**

RUNSCI_BOTH   **Run science processing (both sensors)**

HAR 89 on both sensors (DO NOT enable both HV sweeps)
COR, NOI, 3DR-HEEA
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0009	0x2069
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x0009	0x0069
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x2249	0x2249
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

5.4.17.2:   HEEA grid to -8 Volts

HEEA grid on

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHCISG	0x2000	0x0010	0x2010

5.4.17.3:   HEEA MCP Commissioning

HEEA only; MCP Commissioning

This example is for the case of an operating level of 19. Every level, starting from level 0, is commanded in turn, and a pause for noise assessment before proceeding is required for each step.

The delay time, *[observe mcp noise]*, will be decided by the PI for each level during the test. A value of 5 minutes is suggested as the default, and as the basis for the duration estimate above. However, experience suggests that while a minimum time for this procedure is easily established, the true time may vary from sensor to sensor.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPHMCPS	0x2040	0x0000	0x2040	0
ZEPHHVGE	0x20C3	no parameter	0x20C3	
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0001	0x2041	1
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0002	0x2042	2
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0003	0x2043	3
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0004	0x2044	4
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0005	0x2045	5
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0006	0x2046	6
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0007	0x2047	7
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0008	0x2048	8
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0009	0x2049	9
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000A	0x204A	10
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000B	0x204B	11
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000C	0x204C	12
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000D	0x204D	13
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000E	0x204E	14
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x000F	0x204F	15
delay [observe mcp noise] seconds				
ZEPHMCPS	0x2040	0x0010	0x2050	16
delay [observe mcp noise] seconds				

ZEPHMCPS	0x2040	0x0011	0x2051	17

delay [observe mcp noise] seconds

ZEPHMCPS	0x2040	0x0012	0x2052	18

delay [observe mcp noise] seconds

ZEPHMCPS	0x2040	0x0013	0x2053	19

delay [observe mcp noise] seconds

5.4.17.4: HEEA grid to 0 Volts

HEEA grid off

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHCISG	0x2000	0x0000	0x2000

delay [observe mcp noise] seconds

5.4.17.5: HEEA MCP and Sweep HV Turn Off

HEEA only; MCP Turn Off

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHMCPS	0x2040	0x0000	0x2040

(set the MCP level back to 0)

ZEPHHVGD	0x20C0	no parameter	0x20C0

(disable the MCP)

delay 120 seconds

5.4.17.6: Halt Science (return to READY BOTH SAFE)

HS

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

Step 8

5.4.18 Step 8 (Revised for NM1) : MCP Operational Level Check

Duration

1 hour per iteration (tbc)

Aims

The operating level for an MCP, i.e. the preferred voltage applied across the MCP, varies from MCP to MCP. Thus an initial operating level is assessed during ground calibration work. The test described here for Commissioning is intended to confirm that the ground calibration result holds when the instrument is exposed to a real space plasma, rather than a simple laboratory electron beam.

The test may need to be repeated in plasma environments which are not visited during commissioning. The test may also need to be repeated from time to time, to monitor possible changes in MCP behaviour. Repeat tests may use an abbreviated version of the test described here.

It is desired to operate within the MCP gain plateau region in which the change of counts above threshold with voltage is minimum.

The choice of level must also reconcile two requirements:

- to maximise signal to noise (a higher level means a higher gain and a better signal to noise ratio)
- to preserve instrument lifetime (a lower level means less gain and reduced rate of charge extraction – hence, possibly, a longer instrument lifetime). We also note that a lower level has a reduced risk of high voltage breakdown.

Data collected in this test may be used to determine the behaviour of the MCP as a function of MCP level, and hence forms the basis for the engineering performance analysis outlined above.

Sequence Description

Starting from Science Mode (with MCPs off), the sweeps are directly enabled and the MCPs are switched to the minimum operational level in a number of steps.
The MCP level on one sensor is then incremented and the counts observed, while the other sensor is used to monitor the environment (which should be stable during the test). Then the process is repeated with the roles of the sensors reversed.

Initial State Requirement

READY BOTH SAFE
NM1
Magnetotail Plasmasheet

For the purpose of this test it is necessary to have uniform plasma conditions with significant flux levels over a long period, with no boundaries and no changes over spin to spin duration. During Commissioning, the best environment available will be the magnetotail plasmasheet, however a repeat of the activity in the solar wind may also be requested. The duration of a given plasmasheet passage is estimated to usually lie between 1 and 5 hours, but to be unpredictable. The test is designed to fall within an hour, but repetition may be requested during a pass. It is required that this test be performed on several consecutive passes. A related test will also be used routinely throughout the mission to check whether the MCP settings are stable.

Final State

READY BOTH SAFE

Procedure

`5.4.18.1a: From READY BOTH SAFE to SCIENCE (Plasmasheet Case)`

SETUP_1	**Sensor setup and science configuration**
GS	**Grid Switch**
RUNSCI_BOTH	**Run science processing (both sensors)**

The DPU needs to be told the presets and sweep modes of the sensors before science processing is initiated. Note, HV sweep levels are chosen to give good coverage of plasmasheet plasma energy range

LAR 83 on both sensors for Plasmasheet
COR, NOI, 3DR-Both
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0014	0x2094
ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x0014	0x0094
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0249	0x0249
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPHCISG	0x2000	0x0010	0x2010
ZEPLCISG	0x0000	0x0010	0x0010
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

`5.4.18.1b: From READY BOTH SAFE to SCIENCE (Lobe Case)`

SETUP_1	**Sensor setup and science configuration**
GS	**Grid Switch**
RUNSCI_BOTH	**Run science processing (both sensors)**

The DPU needs to be told the presets and sweep modes of the sensors before science processing is initiated. Note, HV sweep levels are chosen to give coverage of the lobe plasma energy range above the photoelectrons.

LAR 91 on both sensors for Lobes
COR, NOI, 3DR-Both
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0249	0x0249
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPHCISG	0x2000	0x0010	0x2010
ZEPLCISG	0x0000	0x0010	0x0010
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

5.4.18.2 Enable Sweep and MCP HV's

Enable Sweeps and MCPs

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPHMCPS	0x2040	0x0000	0x2040	0
ZEPHHVGE	0x20C3	0x0000	0x20C3	
ZEPLMCPS	0x0040	0x0000	0x0040	0
ZEPLHVGE	0x00C3	0x0000	0x00C3	

5.4.18.3: Set HEEA MCP to Monitoring Level (Gain of 1 to 1.5 x10^6)

This example is for the case of a monitoring level of 15.

HEEA will monitor the environment while LEEA tests are carried out.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPHMCPS	0x2040	0x000f	0x204f	15

delay 120 secs

This step will be repeated as many times as necessary to step up the MCP level to operational

MATERIAL HAS BEEN REMOVED BELOW

5.4.18.4: Increment MCP LEEA Levels to Upper Limit (Gain of 4 x10^6)

The test example is for the case of a LEEA operating level of 19. Every level, starting from level 0, is commanded in turn, and a pause for noise assessment before proceeding is required for each step. The highest level will be the operational level based on laboratory assessment.

The delay time, [*accumulate mcp counts*], will be decided by the PI for each level during the test. A value of 2 minutes is suggested as the default, and as the basis for the duration estimate above. However, experience suggests that while a minimum time for this procedure is easily established, the true time may vary from sensor to sensor.

delay [accumulate mcp counts] seconds; MCP is at level 0

ZEPLMCPS	0x0040	0x0002	0x0042	2

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0004	0x0044	4

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0006	0x0046	6

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0008	0x0048	8

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000A	0x004A	10

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000B	0x004B	11

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000C	0x004C	12

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000D	0x004D	13

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000E	0x004E	14

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x000F	0x004F	15

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0010	0x0050	16

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0011	0x0051	17

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0012	0x0052	18

delay [accumulate mcp counts] seconds

ZEPLMCPS	0x0040	0x0013	0x0053	19

delay [accumulate mcp counts] seconds

LEEA now held at level 19 while HEEA MCP voltage is raised

5.4.18.4 Set (lower) LEEA MCP to Monitoring Level (Gain of 1 to 1.5 x10^6)

This example is for the case of a monitoring level of 15.

LEEA will monitor the environment while HEEA tests are carried out.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x000f	0x004f	15

delay 120 secs

5.4.18.5: Increment MCP HEEA Levels to Upper Limit (Gain of 4 x10^6)

The test example is for the case of HEEA operating level of 19. Every level, starting from level 0, is commanded in turn, and a pause for noise assessment before proceeding is required for each step. The highest level will be the operational level based on laboratory assessment.

The delay time, [*accumulate mcp counts*], will be decided by the PI for each level during the test. A value of 2 minutes is suggested as the default, and as the basis for the duration estimate above. However, experience suggests that while a minimum time for this procedure is easily established, the true time may vary from sensor to sensor.

ZEPHMCPS	0x2040	0x0000	0x2040	0

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0002	0x2042	2

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0004	0x2044	4

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0006	0x2046	6

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0008	0x2048	8

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000A	0x204A	10

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000B	0x204B	11

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000C	0x204C	12

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000D	0x204D	13

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000E	0x204E	14

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x000F	0x204F	15

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0010	0x2050	16

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0011	0x2051	17

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0012	0x2052	18

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0013	0x2053	19

delay [accumulate mcp counts] seconds

5.4.18.6: Disable Sweeps and MCPs

Set both MCP levels to zero, disable sweeps and switch off grids

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	0

(set the MCP level back to 0)

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0000	0x2040	0

(set the MCP level back to 0)

delay [accumulate mcp counts] seconds

ZEPLHVGD	0x00C0	no parameter	0x00C0	

(disable the MCP)

ZEPHHVGD	0x20C0	no parameter	0x20C0	

(disable the MCP)

delay 120 seconds

ZEPHCISG	0x2000	0x0000	0x2000
ZEPLCISG	0x0000	0x0000	0x0000

5.4.18.7: Halt Science (return to READY BOTH SAFE)

HS Halt Science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.19 Step 8b (Deleted): Turn PEACE Off after HV Sweep and MCP Work

Removed (See 5.3.3.1 for READY BOTH SAFE to OFF Commands)

Step 9

5.4.20 Step 9a: (NM1 or BM1) Demonstrate Standard Operating Mode

Duration

15 minutes

Aims

Set up instrument in standard operational mode STD-ALL-1e and confirm correct system function.

Sequence Description

Demonstrate usual turn on.

Initial State Requirement

PEACE OFF
NM1 or BM1
Any Region

Final State

READY BOTH HV ON

Procedure

5.4.20.1: PEACE OFF to READY BOTH SAFE

PO **Power On 28V**

EE **Execute Executive**

RA2 **Run Application (two processor)**

LV_BOTH **Turn on low voltage power to both sensors**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x8000	0x0081	0x8081
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			
ZEPDBOOS	0x4D00	0x0001	0x4D01
delay 15 seconds			
ZEPDEAPP	0x5200	0x0091	0x5291
delay 15 seconds			
ZEPDLPCN	0x4B00	0x0003	0x4B03

ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			
ZEPDHPCN	0x6B00	0x0003	0x6B03
ZEPDCONF	0x4F55	no parameter	0x4F55
delay 30 seconds			

5.4.20.2: From READY BOTH SAFE to STD-ALL-1e, 88m28-60m00-cplrx-anl-16w02

INTERFACE **Spacecraft interface and watchdog**

SETUP_2 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

HV_BOTH **High voltage enable: both sensors**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x00e6	0x4ce6	Open all IEL's
ZEPHSMPS	0x000f	0x206f	HEEA Sweep mode + PS
ZEPHSPSS	0x0016	0x2096	HEEA Sweep PS
ZEPLSMPS	0x000f	0x006f	LEEA sweep mode + PS
ZEPLSPSS	0x000f	0x008f	LEEA sweep PS
ZEPDDATS	0x0000	0x4300	Datasets control
ZEPDDATP	0x02d5	0x02d5	Datasets setup
ZEPDHIPS	0x0008	0x4208	Correlator setup
ZEPDMAGS	0x0000	0x4400	Mag field selection
ZEPDSPOT	0x0004	0x4504	S/c Potential setup
ZEPDLPUE	0x0008	0x5608	3DX 1 control
ZEPDPUPS	0x0002	0x0002	3DX 1 setup
ZEPDLPUE	0x000f	0x560f	3DX 1 energy limits control
ZEPDPUPS	0x181e	0x181e	3DX 1 energy limits
ZEPDPRCN	0x0000	0x4700	Start "Science Processing"
delay 20 seconds			
ZEPHMCPS	0x0000	0x2040	HEEA MCP level zero
ZEPLMCPS	0x0000	0x0040	LEEA MCP level zero
ZEPHHVGE	no parameter	0x20C3	Enable HV's
ZEPLHVGE	no parameter	0x00C3	Enable HV's

ZEPHMCPS	0x00ML	0x20ML*	HEEA MCP level
ZEPLMCPS	0x00ML	0x00ML*	LEEA MCP level

delay 120 seconds

wait 6 minutes to accumulate data

5.4.20.3: Halt Science (go to READY BOTH HV ON)

HS Halt Science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.21 Step 9b: (NM1 or BM1) Demonstrate Interference Campaign Macros

ONLY DONE ON THE FIRST SPACECRAFT

Duration

1 hour 15 mins

Aims

Demonstrate proper loading and functioning of Interference Campaign Macros (uplinked earlier)

Sequence Description

Run Interference Campaign Macros with pauses to collect data in each case

Initial State Requirement

READY BOTH HV ON
NM1 or BM1
Any Region

Final State

READY BOTH HV ON

Procedure

`5.4.21.1: Test of first set of macros for EDI campaign`

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name IPE-BM1-1: 60h30-58f58-cplf (with EDI data in COR), T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDMAC1	0x0000	0x5e00	Launch sensors setup macro
ZEPDMAC1	0x0001	0x5e01	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	

delay 20 seconds

Collect data for 5 minutes

5.4.21.2: Test of second set of macros for EDI campaign

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

For Science Mode Name IPE-BM1-2: 58f58-60h30-cplf (with EDI data in COR), T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0002	0x5e02	Launch sensors setup macro
ZEPDMAC1	0x0001	0x5e01	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.3: Test of macros for Electronic noise campaign

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

For Science Mode Name IPW-NM1-5: 88m28-60m00-cnlf, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0009	0x5e09	Launch sensors setup macro
ZEPDMAC1	0x0007	0x5e07	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.4: Test of first set of macros for WHISPER 2 and 3 campaigns

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name IPW-BM1-1: 30h00-30h00-cplf, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0003	0x5e03	Launch sensors setup macro
ZEPDMAC1	0x0008	0x5e08	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.5: Test of second set of macros for WHISPER 2 and 3 campaigns

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name IPW-BM1-2: 59h29-59h29-cplf, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0004	0x5e04	Launch sensors setup macro
ZEPDMAC1	0x0008	0x5e08	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.6: Test of third set of macros for WHISPER 2 and 3 campaigns

Prohibited unless otherwise indicated by PI

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

For Science Mode Name IPW-BM1-3: 88h58-88h58-cplf, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0005	0x5e05	Launch sensors setup macro
ZEPDMAC1	0x0008	0x5e08	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.7: Test of macros for WHISPER 4 campaign

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

For Science Mode Name IPW-BM1-4: 60m00-60m00-cplf, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0006	0x5e06	Launch sensors setup macro
ZEPDMAC1	0x0008	0x5e08	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.8: Test of macros for Spacecraft Potential, CIS-ASPOC and EFW-Langmuir campaigns

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name ISC-BM1-2: 88l28-60l00-ctx-apl-40w00, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x000c	0x5e0c	Launch sensors setup macro
ZEPDMAC1	0x000d	0x5e0d	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.9: Test of macros for Standard Mode (MAR)

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name STD-ALL-1e: 88m28-60m00-cplrx-anl-16w02, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x0009	0x5e09	Launch sensors setup macro
ZEPDMAC1	0x000a	0x5e0a	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.10: Test of macros for Standard Mode (LAR)

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

For Science Mode Name STD-ALL-2e: 88l28-60l00-cplrx-anl-16w02, T1-SP0

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			
ZEPDMAC1	0x000c	0x5e0c	Launch sensors setup macro
ZEPDMAC1	0x000a	0x5e0a	Launch DPU setup macro
ZEPDPRCN	0x0000	0x4700	
delay 20 seconds			
Collect data for 5 minutes			

5.4.21.11: Halt science to get back to READY BOTH HV ON state

HS **Halt Science**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	
delay 20 seconds			

5.4.22 Step 9c: (NM1 or BM1) Demonstration of Eclipse Mode

Duration

20 mins (tbc)

Aims

Demonstrate use of PEACE "internal sun pulse" as timing control.

Sequence Description

Standard science mode (STD-ALL-1e), but select "eclipse mode"
The eclipse mode is turned on, a standard science mode is run for ten minutes and then PEACE is turned off, which also turns off eclipse mode.

Initial State Requirement

READY BOTH HV ON
NM1 or BM1
Any Region

Final State

PEACE OFF

Procedure

5.4.22.1: Turn down MCP levels, switch off sweeps and set up Eclipse Mode (internal sun pulse generator *on*)

(MCP Level Change)
Lower the MCP to PI selected level (e.g. level 2 shown here on both)

HV_MNT_BOTH
Sweep HVs off but MCP HVs still on

ECLIP
Turn off watchdog, set sunpulse offset and turn eclipse mode on, re-enable watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHMCPS	0x2040	0x0002	0x2042
ZEPLMCPS	0x0040	0x0002	0x0042
ZEPHMCPE	0x20c1	no parameter	0x20c1
ZEPLMCPE	0x00c1	no parameter	0x00c1
ZEPDHWCE	0x4C00	0x0012	0x4C12
Wait 10 seconds			
ZEPDSN1S	0x5500	0x0000	0x5500

ZEPDSN2S	0x0000	0xBFFE	0xBFFE

Wait 20 seconds

ZEPDHWCE	0x4C00	0x0016	0x4C16

Wait 10 seconds

5.4.22.2: From READY BOTH to SCIENCE (Standard Mode, STD-ALL-1e)

INTERFACE **Spacecraft interface and watchdog**

SETUP_2 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

HV_MEL_BOTH
Re-enable Sweep HVs and keep MCP HVs on

(MCP Level Change)
Return the MCP to PI selected level (probably corresponds to gain of 2 x 10^6)

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x00e6	0x4ce6	Open all IEL's
ZEPHSMPS	0x000f	0x206f	HEEA Sweep mode + PS
ZEPHSPSS	0x0016	0x2096	HEEA Sweep PS
ZEPLSMPS	0x000f	0x006f	LEEA sweep mode + PS
ZEPLSPSS	0x000f	0x008f	LEEA sweep PS
ZEPDDATS	0x0000	0x4300	Datasets control
ZEPDDATP	0x02d5	0x02d5	Datasets setup
ZEPDHIPS	0x0008	0x4208	Correlator setup
ZEPDMAGS	0x0000	0x4400	Mag field selection
ZEPDSPOT	0x0004	0x4504	S/c Potential setup
ZEPDLPUE	0x0008	0x5608	3DX 1 control
ZEPDPUPS	0x0002	0x0002	3DX 1 setup
ZEPDLPUE	0x000f	0x560f	3DX 1 energy limits control
ZEPDPUPS	0x181e	0x181e	3DX 1 energy limits
ZEPDPRCN	0x0000	0x4700	Start "Science Processing"

delay 20 seconds

ZEPHHVGE	0x20c3	no parameter	0x20c3
ZEPLHVGE	0x00c3	no parameter	0x00c3
ZEPHMCPS	0x2040	0x00uu	0x20uu
ZEPLMCPS	0x0040	0x00uu	0x00uu

wait 10 minutes to accumulate data

5.4.22.3: MCP's to zero, sweeps off, halt science, reset SPOS and power off PEACE

(MCP Level Change)
Lower the MCP levels to 0

SAFE

Disable all HVs (Sweep and MCP)

HS **Halt Science**

Commands to set SPOS back to henceforth value (default of 176 = 0x00b0)

PDP **Power down PEACE**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHMCPS	0x2040	0x0000	0x2040
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPHHVGD	0x20c0	no parameter	0x20c0
ZEPLHVGD	0x00c0	no parameter	0x00c0
ZEPDPRCN	0x4700	0x00ff	0x47ff
delay 20 seconds			
ZEPDHWCE	0x4C00	0x0012	0x4C12
Wait 10 seconds			
ZEPDSN1S	0x5500	0x0000	0x5500
ZEPDSN2S	0x0000	0x00b0*	0x00b0*
Wait 20 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16
Wait 10 seconds			
ZEPHHVGD	0x20c0	no parameter	0x20c0
ZEPHLVGD	0x00c0	no parameter	0x00c0
delay 120 seconds to allow MCP power capacitors to discharge			
ZEPDRSET	0x48a5	no parameter	0x48a5
delay 120 seconds to allow sensor power capacitors to discharge			

"Spacecraft macro to turn off 28V supply to PEACE DPU"
delay 25 seconds

* this value may not be b0 (176 dec) – it is a henceforth value

Step 10

5.4.23 Pre-step 10: Additional Step: Prepare for Step 10

Duration

5 mins

Aims

Put PEACE in to READY BOTH SAFE, with the IEL from FGM shut (we want to ensure that the azimuthal zone used by the 3DX-spad is set to default choice of 0)

Initial State Requirement

PEACE OFF
Real-time contact interval.

Final State

READY BOTH SAFE

Procedure

See 5.3.3.3, but the IEL from FGM must be closed

5.4.24 Step 10 (Revised for NM1) : Solar Background Assessment

Duration:

1 hour 20 minutes

Aim:

To establish the level of counts generated directly or indirectly by sunlight seep within the analyser

Initial State Requirement

READY BOTH SAFE IELs shut
NM1
Magnetotail lobes (want to minimise fluxes of ambient plasma)

Final State

READY BOTH SAFE

Description:

The two main components of a possible solar background signature generated within the analyser are

i. solar photons causing events directly in the MCP, after reflecting off the internal surfaces of the analyser, and photoelectrons generated within the analyser near the MCP, which are then detected by the MCP.

ii. photoelectrons generated within the analyser near the collimator, which are then analysed before detection by the MCP.

If present, the direct solar photon component will be seen at all analyser voltages whenever the analyser collimator points at the sun (it might also be seen at other spin phases if there is an unexpected light leak). It is expected that there will be an insignificant response to solar photons, but this should be verified.

Photoelectrons generated by solar photons deep within the analyser might also be seen when the analyser collimator points at the sun. These photoelectrons are expected to have low energies (below 20 eV). If produced near the MCP, or on the grid, these may be detected independent of the analyser voltage.

Thus both effects may generate a sweep-independent signal, present only for a narrow range of spin phase, possibly a single energy bin, corresponding to the aperture seeing the Sun. We would expect the signal (if present) to shift in apparent analyser energy as we vary the spin phase angle at which the sweep starts. Similarly, if the Sweep Preset is altered, the energy bin associated with the moment that the sun-spacecraft line is parallel to the collimator plane will be changed in a strictly predictable way.

The signal could be rather weak, so the test must be carried out some where there is usually very little plasma, and should last long enough that a weak signal can be detected.

The grid should be turned on and off in order to discriminate between photons and electrons reaching the MCP.

In order to search for these signatures, the sensors are set to cover the higher part of the energy range, so as to minimise the contribution of spacecraft photoelectrons. By carrying out the experiment in the lobes, we hope to minimise the contribution of ambient plasma electrons also. HAR mode is used so that the scan in spin phase angle is short (since HAR has the narrowest azimuth angle resolution). HAR cannot be used on both sensors at the desired preset.

Sequence

The activity starts by collecting full 3DX data (all basic segments) from HEEA (5 minutes). This should be inspected to see if there is an obvious solar signature, in which case it should be used to confirm that the 3DX-spad will be aligned along the intended axis (the sun-spacecraft line).

With the sun pulse offset at its usual value of 176, the HEEA looks at the sun at the very beginning of the 10th sweep of a spin. Hopefully little is seen, as the signal would be mainly in the flyback.

The sunpulse rephase offset is next changed to 2352. Any signal should now be at around bin 9 of a HAR 16 bin sweep. After collecting (5 minutes) and studying a few (<5) distributions, the data product is altered to 3DX-spad i.e. two [opposing] basic segments only. This can be done without a science processing reset. Next, confirm that the azimuth in the CORE is 0, and the SPOS is correct, and if possible that the signature in the 3DX is as expected. Collect plenty of 3DX-spad (15 minutes - flip grids halfway); alter preset down by 10, collect 3DX-spad (15 minutes – flip grids halfway); switch to LEEA and repeat. Repeat cycle with sunpulse offset 2224. Reset sunpulse offset to 176. Next test/end.

Rate of 3DX-nw is at least 1 per 16 spins, or about 1 per minute
Rate of 3DX-spad is at least 1 per 2 spins, or about 7 per minute
Rate of 3DF is at least 1 per 32 spins (approx 1 per 2 minutes)

Grids?

`5.4.24.1: Setup HEEA sensor and collect 3DX-cx-anh-nw, SPOS = 176`

SETUP_2 **Setup sensors and science configuration**
(88h58-60m00-cx-anh-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HV_HEEA **High voltage enable, HEEA only. PI team specify MCP level (Gain 2 x 10^6)**

HS_SAFE **SAFE the (HEEA) HVs, Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0009	0x2069
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0281	0x0281
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0010	0x0010
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
ZEPHMCPS	0x2040	0x0000	0x2040
ZEPHHVGE	0x20C3	No parameter	0x20C3
ZEPHMCPS	0x2040	henceforth value	0x20ML
delay 120 seconds			

Wait 5 minutes minimum (and inspect transmitted 3DX data)

ZEPHHVGD	0x20c0	No parameter	0x20C0
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

`5.4.24.2: Reset SPOS to 2352`

Disable watchdog

USO

Enable watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4C00	0x0012	0x4C12
Wait 10 seconds			
ZEPDSN1S	0x5500	0x0000	0x5500
ZEPDSN2S	0x0000	0x0930	0x0930
Wait 20 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16
Wait 10 seconds			

`5.4.24.3: Setup HEEA sensor and collect 3DX-cx-anh-nw, 3DX-cx-tnh-nw, with SPOS = 2352`

SETUP_2 **Setup sensors and science configuration**
(88h58-60m00-cx-anh-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HV_HEEA **High voltage enable, HEEA only. PI team specify MCP level (Gain 2 x 10^6)**

DPS

HS **Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0009	0x2069
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0281	0x0281
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0010	0x0010
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
ZEPHMCPS	0x2040	0x0000	0x2040
ZEPHHVGE	0x20C3	No parameter	0x20C3
ZEPHMCPS	0x2040	henceforth value	0x20ML
delay 120 seconds			
Wait 5 minutes minimum (and inspect transmitted 3DX data) Go to 88h58-60m00-cx-tnh-nw			
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
Wait 15 minutes			
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.4: Change preset (don't disable HVs) on HEEA sensor and collect 3DX-cx-tnh-nw, with SPOS = 2352

SETUP_2 **Setup sensors and science configuration**
(78h48-60m00-cx-tnh-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HS_SAFE **SAFE the (HEEA) HVs, Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000b	0x206b
ZEPHSPSS	0x2080	0x0013	0x2093
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0010	0x0010
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
Wait 15 minutes			
ZEPHMCPS	0x2040	henceforth value	0x20ML
ZEPHHVGD	0x20c0	No parameter	0x20C0
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.5: Setup LEEA sensor and collect 3DX-cx-tnl-nw, with SPOS = 2352

SETUP_2 **Setup sensors and science configuration**
(60m00-88h58-cx-tnl-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HV_LEEA **High voltage enable, LEEA only. PI team specify MCP level (Gain 2 x 10^6)**

HS **Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPS	0x0060	0x0009	0x0069
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0000	0x0000
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPLHVGE	0x00C3	No parameter	0x00C3
ZEPLMCPS	0x0040	henceforth value	0x00ML
delay 120 seconds			
Wait 15 minutes			
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.6: Change preset (don't disable HVs) on HEEA sensor and collect 3DX-cx-tnl-nw, with SPOS = 2352

SETUP_2 **Setup sensors and science configuration**
(60m00-78h48-cx-tnl-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HS_SAFE **SAFE the (LEEA) HVs, Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPS	0x0060	0x000b	0x006b
ZEPLSPSS	0x0080	0x0013	0x0093
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0000	0x0000
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
Wait 15 minutes			
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPLHVGD	0x00c0	No parameter	0x00C0
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.7: Reset SPOS to 2224

Disable watchdog

USO

Enable watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4C00	0x0012	0x4C12
Wait 10 seconds			
ZEPDSN1S	0x5500	0x0000	0x5500
ZEPDSN2S	0x0000	0x08b0	0x08b0
Wait 20 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16
Wait 10 seconds			

5.4.24.8: Setup HEEA sensor and collect 3DX-cx-tnh-nw, with SPOS = 2224

SETUP_2 **Setup sensors and science configuration**
(88h58-60m00-cx-tnh-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HV_HEEA **High voltage enable, HEEA only. PI team specify MCP level (Gain 2 x 10^6)**

DPS

HS **Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0009	0x2069
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0010	0x0010
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
ZEPHMCPS	0x2040	0x0000	0x2040
ZEPHHVGE	0x20C3	No parameter	0x20C3
ZEPHMCPS	0x2040	henceforth value	0x20ML
Wait 15 minutes			
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.9: Change preset (don't disable HVs) on HEEA sensor and collect 3DX-cx-tnh-nw, with SPOS = 2224

SETUP_2 **Setup sensors and science configuration**
(78h48-60m00-cx-tnh-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HS_SAFE **SAFE the (HEEA) HVs, Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000b	0x206b
ZEPHSPSS	0x2080	0x0013	0x2093
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0010	0x0010
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
Wait 15 minutes			
ZEPHMCPS	0x2040	henceforth value	0x20ML
ZEPHHVGD	0x20c0	No parameter	0x20C0
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.10: Setup LEEA sensor and collect 3DX-cx-tnl-nw, with SPOS = 2224

SETUP_2 **Setup sensors and science configuration**
(60m00-88h58-cx-tnl-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HV_LEEA **High voltage enable, LEEA only. PI team specify MCP level (Gain 2 x 10^6)**

HS **Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPS	0x0060	0x0009	0x0069
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0000	0x0000
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPLHVGE	0x00C3	No parameter	0x00C3
ZEPLMCPS	0x0040	henceforth value	0x00ML
delay 120 seconds			
Wait 15 minutes			
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

`5.4.24.11: Change preset (don’t disable HVs) on HEEA sensor and collect 3DX-cx-tnl-nw, with SPOS = 2224`

SETUP_2 **Setup sensors and science configuration**
(60m00-78h48-cx-tnl-nw)

RUNSCI_BOTH **Run science processing (both sensors)**

HS_SAFE **SAFE the (LEEA) HVs, Halt science processing**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPS	0x0060	0x000b	0x006b
ZEPLSPSS	0x0080	0x0013	0x0093
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0681	0x0681
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4504	0x0004	0x4504
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0000	0x0000
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0x000f	0x000f
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds			
Wait 15 minutes			
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPLHVGD	0x00c0	No parameter	0x00C0
ZEPDPRCN	0x4700	0x00ff	0x47ff
Delay 120 seconds			

5.4.24.12: Reset SPOS to 176 (or henceforth)

Disable watchdog

USO

Enable watchdog

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4C00	0x0012	0x4C12
Wait 10 seconds			
ZEPDSN1S	0x5500	0x0000	0x5500
ZEPDSN2S	0x0000	0x00b0	0x00b0
Wait 20 seconds			
ZEPDHWCE	0x4C00	0x0016	0x4C16
Wait 10 seconds			

5.4.24.13: Optional opportunity to change IELs while in READY BOTH SAFE state

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x0096	0x4c96	Open FGM IEL only

(see also 5.3.3.6)

5.4.26 Post-step 10: Additional Step: Optional IEL Switch

Duration

1 mins

Aims

While PEACE is in READY BOTH SAFE, allows us to open one or more IELs, following Step 10 in which the IEL from FGM was shut.

Initial State Requirement

READY BOTH SAFE
Real-time contact interval.

Final State

READY BOTH SAFE

Procedure

See 5.3.3.6

Step 11

5.4.27 Step 11a (Revised for NM1) : HEEA and LEEA Response Cross-Calibration

Duration

?? mins

Aims

Collect best resolution 3-D data from both sensors simultaneously while they are in the same sweep mode with the same presets; collect data across the full energy range of the instrument. This data is to be used in assessing the HEEA/LEEA relative calibration for each instrument in turn.

Initial State Requirement

READY BOTH SAFE

NM1

Try in the plasmasheet and the lobes (and elsewhere post-commissioning on Special Orbits)

Final State

READY BOTH SAFE

Description

Set up both sensors with the same preset. Collect data 3DF-D distributions. Collect LER-HEEA if both sensors have sweeps that go below level 16, or LER-LEEA if its only LEEA. These allow collection of a distribution every 30 spins or so. Repeat with a new preset until the full instrument energy range has been covered. Do for LAR and MAR.

Procedure

`5.4.27.1:      Setup sensors into 60m00-60m00-clf`

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPSS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0001	0x4301
ZEPDDATP	0x0000	0x0231	0x0231
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504

ZEPDPRCN	0x4700	0x0000	0x4700

5.4.27.2: Turn on Sweep and MCP HVs

HV_BOTH **High voltage enable: both sensors**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x0000	0x2040	HEEA MCP level zero
ZEPLMCPS	0x0000	0x0040	LEEA MCP level zero
ZEPHHVGE	no parameter	0x20C3	Enable HV's
ZEPLHVGE	no parameter	0x00C3	Enable HV's
ZEPHMCPS	0x00ML	0x20ML*	HEEA MCP level
ZEPLMCPS	0x00ML	0x00ML*	LEEA MCP level

delay 120 seconds

5.4.27.3: Collect data in 60m00-60m00-clf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.27.4: Setup sensors into 60100-60100-clf

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPSS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0001	0x4301
ZEPDDATP	0x0000	0x0231	0x0231
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

5.4.27.5: Collect data in 60100-60100-clf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME FIXED BIT PATTERN FREE BIT PATTERN TOTAL BIT PATTERN

Wait 10 minutes

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.27.6: Setup sensors into 88m28-88m28-cf

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPSS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0221	0x0221
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

5.4.27.7: Collect data in 88m28-88m28-cf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.27.8: Setup sensors into 88128-88128-cf

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPSS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0221	0x0221
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

5.4.27.9: Collect data in 88128-88128-cf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.27.10: Disable Sweeps and MCPs (READY BOTH HVs ON to READY BOTH SAFE)

Set both MCP levels to zero, disable sweeps

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	0
ZEPHMCPS	0x2040	0x0000	0x2040	0
ZEPLHVGD	0x00C0	no parameter	0x00C0	
ZEPHHVGD	0x20C0	no parameter	0x20C0	

delay 120 seconds

5.4.28 Step 11b (Revised for NM1) : Sweep Mode Cross-Calibration

Duration

?? mins

Aims

Collect best resolution 3-D data from both sensors simultaneously while they are in different sweep modes with the same presets (except the HAR to MAR or LAR case); collect data across the full energy range of the instrument.

Initial State Requirement

READY BOTH SAFE

NM1

Try in the plasmasheet and the lobes (and elsewhere post-commissioning on Special Orbits)

Final State

READY BOTH SAFE

Description

Set up both sensors with the same preset. Collect data 3DF-D distributions. These allow collection of a distribution every 30 spins or so. Repeat with a new preset until the full instrument energy range has been covered. Do for LAR and MAR.

Procedure

`5.4.28.1: Setup sensors into 60l00-60m00-clf`

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPSS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0001	0x4301
ZEPDDATP	0x0000	0x0231	0x0231
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

5.4.28.2: Turn on Sweep and MCP HVs

HV_BOTH **High voltage enable: both sensors**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x0000	0x2040	HEEA MCP level zero
ZEPLMCPS	0x0000	0x0040	LEEA MCP level zero
ZEPHHVGE	no parameter	0x20C3	Enable HV's
ZEPLHVGE	no parameter	0x00C3	Enable HV's
ZEPHMCPS	0x00ML	0x20ML*	HEEA MCP level
ZEPLMCPS	0x00ML	0x00ML*	LEEA MCP level

delay 120 seconds

5.4.28.3: Collect data in 60l00-60m00-clf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
Wait 10 minutes			
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

`5.4.28.4: Setup sensors into 60m00-60l00-clf`

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x000f	0x208f
ZEPLSMPSS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0001	0x4301
ZEPDDATP	0x0000	0x0231	0x0231
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

`5.4.28.5: Collect data in 60m00-60l00-clf, then Halt Science Processing`

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

`5.4.28.6: Setup sensors into 88l28-88m28-cf`

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPSS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0221	0x0221
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

`5.4.28.7: Collect data in 88l28-88m28-cf, then Halt Science Processing`

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.28.8: Setup sensors into 88m28-88128-cf

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPSS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPSS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x0016	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0221	0x0221
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

5.4.28.9: Collect data in 88m28-88128-cf, then Halt Science Processing

HS **Halt Science**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN

Wait 10 minutes

ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.28.10: Disable Sweeps and MCPs (READY BOTH HVs ON to READY BOTH SAFE)

Set both MCP levels to zero, disable sweeps

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	0
ZEPHMCPS	0x2040	0x0000	0x2040	0
ZEPLHVGD	0x00C0	no parameter	0x00C0	
ZEPHHVGD	0x20C0	no parameter	0x20C0	

delay 120 seconds

Step 14

5.4.35 Step 14 Cautious MCP Turn-On in New Plasma Region

Duration

Estimated at 1 hour per iteration (could be 2 or 3 hours for full test if all stages are needed)

Aims

The choice of operating level for an MCP (see also Step 8 and discussion therein) depends on a number of considerations. This test is concerned with ensuring that the preferred level is suitable in the magnetotail can be used in the magnetosheath or solar wind, where the fluxes of naturally occurring electrons are expected to be significantly higher than in the magnetotail, and the photoelectron levels remain so far uncharacterised with PEACE (Oct 2000). The test may need to be repeated after review of data from the first go.

Initial State Requirement

READY BOTH SAFE
NM1
Magnetosheath (must also do in Solar Wind)
Do at earliest opportunity in both cases

Final State

READY BOTH SAFE

Discussion

There is a concern that the sensitivity of the MCP at the magnetotail operating level may be such that in the expected high fluxes of the magnetosheath and solar wind, the count rates become comparable to count rates at which, in open head ground mcp testing, mcp pulse height distributions collapsed. The critical count rate in these ground tests was observed to be a function of mcp level.

This test allows a gradual increase of mcp level while the count rates are being monitored in real time, so that the PI team can call a pause/halt in the level increase according to their judgement of the safety of further level increases.

The test also needs to be performed by raising the levels in parallel on both sensors, but always raising HEEA to a given gain after LEEA (remembering that the level corresponding to a given gain may be different comparing HEEA and LEEA) since HEEA is more sensitive than LEEA. In the magnetotail commissioning, count rates in HEEA were seen to be larger than LEEA levels by a factor of about 4, although when photoelectrons are also within the sampled energy range, the factor grows larger.

The outline test given here is fairly general and uses three stages, identical except in sensor setup. In the first, LEEA and HEEA use LAR preset 91. In the second, LEEA uses LAR preset 63 and HEEA uses LAR preset 91. In the third the two sensors both use preset 63. The energy range expected for sheath and solar wind plasma is below level 60, so the second and third stages are recommended for the magnetosheath and solar wind studies. LAR is used because it spends longer at each level and so is a tougher test on the MCP.

It is possible that the PI team may request a different sensor setup in practice.

The PI team will monitor "total counts" from the HK. If the sweep does not drop below level 17, this gives full counts information. On the other hand, if the sweep does drop below level 17 (e.g. LAR 63 or MAR 63) we also need to use LER and extract "counts below level 17" information from LER. 3DR-D will be collected for science context information. Grids are off.

Sequence Description

Start from READY BOTH SAFE
Setup sensors (three options are shown see 5.4.35.1 a,b,c below)
Setup science data products & TM choices
Start science
Enable HV, with MCPs at low level (no sensitivity)
Raise MCP levels in parallel on both sensors, in steps chosen by PI team, until they are satisfied.
Lower MCPs to low level (no sensitivity)
Halt science
EITHER Repeat with new sensor setup (see 5.4.35.5 a below)
OR HVs off and END (see 5.4.35.5 b below)

Procedure

`5.4.35.1a: From READY BOTH SAFE to SCIENCE SAFE 88l28-88l28-clr`

SETUP_1 **Sensor setup and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

Note, HV sweep levels are chosen to give good coverage of full plasma energy range, but with HEEA away from the photoelectrons

88l28-88l28
COR, LER-LEEA, 3DR-Both
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096

ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x0096	0x0096
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0251	0x0251
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

`5.4.35.1b: From READY BOTH SAFE to SCIENCE SAFE 88l28-60l00-clr`

SETUP_1 **Sensor setup and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

Note, HV sweep levels are chosen to give good coverage of full plasma energy range, but with HEEA away from the photoelectrons

88l28-60l00
COR, LER-LEEA, 3DR-Both
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x008f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0251	0x0251
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

5.4.35.1c: From READY BOTH SAFE to SCIENCE SAFE 60l00-60l00-clr

SETUP_1 **Sensor setup and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

Note, HV sweep levels are chosen to give good coverage of full plasma energy range, but with HEEA away from the photoelectrons

60l00-60l00 COR, LER-LEEA, 3DR-Both
Spacecraft potential algorithm turned off for this test.

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x008f	0x208f
ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x008f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0251	0x0251
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0004	0x4504
ZEPDPRCN	0x4700	0x0000	0x4700

Wait 20 seconds

5.4.35.2 Enable Sweep and MCP HV's

Enable Sweeps and MCPs

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPHMCPS	0x2040	0x0000	0x2040	
delay 5 seconds				
ZEPHHVGE	0x20C3	0x0000	0x20C3	
delay 30 seconds				
ZEPLMCPS	0x0040	0x0000	0x0040	
delay 5 seconds				
ZEPLHVGE	0x00C3	0x0000	0x00C3	
delay 120 seconds				

5.4.35.3: Increment MCP LEEA and HEEA Levels to Upper Limit

Levels (starting from very low sensitivity) are selected by the PI team and a pause for count rate assessment before proceeding is required for each step. The gain will always be raised on LEEA before the gain on HEEA is brought to a similar level (subject to it being considered safe to do so). The highest level will be at the discretion of the PI team, but unlikely to be as high as the 4 million gain level.

The delay time, [*accumulate mcp counts*], will be decided by the PI for each level during the test. A value of 2 minutes is suggested as the default, and as the basis for the duration estimate above. However, experience suggests that while a minimum time for this procedure is easily established, the true time may vary from sensor to sensor.

For MCP levels up to and including level 15

ZEPLMCPS	0x0040	0x00uu	0x00uu

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x00uu	0x20uu

delay [accumulate mcp counts] seconds

At the end of the test, set the MCPs to a low level (e.g. level 2 shown here)

ZEPLMCPS	0x0040	0x0002	0x0042

delay [accumulate mcp counts] seconds

ZEPHMCPS	0x2040	0x0002	0x2042

delay [accumulate mcp counts] seconds

5.4.35.4: Halt Science (return to READY BOTH SAFE)

HS Halt Science

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

5.4.35.5a: Repeat

Return to one of 5.4.35.1a,b or c.
The HVs are currently enabled, but no harm is done by reissuing the HV enable commands (5.4.35.2), as the MCPs are set to safe low levels.

This might be used if we had had HEEA at preset 91 and LEEA at preset 63, and wished to now lower HEEA to preset 63 as well, using the LEEA data as a guide to expected count rates.

5.4.35.5b: End: Disable Sweeps and MCPs, back to READY BOTH SAFE

Set both MCP levels to zero, disable sweeps

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN	LEVEL
ZEPLMCPS	0x0040	0x0000	0x0040	
(set the MCP level back to 0)				
delay [accumulate mcp counts] seconds				
ZEPHMCPS	0x2040	0x0000	0x2040	
(set the MCP level back to 0)				
delay [accumulate mcp counts] seconds				
ZEPLHVGD	0x00C0	no parameter	0x00C0	
(disable the MCP)				
ZEPHHVGD	0x20C0	no parameter	0x20C0	
(disable the MCP)				
delay 120 seconds				

5.5 Stage Two Commissioning (IELs)

5.5.1 Introduction

This section deals with IEL commissioning.

5.5.2 EDI IEL verification

Duration

20 mins

Aims

To test that PEACE receives blanking pulse signals from EDI.

Sequence Description

At start of test, PEACE is in READY BOTH SAFE mode with IEL's disabled, and EDI is powered on. EDI is then initialised, and the correct output interface selected (as in EPIEL_MASTER). PEACE is setup into a standard operating mode, the IEL to EDI is enabled and science processing is started. EDI is then instructed to send a blanking pulse test pattern to PEACE.

Initial State Requirement

READY BOTH SAFE
NM1
Anywhere

Final State

READY BOTH SAFE

Procedure

5.5.2.1 Setup PEACE, EDI and perform test

PEACE sensor setup: HEEA in MAR mode, sweeping from levels 88 to 28, and LEEA also in MAR mode, sweeping from levels 60 to 0.
Data products telemetered: COR (with EDI data inserted), LER, PAD, 3DR.

SETUP_0 **Setup sensors and science configuration**

DPS **Data product selection**

RUNSCI_BOTH **Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
Setup EDI as necessary			
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0080	0x4380
ZEPDDATP	0x0000	0x0255	0x0255
ZEPDHWCE	0x4c00	0x0036	0x4c36
ZEPDPRCN	0x4700	0x0000	0x4700

EDI now instructed to send blanking pulse

Collect data for 5 minutes

5.5.2.2 Return to READY BOTH SAFE

Turn off science processing to return instrument to READY BOTH SAFE state, and close IEL interface

HS **Halt Science**

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF
delay 20 seconds while processing shuts down			
ZEPDHWCE	0x4c00	0x0016	0x4c16

Reception of the EDI blanking pulse can now be verified by looking at the PEACE COR science packets.

5.5.3 Correlator IEL verification

Duration

45+ mins.

Aims

To verify that WEC sees correlator data from PEACE.

Sequence Description

At start of test, PEACE is in READY BOTH SAFE mode with IEL's disabled, and WEC is powered on. WEC is then setup into a standby state with the correlator off. PEACE is setup into a standard state and instructed to increment polar zone every spin. Science processing is started and stims turned on. WEC then investigates output from PEACE for 10 mins.
PEACE then turns off stims and turns on high voltages on MCP's and Sweeps, WEC again investigates output for 12 mins.
PEACE Science Processing then halted and PEACE set up into a state where the correlator will follow the selected polar zone. Science processing started again and WEC again investigates output for 10 mins.
Finally, PEACE Science Processing stopped again and PEACE set up to swap HEEA and LEEA magnetic field coarse zones after half a spin. Science processing started and WEC again investigates for 10 mins.

Initial State Requirement

READY BOTH SAFE
NM1
Anywhere except eclipse

WEC needs to know PEACE sunpulse offset so that they can set their offset.

Final State

READY BOTH SAFE

Procedure

5.5.3.1 Setup PEACE, WEC and perform first part of test

PEACE sensor setup: HEEA in MAR mode, sweeping from levels 88 to 28, and LEEA also in MAR mode, sweeping from levels 60 to 0.
Data products telemetered: COR, LER, PAD, 3DR.

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

Turn on HEEA and LEEA stimuli

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f

ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0255	0x0255
ZEPDHIPS	0x4200	0x0002	0x4202

(set polar zone to increment once per spin)

ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0000	0x4500
ZEPDPRCN	0x4700	0x0000	0x4700

(delay 20 seconds)

ZEPHSTMN	0x20e1	0x0002	0x20e3
ZEPLSTMN	0x00e1	0x0002	0x00e3

WEC now follows this procedure:

Stop any macro that may be running, stop correlator if on

Start correlator, SRP offset nominal, HBR, level 4

Set offset 'nominal – 2'

Set offset 'nominal – 1'

Set offset 'nominal + 1'

Set offset 'nominal + 2'

Set offset 'nominal'

5.5.3.2 Turn off stims, turn on HV's, perform second part of test

Turn off HEEA and LEEA stimuli

HV_BOTH High voltage enable; both sensors

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSTMF	0x20e0	0x0000	0x20e0
ZEPLSTMF	0x00e0	0x0000	0x00e0
ZEPHMCPS	0x2040	0x0000	0x2040
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPHHVGE	0x20C3	no parameter	0x20C3
ZEPLHVGE	0x00C3	no parameter	0x00C3
ZEPHMCPS	0x2040	0x00**	0x20**

(Set HEEA MCP level to 'henceforth')

ZEPLMCPS	0x0040	0x00**	0x00**

(Set LEEA MCP level to 'henceforth')

delay 120 seconds

WEC now monitors for 12 mins

5.5.3.3 Halt science, change correlator control and start science, perform third part of test

HS	**Halt Science**
SETUP_1	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

(delay 20 seconds while science processing shuts down)

ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0255	0x0255
ZEPDHIPS	0x4200	0x0000	0x4200

(set correlator zone to selected polar zone)

ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0000	0x4500
ZEPDPRCN	0x4700	0x0000	0x4700

(delay 20 seconds)

WEC now monitors for 10 mins.

5.5.3.4 Halt science, change correlator control and start science, perform fourth part of test

HS	**Halt Science**
SETUP_1	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

(delay 20 seconds while science processing shuts down)

ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x0255	0x0255
ZEPDHIPS	0x4200	0x0008	0x4208

(set correlator zone to selected polar zone and swap HEEA and LEEA magnetic field coarse zones after half a spin)

ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0000	0x4500
ZEPDPRCN	0x4700	0x0000	0x4700

(delay 20 seconds)

WEC now monitors for 10 mins.

5.5.3.5 Return PEACE to READY BOTH SAFE

Turn off science processing and HV's to return instrument to READY BOTH SAFE state.

HS_SAFE Halt Science processing, SAFE the HV's

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHHVGD	0x20c0	no parameter	0x20c0
ZEPLHVGD	0x00c0	no parameter	0x00c0

(Wait 120 seconds for capacitor discharge)

ZEPDPRCN	0x4700	0x00FF	0x47FF

(delay 20 seconds while processing shuts down)

WEC is now returned to standby mode.

5.5.4 ASPOC IEL verification

Duration

10 mins.

Aims

To verify that ASPOC sees spacecraft potential data from PEACE.

Sequence Description

At start of test, PEACE is in READY BOTH SAFE state with IEL's disabled, and ASPOC is powered on and automatically enters STANDBY mode. PEACE is setup into a standard state with IEL to ASPOC enabled and then instructed to send a test pattern of values incrementing from 0 to 255 to ASPOC.

Initial State Requirement

READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Procedure

5.5.4.1 Setup PEACE, ASPOC and perform test

PEACE sensor setup: HEEA in MAR mode, sweeping from levels 88 to 28, and LEEA also in MAR mode, sweeping from levels 60 to 0.
Data products telemetered: COR, LER, PAD, 3DR.

INTERFACE **Spacecraft interface and watchdog**

SETUP_0 **Setup sensors and science configuration**

Setup ASPOC test pattern

RUNSCI_BOTH **Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4c00	0x0006	0x4c06
Open IEL to ASPOC			
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F

ZEPDSPOT	0x4500	0x0003	0x4503
ZEPDPRCN	0x4700	0x0000	0x4700

(Wait 5 minutes for ASPOC to accumulate data)

5.5.4.2 Return PEACE to READY BOTH SAFE

Turn off science processing to return instrument to READY BOTH SAFE state, close IEL's.

HS **Halt Science**

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

ZEPDHWCE	0x4c00	0x0016	0x4c16

5.5.5 FGM IEL verification (TBD)

Duration

5 mins.

Aims

To verify that PEACE receives correct magnetic field values from FGM.

Sequence Description

At start of test, PEACE is in READY BOTH SAFE state with IEL's disabled, and FGM is powered on. PEACE is then setup into a standard state and IEL to FGM enabled.

Initial State Requirement

READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Procedure

5.5.5.1 Setup PEACE, FGM and perform test

PEACE sensor setup: HEEA in MAR mode, sweeping from levels 88 to 28, and LEEA also in MAR mode, sweeping from levels 60 to 0.
Data products telemetered: COR, LER, PAD, 3DR.

INTERFACE **Spacecraft interface and watchdog**

SETUP_1 **Setup sensors and science configuration**

RUNSCI_BOTH **Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHWCE	0x4c00	0x0096	0x4c96
Open IEL to FGM			
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0080	0x4300
ZEPDDATP	0x0000	0x0255	0x0255

ZEPDHIPS	0x4200	0x0008	0x4200
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0000	0x4500
ZEPDPRCN	0x4700	0x0000	0x4700

(Wait for 2 minutes to accumulate data)

5.5.5.2 Return PEACE to READY BOTH SAFE

Turn off science processing to return instrument to READY BOTH SAFE state, close IEL's.

HS **Halt Science**

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF
delay 20 seconds while processing shuts down			
ZEPDHWCE	0x4c00	0x0016	0x4c16

Usual procedure now is to check over COR science data packets to verify that data was received from FGM, then to choose a certain time and compare the vectors FGM have with those received by PEACE.

5.5.6 DWP IEL Verification

Duration

10 mins

Aims

To verify that PEACE receives WHISPER blanking pulse.

Sequence Description

At start of test, PEACE is in READY BOTH state with IEL's disabled, and DWP is powered on. PEACE is then setup into a standard state and the IEL to DWP enabled. DWP is then instructed to send a blanking pulse test pattern to PEACE.

Initial State Requirement

READY BOTH SAFE
NM1

Final State

READY BOTH SAFE

Procedure

5.5.6.1 Setup PEACE, DWP and perform test

PEACE sensor setup: HEEA in MAR mode, sweeping from levels 88 to 28, and LEEA also in MAR mode, sweeping from levels 60 to 0.
Data products telemetered: COR (with EDI data inserted), LER, PAD, 3DR.

SETUP_0	**Setup sensors and science configuration**
DPS	**Data product selection**
INTERFACE	**Spacecraft interface and watchdog**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
Setup DWP as necessary			
ZEPHSMPS	0x2060	0x000f	0x206f
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x000f	0x006f
ZEPLSPSS	0x0080	0x000f	0x008F
ZEPDDATS	0x4300	0x0080	0x4380

ZEPDDATP	0x0000	0x0255	0x0255
ZEPDHWCE	0x4c00	0x0056	0x4c56
ZEPDPRCN	0x4700	0x0000	0x4700

DWP now instructed to send blanking pulse

Collect data for 5 minutes

5.5.2.2 Return to READY BOTH

Turn off science processing to return instrument to READY BOTH state, and close IEL interface

HS **Halt Science**

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

delay 20 seconds while processing shuts down

ZEPDHWCE	0x4c00	0x0016	0x4c16

Reception of the DWP blanking pulse can now be verified by looking at the PEACE COR science packets.

5.6 Stage Three Commissioning (Coordinated with ASPOC)

5.6.1 Introduction

Our tests related to spacecraft potential need to be repeated with ASPOC on. This can only be done during or after the IEL tests. Steps 10b and 13 above should be repeated with ASPOC on.

5.6.2 Repeat Step 10 b with ASPOC On.

5.6.3 Repeat Step 13 with ASPOC On.

5.7 Stage Four Interference Campaigns

5.7.1 Introduction

There are two experiments on board the Cluster spacecraft which may affect the electrons detected by PEACE: the Electron Drift Experiment (EDI) and the WEC experiment, WHISPER.

EDI emits a beam of electrons which is deflected by the magnetic field to arrive back at the spacecraft. The EDI campaign is used to check if PEACE can see this beam as it returns, and if so whether the blanking pulse issued to PEACE by EDI occurs at the correct times.

WHISPER emits an electromagnetic pulse into the plasma and looks for resonances, these could affect electrons detected by PEACE. WHISPER has three modes, Continuous, Gliding, and Synchronous. In Continuous mode, the instrument is constantly emitting pulses in sweeps of energy levels. In Gliding mode it emits pulses for one spin octant, waits for 16 octants then emits for another octant, and so on. The Synchronous mode has been designed so that WHISPER only emits pulses when PEACE (and CIS) are in flyback mode and so should cause no perturbations to PEACE electrons.

5.7.2 Electron counts from EDI electron beam

Duration:

30 mins.

Requirements:

To detect the small change in the number of counts expected from the EDI beam. BM1 telemetry will be required to enable frequent 3DF distributions to be collected.

Test should be performed in a region of low ambient electron density and steady magnetic field, ie the tail lobes.

Aim:

To establish that the beam intensity is sufficiently low so as to have a very small influence on the PEACE distributions. Also to establish whether or not the EDI blanking pulse functions as expected.

Description:

The EDI produces a 1keV electron beam which may enter the aperture of the PEACE sensors. The EDI on board processor calculates when this is the case and a blanking pulse in transmitted to the PEACE DPU at the time when the beam is expected to reach HEEA or LEEA. The DPU telemeters the number of blanking pulses that are received in each spacecraft spin and the time at which the last blanking pulse is received.

Initial State Requirement

RUNNING_HV_ON
BM1

Final State

RUNNING_HV_ON

Procedure

5.7.2.1 Setup PEACE from STD-ALL-1E and perform EDI test part 1

LEEA is set up into a configuration where it looks at electrons of energy around that of those produced by EDI, and HEEA is set at the fixed energy of the EDI electrons.
Sensor configuration: LEEA in HAR mode, sweeping from level 60 to level 30; HEEA in fixed energy mode, level 58.
Data telemetered: COR, PAD, LER and 3DF.

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff

(delay for 20 seconds while science processing stops)

ZEPDMAC1	0x5e00	0x0000	0x5e00

ZEPDMAC1	0x5e00	0x0001	0x5e01

(Send macros to set up sensors and DPU)

ZEPDPRCN	0x4700	0x0000	0x4700

(delay for 20 seconds while science processing starts)

EDI in GEOS mode, 1nA, wait for 25 spins

EDI in GEOS mode, 10nA, wait for 25 spins

EDI in GEOS mode, 100nA, wait for 25 spins

EDI in WW mode, wait for 25 spins

5.7.2.2 Setup PEACE and perform EDI test part 2

LEEA is set at the fixed energy of the EDI electrons, and HEEA is set up into a configuration where it looks at electrons of energy around that of those produced by EDI.
Sensor configuration: LEEA in fixed energy mode, level 58; HEEA in HAR mode, sweeping from level 60 to level 30.
Data telemetered: COR, PAD, LER and 3DF.

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff

(delay for 20 seconds while science processing stops)

ZEPDMAC1	0x5e00	0x0002	0x5e02
ZEPDMAC1	0x5e00	0x0001	0x5e01
ZEPDPRCN	0x4700	0x0000	0x4700

(delay for 20 seconds while science processing starts)

EDI in GEOS mode, 1nA, wait for 25 spins

EDI in GEOS mode, 10nA, wait for 25 spins

EDI in GEOS mode, 100nA, wait for 25 spins

5.7.2.3 Return to DIS or CSIS state

There are two options when this test is finished, return to the Default Intermediate State, or to perform the test again. To perform again, sections 5.7.2.1 and 5.7.2.2 are simply run again, and to return to the DIS state the following commands must be sent:

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff

(delay for 20 seconds while science processing stops)

ZEPDMAC1	0x5e00	0x0009	0x5e09

ZEPDMAC1	0x5e00	0x000a	0x5e0a
ZEPDPRCN	0x4700	0x0000	0x4700

(delay for 20 seconds while science processing starts)

5.7.3 Electronic Noise Test

Duration:

Aim:

To establish whether noise is seen in the PEACE sensors as a result of the other experiments.

Requirements:

Test can be performed anywhere with low levels of penetrating radiation, and need only be performed once.

Test to be performed in NM1, NOI distribution will be used to look for noise.

Description:

Test starts with all experiments in out-of-acquisition interval modes (off for PEACE). PEACE then powered on, where it is put into a standard state with sweeps off, MCP's on at level 2, and grids on. Other experiments are then turned on one at a time and PEACE looks for noise for 3 mins with stims on, then 3 mins with stims off for each one. After all instruments are on and in standard operating modes (WHISPER in continuous mode at 200Vpp) PEACE goes through a test cycle of combinations of stims on/off, grids on/off, MCP's on/off and sweeps on/off. After this, WHISPER is returned to passive mode and PEACE returned to standard operating mode.

Initial State Requirement

OFF
NM1

Final State

RUNNING_HV_ON

Procedure

`5.7.3.1 Power on PEACE and setup to mode INL-NM1-1 (88m28-60m00-cnlf)`

PO	**Power On 28V**
EE	**Execute Executive**
RA2	**Run Application (two processor)**
LV_BOTH	**Switch on low voltage power to both sensors**
INTERFACE	**Spacecraft Interface and watchdog**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Start Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			

delay 5 seconds

ZEPDLOWL	0x8000	0x0081	0x8081
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			
ZEPDBOOS	0x4D00	0x0001	0x4D01
delay 15 seconds			
ZEPDEAPP	0x5200	0x0091	0x5291
delay 15 seconds			
ZEPDLPCN	0x4b00	0x0003	0x4b03
ZEPDCONF	0x4f55	No parameter	0x4f55
Delay 30 seconds			
ZEPDHPCN	0x6b00	0x0003	0x6b03
ZEPDCONF	0x4f55	No parameter	0x4f55
Delay 30 seconds			
ZEPDHWCE	0x4c00	0x00e6	0x4ce6
ZEPDMAC1	0x5e00	0x0009	0x5e09
ZEPDMAC1	0x5e00	0x0007	0x5e07
ZEPDPRCN	0x4700	0x0000	0x4700

Delay 20 seconds while science processing starts

`5.7.3.2 MCP's to level 2, grids on, then turn on other instruments and monitor noise using stims`

GS **Grid switch**

HV_MCPLEV_2 **Switch on HV's to level 2**

HV_MNT_BOTH **HV MCP enable**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHCISG	0x2000	0x0010	0x2010
ZEPLCISG	0x0000	0x0010	0x0010
ZEPHMCPS	0x2040	0x0002	0x2042
ZEPLMCPS	0x0040	0x0002	0x0042

ZEPHMCPE	0x20c1	No parameter	0x20c1
ZEPLMCPE	0x00c1	No parameter	0x00c1

5.7.3.3 Step-by step payload turn-on test

Other instruments now turned on one at a time, and after each turn on PEACE goes through the sequence

STIMS_OFF **Switch off stims**

VAR_STIMS_ON **Switch on variable stims**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHSTMN	0x20e1	0x0000	0x20e1
ZEPLSTMN	0x00e1	0x0000	0x00e1
Accumulate data for 3 mins			
ZEPHSTMF	0x20e0	No parameter	0x20e0
ZEPLSTMF	0x00e0	No parameter	0x00e0
Accumulate data for 3 mins			

5.7.3.4 Comprehensive test

WHISPER commanded into Continuous mode, 200 Vpp

GS	**Grids off**
STIMS_OFF	**Stims off**
GS	**Grids on**
HV_MEL_BOTH	**Sweeps on**
GS	**Grids off**
VAR_STIMS_ON	**Variable stims on**
GS	**Grids on**
SAFE	**Sweeps and MCP's off**
STIMS_OFF	**Stims off**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPHCISG	0x2000	0x0000	0x2000
ZEPLCISG	0x0000	0x0000	0x0000
Accumulate data for 3 mins			
ZEPHSTMF	0x20e0	No parameter	0x20e0

ZEPLSTMF	0x00e0	No parameter	0x00e0
Accumulate data for 3 mins			
ZEPHCISG	0x2000	0x0010	0x2010
ZEPLCISG	0x0000	0x0010	0x0010
Accumulate data for 3 mins			
ZEPHHVGE	0x20c3	No parameter	0x20c3
ZEPLHVGE	0x00c3	No parameter	0x00c3
Accumulate data for 3 mins			
ZEPHCISG	0x2000	0x0000	0x2000
ZEPLCISG	0x0000	0x0000	0x0000
Accumulate data for 3 mins			
ZEPHSTMN	0x20e1	0x0000	0x20e1
ZEPLSTMN	0x00e1	0x0000	0x00e1
Accumulate data for 3 mins			
ZEPHCISG	0x2000	0x0010	0x2010
ZEPLCISG	0x0000	0x0010	0x0010
Accumulate data for 3 mins			
ZEPHHVGD	0x20c0	No parameter	0x20c0
ZEPLHVGD	0x00c0	No parameter	0x20c0
Accumulate data for 3 mins			
ZEPHSTMF	0x20e0	No parameter	0x20e0
ZEPLSTMF	0x00e0	No parameter	0x00e0
Accumulate data for 3 mins			

5.7.3.5 Return to STD-ALL-1e after Electronic Noise Test

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration**
RUNSCI_BOTH	**Start Science Processing (both sensors)**
HV_BOTH	**HV enable at operational level; Both sensors**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF
Delay 20 seconds while science processing shuts down			
ZEPDMAC1	0x5e00	0x0009	0x5e09

ZEPDMAC1	0x5e00	0x000a	0x5e0a
ZEPDPRCN	0x4700	0x0000	0x4700

Delay 20 seconds while science processing starts

ZEPHMCPS	0x2040	0x0000	0x2040
ZEPLMCPS	0x0040	0x0000	0x0040
ZEPHHVGE	0x20c3	No parameter	0x20c3
ZEPLHVGE	0x00c3	No parameter	0x00c3
ZEPHMCPS	0x2040	0x00uu	0x20uu
ZEPLMCPS	0x0040	0x00uu	0x00uu

Uu's here are henceforth settings of the MCP voltage level which will be determined during the earlier part of commissioning.

5.7.4 Interference from WHISPER: Test 2

Duration:

1 hour 15 mins.

Aim:

To establish whether there is interference from WHISPER when it is running in Continuous mode.

Requirements:

Test should be repeated in different environments, eg in the magnetosheath and lobes, and possibly the solar wind.
Again BM1 would be necessary as 3DF's are being telemetered.

Description:

The test is made up of 6 blocks. This is necessary for PEACE to cover the full range of electron energies in HAR mode and for the test to be performed once with ASPOC on and once with ASPOC off.

Initial State Requirement

RUNNING_HV_ON
BM1

Final State

RUNNING_HV_ON

Procedure

`5.7.4.1 Setup PEACE from STD-ALL-1e and perform test WHISPER 2`

Whisper in Continuous mode.
Test in 6 blocks so that PEACE can cover full energy range in HAR mode.
Block A:
LEEA and HEEA both in HAR mode sweeping from level 88 to level 58
ASPOC on
Block B:
LEEA and HEEA both in HAR mode sweeping from level 59 to level 29
ASPOC on
Block C:
LEEA and HEEA both in HAR mode sweeping from level 30 to level 0
ASPOC on
Block D:
LEEA and HEEA both in HAR mode sweeping from level 30 to level 0
ASPOC off
Block E:
LEEA and HEEA both in HAR mode sweeping from level 59 to level 29
ASPOC off
Block F:
LEEA and HEEA both in HAR mode sweeping from level 88 to level 58
ASPOC off

Datasets telemetered: COR, PAD, LER, 3DF.

HS	**Halt science processing**
SETUP_4	**Sensor configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

This sequence then repeated five times.

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
BLOCKS A-C: ASPOC on			
BLOCK A			
ZEPDPRCN	0x4700	0x00ff	0x47ff
(delay 20 seconds for science processing to shut down)			
ZEPDMAC1	0x5e00	0x0005	0x5e05
ZEPDMAC1	0x5e00	0x0007	0x5e07
ZEPDPRCN	0x4700	0x0000	0x4700
(delay 20 seconds for science processing to start)			
WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp			
BLOCK B			
ZEPDPRCN	0x4700	0x00ff	0x47ff
(delay 20 seconds for science processing to shut down)			
ZEPDMAC1	0x5e00	0x0004	0x5e04
ZEPDMAC1	0x5e00	0x0007	0x5e07
ZEPDPRCN	0x4700	0x0000	0x4700
(delay 20 seconds for science processing to start)			
WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp			
BLOCK C			
ZEPDPRCN	0x4700	0x00ff	0x47ff
(delay 20 seconds for science processing to shut down)			
ZEPDMAC1	0x5e00	0x0003	0x5e03
ZEPDMAC1	0x5e00	0x0007	0x5e07
ZEPDPRCN	0x4700	0x0000	0x4700
(delay 20 seconds for science processing to start)			
WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp			

BLOCKS D-F: ASPOC off

BLOCK D as BLOCK C, no commands for PEACE

WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp

BLOCK E commands as for BLOCK B

WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp

BLOCK F commands as for BLOCK A

WHISPER now alternates between active and passive at 50Vpp, 100Vpp and 200Vpp.

5.7.4.2 Return to STD-ALL-1E after WHISPER 2

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration using macros**
RUNSCI_BOTH	**Start Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF
Delay 20 seconds while science processing shuts down			
ZEPDMAC1	0x5e00	0x0009	0x5e09
ZEPDMAC1	0x5e00	0x000a	0x5e0a
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds while science processing starts			

5.7.5 Interference from WHISPER: Test 3

Duration:

1 hour.

Aim:

To investigate whether the WHISPER Gliding mode is compatible with PEACE operation.

Requirements:

WHISPER has to be synchronised to the PEACE sweep, thus WHISPER (and CIS) must be told the PEACE sun pulse offset.
Test should be repeated in different environments.
BM1 necessary for frequent returns of 3DF data products.

Description:

The test is made up of 3 blocks. This is necessary for PEACE to cover the full range of electron energies in HAR mode.

Initial State Requirement

RUNNING_HV_ON
BM1

Final State

RUNNING_HV_ON

Procedure

5.7.5.1 Setup PEACE from STD-ALL-1E and perform test WHISPER 3

Whisper in Gliding mode.
Test in 6 blocks so that PEACE can cover full energy range in HAR mode with ASPOC on and off.
Block A:
LEEA and HEEA both in HAR mode sweeping from level 88 to level 58.
Block B:
LEEA and HEEA both in HAR mode sweeping from level 59 to level 29.
Block C:
LEEA and HEEA both in HAR mode sweeping from level 30 to level 0.

Datasets telemetered: COR, PAD, LER, 3DF.

HS	**Halt science processing**
SETUP_4	**Sensor configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

This sequence then repeated three times.

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff

ZEPDMAC1	0x5e00	0x0005	0x5e05
ZEPDMAC1	0x5e00	0x0008	0x5e08
ZEPDPRCN	0x4700	0x0000	0x4700

WHISPER active and passive at 50Vpp, 100Vpp and 200Vpp

ZEPDPRCN	0x4700	0x00ff	0x47ff
ZEPDMAC1	0x5e00	0x0004	0x5e04
ZEPDMAC1	0x5e00	0x0008	0x5e08
ZEPDPRCN	0x4700	0x0000	0x4700

WHISPER active and passive at 50Vpp, 100Vpp and 200Vpp

ZEPDPRCN	0x4700	0x00ff	0x47ff
ZEPDMAC1	0x5e00	0x0003	0x5e03
ZEPDMAC1	0x5e00	0x0008	0x5e08
ZEPDPRCN	0x4700	0x0000	0x4700

WHISPER active and passive at 50Vpp, 100Vpp and 200Vpp

5.7.5.2 Return to STD-ALL-1E after WHISPER 3

HS **Halt Science**

SETUP_4 **Setup sensors and science configuration using macros**

RUNSCI_BOTH **Start Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF

Delay 20 seconds while science processing shuts down

ZEPDMAC1	0x5e00	0x0009	0x5e09
ZEPDMAC1	0x5e00	0x000a	0x5e0a
ZEPDPRCN	0x4700	0x0000	0x4700

Delay 20 seconds while science processing starts

5.7.6 Interference from WHISPER: Test 4

Duration:
20 minutes.

Aim:
To investigate whether the WHISPER Synchronised mode is compatible with PEACE operation.

Requirements:
WHISPER has to be synchronised to the PEACE sweep, thus WHISPER (and CIS) must be told the PEACE sun pulse offset.
Test should be repeated in different environments of low levels of penetrating radiation.
BM1 necessary for frequent returns of 3DF data products.

Description:
PEACE is setup into a mode where HEEA and LEEA are in the same mode, and WHISPER emits pulses timed to the PEACE flybacks. The timing is varied to check when WHISPER is synchromised correctly.

Sequence:

5.7.6.1 Setup PEACE and perform test WHISPER 4

WHISPER in Synchronised mode.
PEACE in same state throughout test (HEEA, LEEA in MAR mode, sweeping from level 60 to level 0), and WHISPER transmission times varied.

Datasets telemetered: COR, LER, PAD and 3DF.

HS	**Halt science processing**
SETUP_4	**Sensor configuration**
RUNSCI_BOTH	**Run science processing (both sensors)**

COMMAND NAME	FREE BIT PATTERN	FIXED BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff
ZEPDMAC1	0x5e00	0x0006	0x5e06
ZEPDMAC1	0x5e00	0x0008	0x5e08
ZEPDPRCN	0x4700	0x0000	0x4700

WHISPER start to transmit at T – 15.4ms
WHISPER start to transmit at T – 13.2ms
WHISPER start to transmit at T – 11.0ms
WHISPER start to transmit at T – 8.8ms
WHISPER start to transmit at T – 6.6ms
WHISPER start to transmit at T – 4.4ms
WHISPER start to transmit at T – 2.2ms
WHISPER start to transmit at T
WHISPER start to transmit at T + 2.2ms
WHISPER start to transmit at T +4.4ms

5.7.5.2 Return to STD-ALL-1E after WHISPER 4

HS	**Halt Science**
SETUP_4	**Setup sensors and science configuration using macros**
RUNSCI_BOTH	**Start Science Processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00FF	0x47FF
Delay 20 seconds while science processing shuts down			
ZEPDMAC1	0x5e00	0x0009	0x5e09
ZEPDMAC1	0x5e00	0x000a	0x5e0a
ZEPDPRCN	0x4700	0x0000	0x4700
Delay 20 seconds while science processing starts			

5.7.7 RAPID / PEACE Intercalibration

Aim:

To try to cross – calibrate the PEACE and RAPID instruments.

Requirements:

Regions of low and high electron fluxes needed.
RAPID will require 18 spins for a full distribution in energy and geometry to be downloaded.
RAPID – IES in Histogram mode.

Description:

RAPID – IES and PEACE are setup in similar modes so they are detecting electrons which are as similar as possible.

Sequence:

Setup mode for PEACE depends upon the spacecraft spin period.
HEEA will be in LAR mode, energy levels from 88 to 28, and LEEA will be in LAR mode with energy levels from 60 to 0.
Datasets to be telemetered: COR, PAD, LER, 3DR and 3DX.

HS	**Halt Science**
SETUP_2	**Setup sensors and science configuration**
RUNSCI_BOTH	**Start science processing (both sensors)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDPRCN	0x4700	0x00ff	0x47ff
ZEPHSMPS	0x2060	0x0007	0x2067
ZEPHSPSS	0x2080	0x0016	0x2096
ZEPLSMPS	0x0060	0x0007	0x0067
ZEPLSPSS	0x0080	0x000f	0x008f
ZEPDDATS	0x4300	0x0000	0x4300
ZEPDDATP	0x0000	0x02d5	0x02d5
ZEPDHIPS	0x4200	0x0008	0x4208
ZEPDMAGS	0x4400	0x0000	0x4400
ZEPDSPOT	0x4500	0x0000	0x4500
ZEPDLPUE	0x5600	0x0008	0x5608
ZEPDPUPS	0x0000	0x0012	0x0012
ZEPDLPUE	0x5600	0x000f	0x560f
ZEPDPUPS	0x0000	0xuuuu	0xuuuu
(window limits command, this will vary according to the spin period)			
ZEPDPRCN	0x4700	0x0000	0x4700

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PEACE USER MANUAL CHAPTER 6

Version 4.6
17-January-2001

Change Sheet since Cluster 1

Version 3.1

Transfer of some commanding material to Chapter 3.
Removal of references to Fine Zones.

Version 3.2

Reorganisation. Inclusion of material agreed with JSOC

Version 3.3

Parameter tables update

Version 3.4

Additional versions of STARTUP_TESTS and SAFE_HVON to allow for alternative use of grids.
Further reorganisation

Version 3.5

Changed the order of HEEA/LEEA setup commands in 6.4.1.1, 6.4.1.3, 6.4.3.3, 6.5.5.1 and 6.5.5.3
Changed descriptions of 'H' and 'I' in section 6.3.4.3
Added comments to section 6.4.4
Added commands to table 6.7.3.3

Version 4.1

Amended table 6.7.3.1

Version 4.2

6.4.1 - Added in information about new standard mode STD-NM1-2 (like STD-NM1-1 but using LAR) and made new table for this at end of chapter (6.7.3.1)
6.5.3 - Changed IPW-BM1-5 to IPW-NM5 and described it as 88m28-60m00-cnlf

Version 4.3

6.2 - Added that this section is deliberately left blank.

Version 4.4

Changed STD-NM1 and STD-BM1 to STD-ALL (6.3.1.1, 6.4.1.3, 6.4.2, 6.7.3.1)
Added in values for T2 for cycling anodes for correlator (6.3.4.3)
Finalised 6.5.2.3 and 6.5.2.4
Corrected 6.5.3 to include ENL campaign
Corrected 6.5.4
Changed S1 to SP0 throughout to agree with tables (6.4.1.4, 6.5.2.4, 6.5.3.1.3, 6.5.3.2.3)

Version 4.5
Changes to 6.1.4 involving new MCP noise test procedure (S. Szita)

Version 4.6

Corrected tables in 6.7.3

6. NOMINAL OPERATIONS

6.0 Introduction

This chapter deals with nominal operations.

The commanding flow diagrams discussed in Chapter 3 can be simplified for Nominal Operations. JSOC IBMDs for nominal operations will occasionally concatenate several command sequences described in Chapter 3.

We introduce the method for precisely but concisely specifying the nature of an instrument Operational Mode.

The Nominal Operations are considered in three parts; Standard Operations (for standard orbits), Interference Campaign Operations (during Commissioning and special orbits) and Special Operations (for special orbits).

Special operations will be those in which the instruments are configured to make measurements focussed on some particular science topic. The instrument setup will fully exploit a particular aspect of the instrument's capabilities (e.g. using best available time resolution, or energy resolution), at the expense of reduced performance in another area (e.g. energy range coverage).

In contrast, no prejudices or assumptions about the expected nature of the plasma to be measured are made for standard operations in which the survey function will be paramount. In standard operations the sensors will be configured to cover the full energy range, and the transmitted data products will address all science topics with equal weight.

In each case, we describe the Operating Modes and provide the parameters needed for the corresponding command sequences.

6.1 Commanding of Nominal Operations

6.1.1 Interface with JSOC

IBMDs agreed between PEACE and JSOC are described in Chapter 3 and in 6.1.4 below.

Henceforth Parameters are identified and provided in 6.7.1

The parameters needed to implement particular Operational Modes are given in 6.7. These will be the basis for JSOC ***VAL Files***.

Supplementary Inputs are to be based on the material in 6.1.3 below.

6.1.2 Nominal Operations Flow

The baseline model for operations is as follows;

1. The instruments are turned off when not in use.
2. Whenever the instruments are turned on, a test of amplifier thresholds and electronic noise levels will be made using the stims, and a test of the MCP intrinsic noise level will be made before science data collection. (But see 6 below).
3. Whenever the instruments are turned off, a further a test of the MCP intrinsic noise level will be made. (But see 6 below).
4. Occasionally, perhaps once per week, an MCP operational level test may be performed.
5. The instruments will be turned off during radiation belt crossings. The L = 6 L-shell is tentatively set as the cutoff boundary.
6. In order to maximise operations time near auroral zone field lines, the MCP noise tests and stim tests are not perfomed for turn offs prior to, and turn ons following the radiation belt crossings.
7. In accordance with SWT/SOWG policy, the instruments will be operated in a standard mode for two orbits in every three orbits. The third orbit will be available for special operations.
8. Onboard macros for autonomous response to unexpected instrument behaviour may be employed, but at the time of writing a policy is tbd.

These statements may be reviewed as the mission progresses.

6.1.3 PI Supplementary Inputs

6.1.3.1 Perigee Operations

The instruments will be turned off during radiation belt crossings. The L = 6 L-shell is tentatively set as the cutoff boundary. This rule will be kept under review and may be the subject of some experimentation.

6.1.3.2 Instrument Mode Outside Data Acquisition Intervals

The instruments will be turned off (in mode PEACE Off, KAL On) outside data acquisition intervals.

6.1.3.3 Rules for Calibration Activities

If FGM engages in calibration during a science operations interval, PEACE should not transmit PAD data (or SPAD 3DX) - see 6.4.4.(tbc)

During an FGM calibration, the Correlator anode selection should be set to "cycling" (tbc)

Rules for when to carry out the PEACE MCP Operational Level tests are tbd.

6.1.3.4 Default Sensor Configuration

A default operating mode has been defined, for example for use in contingency recovery scenarios (where the contingency is known not to be a problem with PEACE). See 6.4.2

6.1.3.5 Burst Mode 1 Rules

Ensure that the bit indicating a change of spacecraft telemetry mode is set.

If there is a change of PEACE Science Mode involving an exit from the RUNNING state, complete the change prior to the start of, or after the end of the BM1 interval.

6.1.3.6 Burst Mode 3 Rules

PEACE may be allowed to continue in the Standard Science Mode, although on some occasions alternate BM3 PEACE modes may be requested (see 6.4.3).

6.1.3.7 Eclipse Rules

PEACE is able to operate as the spacecraft enters eclipse, provided it is properly commanded. We anticipate scientific benefits regarding spacecraft-plasma interaction studies. It is expected that suitable opportunities will be identified by JSOC and agreed by the SWT.

6.1.4 Nominal Operations IBMDs

The following IBMDs are defined, as concatenations of IBMDs in Chapter 3

6.1.4.1 OFF_RDYBOTH_SAFE

Start Mode	PEACE OFF (KAL On)
End Mode	READY BOTH SAFE
Number of Parameters	0

PO
EE
RA2
LV_BOTH
INTERFACE

6.1.4.2 RDYBOTH_RUNNING_0

Start Mode	READY BOTH SAFE
End Mode	SETUP
Number of Parameters	n = 0, parameters = 4 + 2 = 6

SETUP_0
RUNSCI_BOTH

6.1.4.3 RDYBOTH_SETUP_n (for n = 0 to 3 inclusive)

Start Mode	READY BOTH SAFE
End Mode	SETUP
Number of Parameters	n = 0, parameters = 4 + 2 = 6
	n = 1, parameters = 9 + 2 = 11
	n = 2, parameters = 13 + 2 = 15
	n = 3, parameters = 17 + 2 = 19

SETUP_n

6.1.4.4 SETUP_RUNNING_0

Start Mode	SETUP_n
End Mode	RUNNING SAFE
Number of Parameters	0

RUNSCI_BOTH

6.1.4.5 SETUP_RUNNING_1

Start Mode	SETUP
End Mode	RUNNING SAFE
Number of Parameters	2

RUNSCI_BOTH
DPS

6.1.4.6 SAFE_HVON_0

Start Mode	RUNNING SAFE
End Mode	RUNNING HV ON
Number of Parameters	2

HV_BOTH

6.1.4.7 SAFE_HVON_1

Start Mode	RUNNING SAFE
End Mode	RUNNING HV ON
Number of Parameters	6

GS	(turn grids on)
HV_BOTH	
GS	(turn grids off)

6.1.4.8 STARTUP_TESTS_0

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

STIMTEST	
HV_BOTH	
GS	(turn grids on)
HV_MNOI_BOTH	
GS	(turn grids off)

6.1.4.9 STARTUP_TESTS_1

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

HV_BOTH	
GS	(turn grids on)
HV_MNOI_BOTH	
GS	(turn grids off)

6.1.4.10 STARTUP_TESTS_2

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

STIMTEST
HV_BOTH

6.1.4.11 STARTUP_TESTS_3

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

STIMTEST	
GS	(turn grids on)
HV_BOTH	
HV_MNOI_BOTH	
GS	(turn grids off)

6.1.4.12 STARTUP_TESTS_4

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

GS	(turn grids on)
HV_BOTH	
HV_MNOI_BOTH	
GS	(turn grids off)

6.1.4.13 STARTUP_TESTS_5

Start Mode	RUNNING SAFE	(must be producing NOI data)
End Mode	RUNNING HV ON	
Number of Parameters	2	

STIMTEST	
GS	(turn grids on)
HV_BOTH	
GS	(turn grids off)

6.1.4.14 RUNNING_RDYBOTH

Start Mode	RUNNING HV ON
End Mode	READYBOTH HV ON
Number of Parameters	0

HS

6.1.4.15 SHUTDOWN

Start Mode	RUNNING HV ON
End Mode	PEACE OFF
Number of Parameters	0

HS
PDP

6.1.4.16 SHUTDOWN_TESTS

Start Mode	RUNNING HV ON	(must be producing NOI data)
End Mode	PEACE OFF	
Number of Parameters	0	

HV_MNOI_BOTH
HS
PDP

6.1.4.17 MCP_OP_LEVEL_TEST_0

Start Mode	RUNNING HV ON
End Mode	READY BOTH HV ON
Number of Parameters	17

HS
HV_MOLT_BOTH
HS

6.1.4.18 MCP_OP_LEVEL_TEST_1

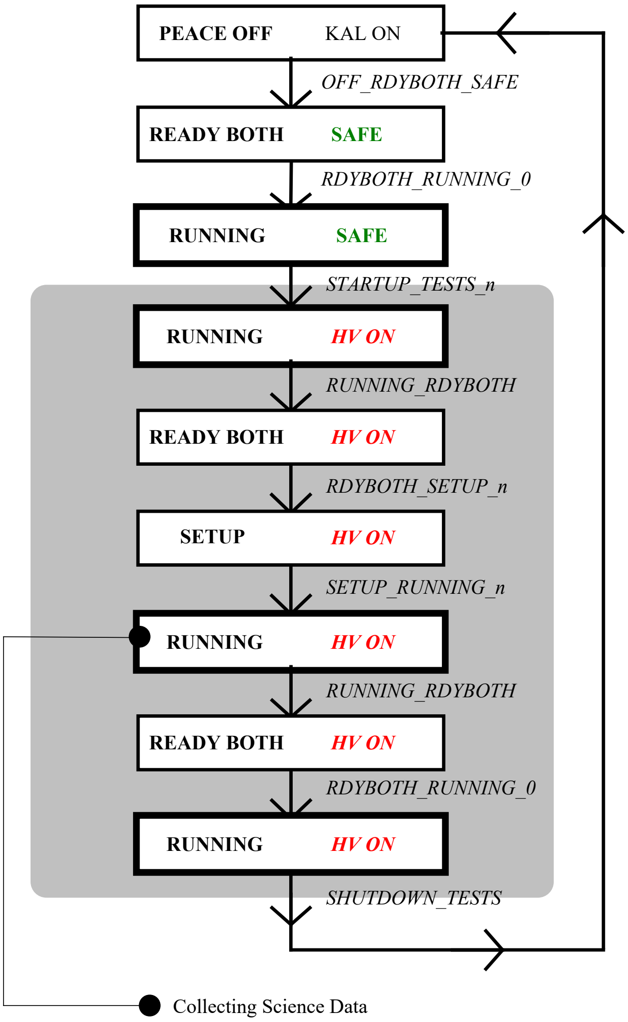
Start Mode	RUNNING HV ON
End Mode	READY BOTH HV ON
Number of Parameters	17

HS	
GS	(turn grids on)
HV_MOLT_BOTH	
GS	(turn grids off)
HS	

6.1.5 Commanding Flow Diagrams

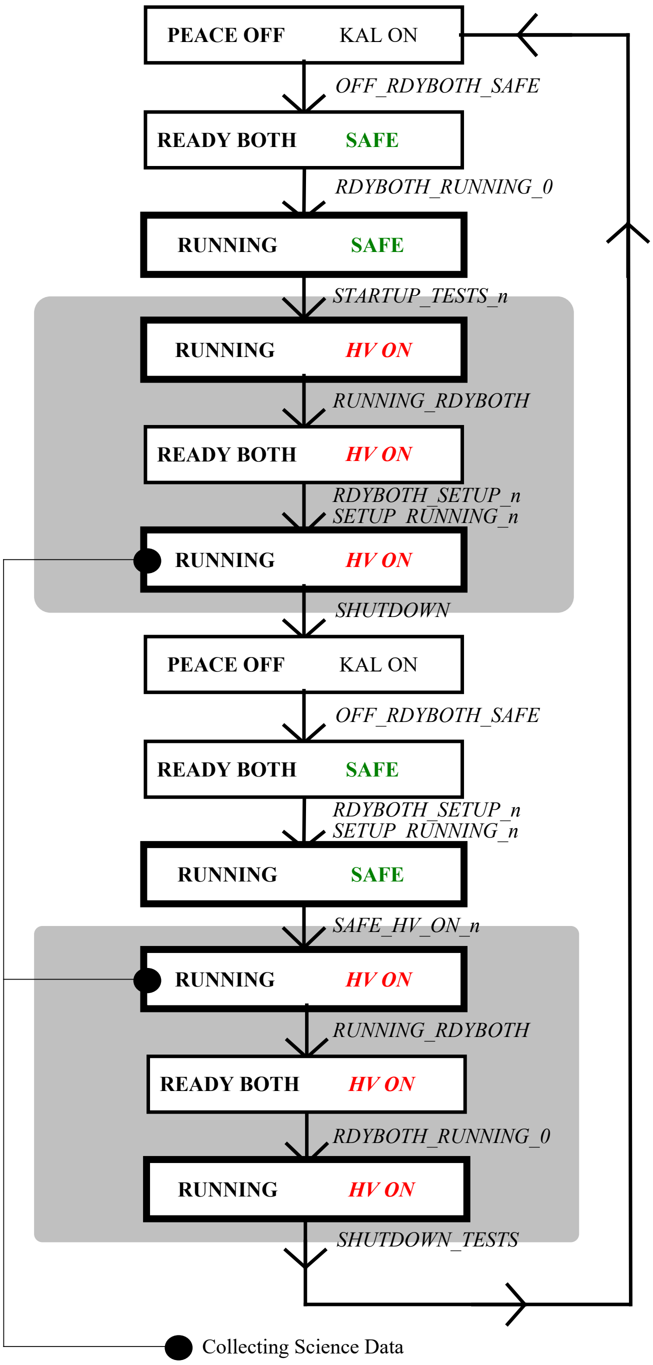
Most of the principles outlined above are represented in the following flow diagrams, which represent the sequence of actions to be carried out in normal operations.

6.1.5.1 Case of an Acquisition Interval with no Mode Changes and no Perigee Pass



6.1.5.2 Case of an Acquisition Interval with no Mode Changes in which there is a Perigee Pass

The instrument is turned off while on prescribed L-shells (those where the radiation hazard is considered significant). The turn off procedure and the turn on procedure is to be as fast as possible, and the turn on procedure to maximise the data taking time to either side of the perigee pass.



6.2 PEACE Commanding Options

This section has deliberately been left empty. The information concerning commanding options is covered in Chapter 3.

6.3 PEACE Mode Naming Conventions

A PEACE Operating Mode represents a particular selection of settings for a large number of commandable aspects of the instrument state. It is convenient to divide these into two groups, those specified to address scientific considerations and those specified for technical reasons in support of the proper operation of the instrument. We thus describe each PEACE Operating Mode in terms of a corresponding Science Mode Name together with an Engineering Mode Name. These in turn relate to more detailed specifications of the Operating Mode, in terms of Science Configuration ID and Engineering Configuration ID information.

6.3.1 Operational Mode Descriptions for use with SWT/JSOC

6.3.1.1 Science Mode Name

Science Mode Names (SMN) are to be used at the level of SWT discussions and within JSOC to identify scientific modes. The science mode names take the form aaa-ddn-m where aaa is "STD" for modes to be used in standard operations or "SP#" (# may be one of several letters) for modes used in special operations only, ddn identifies the telemetry rate for which the mode is intended, and m is the mode number for the class of modes sharing the same aaa-ddn.

A typical science mode name is "STD-ALL-1".

Later in this document we will present tables which relate science mode names to “science configuration IDs” (or SCIDs) which will be used internally by PEACE Science configuration IDs are discussed below.

It is important to note that a single Science Configuration ID (i.e. instrument set-up) may be referred to by more than one science mode name.

6.3.1.2 Engineering Mode Name

Engineering Mode Names (EMN) are to be used at the level of SWT discussions and within JSOC to identify technical setup details. The engineering mode names take the form EM-m where m is the mode number. The same engineering mode is expected to be used with many different science modes.

6.3.2 PEACE Operations Team Mode Identification

6.3.2.1 Science Configuration ID (SCID).

A SCID precisely specifies the way the sensor setup and telemetred data products are controlled, and is intended for use internally by the PEACE team. See 6.2.1 and 6.2.2.

6.3.2.2 Engineering Configuration ID (ECID).

An ECID precisely specifies the way the technical aspects of the instrument are controlled and is intended for use internally by the PEACE team. See 6.2.3 and 6.2.4.

6.3.3 Science Configuration ID (SCID).

6.3.3.1 Aspects of Instrument Configuration to be Described

HV Sweep Control

LEEA HV Sweep Mode
HEEA HV Sweep Mode
LEEA HV Sweep Preset
HEEA HV Sweep Preset

Controlled using Command Sequences SETUP_n

Data sets

Data sets calculated.
Data sets transmitted.

Data sets calculated by default are : CORE, NOI, LER, 3DF

The data sets are prioritised for transmission in that order

The default value will normally be changed for science operations, to replace the NOI data product with the PAD data product.

Controlled using Command Sequences SETUP_n, RUNSCI_BOTH and optionally DPS

6.3.3.2 Sensor Setup

The preferred method of describing the sensor setup within the PEACE operations team will be the sensor configuration label which consists of paired sets of five characters. The first set of 5 characters refer to HEEA, the second set to LEEA, for consistency with command order in SETUP_n. (Note that this aspect of the SCID definition is reversed compared to Cluster I)

Each set of five characters consists of the uppermost energy level, a letter representing the sweep mode, and the lowermost energy level. Thus 60m00 and 88l28 both represent an energy range of 60 energy steps (61 levels). The letter in each set of five characters may be m for MAR, l for LAR, h for HAR, or f for fixed energy mode. In the case of fixed energy mode, the upper and lower energy levels are set equal, e.g. 33f33.

e.g. 88m28-60m00

This labelling scheme can be used to represent any conceivable sensor configuration.

6.3.3.3 Data Product Transmission List (DPTL) Setup

The limited memory available to the processor in a PEACE instrument leads to the following constraints on availability of data products:

i) if the 3DF-D data product is selected, the 3DR or any 3DX data products are unavailable

ii) if the 3DR data products are required, the 3DF-D and larger members of the 3DX family are unavailable (if attempted, the 3DX would be truncated at the end of the spin).

iii) only by selecting neither 3DF-D nor 3DR-D can one ensure transmission of any desired 3DX data product

Thus the onboard processing can produce three different sets of data products for transmission to the ground. These possibilities are shown in the following table. The CORE contains the moments (MOM-D) and the spacecraft potential estimate (SCP-S). A "D" suffix means a dual sensor data product. An "S" suffix means a single sensor data product

Option	Data Products which may be sent together
1	MOM-D, SCP-S, PAD-D, LER-S, 3DF-D
2	MOM-D, SCP-S, PAD-D, LER-S, 3DR-D or 3DR-S, 3DX-S (limited set)
3	MOM-D, SCP-S, PAD-D, LER-S, 3DX-S (full set)

The transmission priority falls from right to left, but it can be altered by command.

Note that there are some 3DX data products whose size depends on the sweep mode.

The desired set of data products to be transmitted is represented by the Data Product Transmission List (DPTL) which is composed of one or more letters, where the letters each represent a data products, as indicated in the following table. NOI and PAD are mutually incompatible. 3DF and 3DR (or 3DX) are mutually incompatible.

Data Product	Shorthand Label
CORE	c
PAD-D	p
NOI_D	n
LER-S	l
3DR-D	r
3DR-L	s
3DR-H	t
3DF-D	f
3DX-1	x
3DX-2	y

Note that implicit data product suppression occurs in all modes except BM1 - in all other telemetry modes the full DPTL cannot be transmitted within a spin and the lower priority data products are either not sent or are sent less often than once per spin - which data products are treated in which way depends on the scenario.

6.3.3.4 Labelling of 3DX Data Products

The convention for labelling of 3DX data products is described in detail in a following section. It is summarised here for convenience, however the principles behind the process of creating a 3DX data product will not be reproduced here.

The following general form of labelling will be used to describe 3DX data products :

$\alpha\beta\gamma$-nnwmm

where,

"α" indicates how many basic segments are transmitted: "**a**" for all i.e. sixteen, "**t**" for two (also known as SPAD)

"β" indicates whether or not summing in energy or polars occurs ("**n**" = no summing, "**e**" = sum in energy, "**p**" = sum in polar)

"γ" is either "**l**" or "**h**", for LEEA or HEEA, or "**b**" for a distribution which is half LEEA and half HEEA (e.g. note that for SPAD with data from both sensors, the SPAD switch mode must also be on) and,

"nnwmm" indicates that data is being selected from within an energy window between levels "nn" (higher) and "mm" (lower). When no window is required, the "nnwmm" suffix will be replaced by "**nw**" - so as to confirm that the lack of window information is intentional, rather than due to a transcription error.

Note that the letter codes used to fill the $\alpha\beta\gamma$ fields are unique: (a,t) (n,e,p) (l,h,b) which prevents any confusion of one with another.

6.3.3.5 SCID Label Convention

The Science Configuration ID is to be used by the PEACE operations team to precisely specify a particular instrument configuration, in all aspects related to the science product to be returned. The SCID combines

i) the sensor configuration label (e.g. 88m28-60m00)
ii) the data product transmission list family label (e.g. r)
iii) if relevant, the 3DX data option code with the 3DX prefix removed (e.g. anh-88w48)

The SCID will be written all in lower case:

e.g. 88m28-60m00-cnlrx-anh-88w48

e.g. 88m28-60m00-clpf-n (note priority of PAD and LER are reversed)

e.g. 88m28-60m00-cplxy-anh-88w48-teh-48w42 (for case of 3DX1 and 3DX2 both using windows)

6.3.3.6 Choices not explicitly dealt with in the SCID

The LER data will be taken from LEEA unless for some reason HEEA is covering the sub-10 eV range and LEEA is not.
A small number of FGM vectors will usually be stored in the CORE; the alternative is to store EDI pulse data, which will usually be done only during the Interference Campaigns.

6.3.4 Engineering Configuration ID (ECID).

6.3.4.1 Aspects of Instrument Configuration to be Described

HV MCP Voltage Control

Command sequence HV_BOTH_n

HEEA MCP level
LEEA MCP level

The choice of level is an engineering decision.

LV Grid Voltage Control

Command sequence GS

If GS is not used, the grids in front of the MCPs on both LEEA and HEEA are at 0 V.

The use of the grids is an engineering decision.

Stim Generator Control

Command sequence STIMTEST

If STIMTEST is not used, the stims are not used.

The use of the STIMTEST is for collection of engineering data.

Control of IELs

Command sequence INTERFACE

Inter-experiment Link with FGM	Usually open
Inter-experiment Link with DWP	Usually open
Inter-experiment Link with EDI	Usually open
Inter-experiment Link with ASPOC	Usually open

Data received from FGM is used in the construction of the pitch angle data product.
Data received from DWP is used to flag WHISPER active sounding
Data received from EDI is used to flag possible interaction between the EDI beam and a PEACE sensor.

Data transmitted to ASPOC may be used by ASPOC to monitor the spacecraft potential.

Correlator Control

Command sequences SETUP_n

Correlator anode selection option. Default is to use the coarse zone in which the magnetic field is calculated to lie (compare PAD) i.e. the first coarse zone from which PAD data is taken from HEEA – but this coarse zone is used throughout the whole spin.

The SMU (sensor management units electronics within the sensor) takes raw high time resolution counts data from all HEEA anodes, and under the control of the DPU, sends this data from a single selected anode to the DWP instrument across the IEL.

If science processing is temporarily disabled (e.g. for a science mode change) the zone in use at the time of disablement remains in effect.

The Default value will not normally be used, following requests from DWP-Correlator.

Source of Magnetic Field Data for PAD Calculation

Command sequences SETUP_n

Magnetic field direction information
Usually takes FGM data from the IEL (but PEACE estimates could also be used)

The Default value will normally be used.

Control of Onboard Spacecraft Potential Estimation

Command sequences SETUP_n

By default the spacecraft potential estimation is disabled.

When commanded on, the choices to be made concern selection of polar/azimuth bins to use as data sources. Data will be taken from LEEA usually (as LEEA is normally used to cover the relevant energy range)

The Default value will normally be used, but the default is subject to review during commissioning.

DPU properties normally set to default values

Command Sequence

Default value is 176 Spin Segment Clock Pulses. Changes are unlikely.

6.3.4.2 MCP Setup

The MCP Operating Level (MCP High Voltage generator level setting) is specified as a paired set of two characters. The first set of 2 characters refers to HEEA, the second set to LEEA, for consistency with the order of commands in the command sequence SETUP_n.

e.g. for the case where both sensors have an operating level of 17 we would have:

17-17

note that the preferred operating level may be a function of the plasma environment.

6.3.4.3 DPU Choices

These are defined by the letter-digit pair of the form Tn where n is an integer. See following table.

A	LEEA Grid	a)	On (Option 0)
		b)	Off (Option 1)
B	HEEA Grid	a)	On (Option 0)
		b)	Off (Option 1)
C	Inter-experiment Link with FGM	a)	Open (Option 0)
		b)	Closed (Option 1 : *default*)
D	Inter-experiment Link with DWP	a)	Open (Option 0)
		b)	Closed (Option 1 : *default*)
E	Inter-experiment Link with EDI	a)	Open (Option 0)
		b)	Closed (Option 1 : *default*)
F	Inter-experiment Link with ASPOC	a)	Open (Option 0 : *default*)
		b)	Closed (Option 1)
G	Magnetic field	a)	FGM (Option 0 : *default*)
		b)	PEACE (Option 1 : Top Region)
		c)	PEACE (Option 2 : Bottom Region)
		d)	PEACE (Option 3 : LEEA 1 + LEEA 2 Region)
		e)	PEACE (Option 4 : HEEA 1 + HEEA 2 Region)
		f)	PEACE (Option 5 : LEEA 1 + HEEA 1 Region)
		g)	PEACE (Option 6 ; LEEA 2 + HEEA 2 Region)
H	Spacecraft potential estimation	a)	Off (Option 0 : *default*)
		b)	On (Option 1 : Using LEEA)
		c)	On (Option 2 : Using HEEA)
		d)	On (Option 3 : Using uplinked fixed value)
		e)	On (Option 4 : Using IEL test pattern)
I	Correlator Anode selection	a)	Option 0 : Follow magnetic field
		b)	Option 1 : Follow magnetic field and swap
		c)	Option 2 : Fixed anode (*default*)
		d)	Option 3 : Cycling anode selection

Notes:

Concerning A and B: This refers to the possible use of the grids during science data collection. It is not expected that this will be the usual situation, at the time of writing.

Concerning C, D, E and F: This refers to the IELs whose state will be defined on a "henceforth" basis.

Concerning G: There are 6 ways in which the magnetic field direction can be selected from the PEACE-data based field direction estimation software. These correspond to each of the 6 possible energy/time interval ranges employed by the moments software. (If a sensor is off, or the energy ranges are not partially overlapped, its < 6). The preferred choice will probably be region dependent and will certainly be dependent in the sensor setup.

Concerning H: This describes how the spacecraft potential is calculated, which is then sent to ASPOC. In the case of "Off" no value will be sent to ASPOC. If Option 3 is chosen and no value has yet been uplinked a default of 5 eV is used. The test pattern of Option 4 sends an incrementing value from 0 to 255 once per spin.

Concerning I: "Follow magnetic field" means use the magnetic field defined in G. "Swap" means to swap LEEA and HEEA coarse zones after half a spin - thus looking both parallel and anti-parallel to the field during the spin.. "Fixed anode" means use a zone whose identity is uplinked from the ground. The "cycling anode" means that the chosen polar zone is incremented once per spin. DWP-Correlator request that Option 1 is part of the PEACE Standard Science Mode, and that Option 3 be used on some Special Orbits. Both to be tried out during Commissioning.

T0 represents the defaults. In other cases, non-defaults are in bold.

	A	B	C	D	E	F	G	H	I
T0	Option 1 Off	Option 1 Off	Option 1 Closed	Option 1 Closed	Option 1 Closed	Option 0 Open	Option 0 FGM	Option 0 Off	Option 2 Fixed
T1	Option 1 Off	Option 1 Off	**Option 0 Open**	**Option 0 Open**	**Option 0 Open**	Option 0 Open	Option 0 FGM	**Option 1 LEEA**	**Option 1 Swap**
T2	Option 1 Off	Option 1 Off	**Option 0 Open**	**Option 0 Open**	**Option 0 Open**	Option 0 Open	Option 0 FGM	**Option 1 LEEA**	**Option 4 Cycling**

6.3.4.4 Spacecraft Potential Estimation Software Setup

The spacecraft potential estimation software uses a grid of 4 polars x 8 azimuths, and calculates an estimate of spacecraft potential during each spin. The polar zone start value can be in the range 0 to 8 (*default* is 4) since the full range is 12. The azimuth zone start value can be in the range 0 to n-8, where n is the number of sweeps in the spin (tbc PJC) (*default* is 0, roughly sun pointing tbc PJC).

There is a facility to prevent the transmission to ASPOC of a spacecraft potential estimate, should the variance on the estimates gathered from the 32 spectra exceed a selectable upper limit. (The *default* value is 1000).

We anticipate that considerable experimentation will be needed to find useful setups, and that they may be dependent on the plasma environment.

SP0 represents the defaults

	Start Polar Zone	Start Azimuth Zone	Variance Upper Limit
SP0	4	0	1000
SP1			
SP2			

6.3.4.5 ECID label Convention

The ECID lists the MCP level information, the binary setup choices information and finally the spacecraft potential setup information.

e.g. 17-17-T1-SP1

6.3.5 HV Sweep Preset Constraints

There are 92 preset values for the HV sweep generator, levels 0 to 91. The top levels, 88 to 91 inclusive, are equal.

6.3.5.1 LAR mode

In the LAR sweep mode, a single sweep consists of 64 steps. The level changes by one step in one bin interval.

The first four bins are Flyback Bins from which data is not recorded.
The fifth bin is the first Data Bin.
The last bin is the sixtieth Data Bin and completes the sweep.

When the preset is 63;

- the first bin corresponds to the step 0-63,
- the second bin corresponds to the step 63-62,
- the third bin corresponds to the step 62-61,
- the fourth bin corresponds to the step 61-60,
- the fifth bin corresponds to the step 60-59,
- the last bin corresponds to the step 1-0.

When the preset is 91;

- the first bin corresponds to the step 28-91,
- the second bin corresponds to the step 91-90,
- the third bin corresponds to the step 90-89,
- the fourth bin corresponds to the step 89-88,
- the fifth bin corresponds to the step 88-87,
- the last bin corresponds to the step 29-28.

Presets smaller than 63 are inappropriate.

Tests confirm that the sweep generator will successfully reach level 88 by the end of the fourth Flyback Bin interval, so it works correctly along the full range of presets, up to 91.

6.3.5.2 MAR mode

In the MAR sweep mode, a single sweep consists of 64 steps. The level changes by two steps in one bin interval.

The first two bins are Flyback Bins from which data is not recorded.
The third bin is the first Data Bin.

The last bin is the thirtieth Data Bin and completes the sweep.

When the preset is 63;

- the first bin corresponds to the step 0-63-62,
- the second bin corresponds to the step 62-61-60,
- the third bin corresponds to the step 60-59-58,
- the last bin corresponds to the step 2-1-0.

When the preset is 91;

- the first bin corresponds to the step 28-91-90,
- the second bin corresponds to the step 90-89-88,
- the third bin corresponds to the step 88-87-86,
- the last bin corresponds to the step 30-29-28.

Presets smaller than 63 are inappropriate.

Experiments confirm that the sweep generator will successfully reach level 88 by the end of the second Flyback Bin interval, so it works correctly along the full range of presets, up to 91.
(There is a slight question about the first data bin, at the highest preset, i.e. 91. tbc)

6.3.5.3 HAR mode

In the HAR sweep mode, a single sweep consists of 32 steps. The level changes by two steps in one bin interval.

The first bin is the Flyback Bin from which data is not recorded.
The second bin is the first Data Bin.
The last bin is the fifteenth Data Bin and completes the sweep.

When the preset is 31;

- the first bin corresponds to the step 0-31-30,
- the second bin corresponds to the step 30-29-28,
- the last bin corresponds to the step 2-1-0.

When the preset is 59;

- the first bin corresponds to the step 0-59-58,
- the second bin corresponds to the step 58-57-56,
- the last bin corresponds to the step 30-29-28.

When the preset is 89;

- the first bin corresponds to the step 28-89-88,
- the second bin corresponds to the step 88-87-86,
- the last bin corresponds to the step 60-59-58.

Presets smaller than 31 are inappropriate.

Experiments confirm that the sweep generator will not successfully reach level 88 by the end of the second Flyback Bin interval, with preset 91. (The preset level where proper performance sets in is tbd. tbc)

6.3.5.4 FIX mode

In the FIX or non-sweeping mode, there is no sweep.

Data collection uses the same Flyback and Data Bin scheme as MAR mode (tbc).

The DPU will not accept a preset larger than 64 in this mode. If a higher preset is commanded, the preset will be set to 64.

6.3.5.5 Constraints on preset values – sensor overlap considerations

The onboard moments code uses the 3DR distribution data as the basis for calculations. There are always 15 reduced energy bins. These are made by summing together four LAR bins, pairs of MAR bins or simply using the usual HAR bins (note that the energy resolution is thus greater in HAR 3DR data than for the other two sweep modes). The code works on the basis that the preset selection has ensured that the reduced energy bin boundaries are aligned at the extremes of the sensor ranges (see Figure 5 in Science Telemetry Format Specification: CL/PE-MSSL-DS-0006).

In LAR mode, the sensor presets for LEEA and HEEA, PS_{LEEA} and PS_{HEEA} should be related by

$PS_{HEEA} = PS_{LEEA} + 4*n$

where n is an integer. (Usually the LEEA preset will be lower than HEEA, though this is not an engineering necessity, so in principle negative values of n are permitted). The condition is obeyed if $PS_{LEEA} = 63$ and $PS_{HEEA} = 91$.

In MAR mode (as with LAR) the sensor presets for LEEA and HEEA, PS_{LEEA} and PS_{HEEA} should be related by

$PS_{HEEA} = PS_{LEEA} + 4*n$

This condition is obeyed if $PS_{LEEA} = 63$ and $PS_{HEEA} = 91$.

In HAR mode, the sensor presets for LEEA and HEEA, PS_{LEEA} and PS_{HEEA} should be related by

$PS_{HEEA} = PS_{LEEA} + 2*n$

This condition is obeyed if $PS_{LEEA} = 63$ and $PS_{HEEA} = 89$.

Care should also be taken if using different sweep modes on the two sensors. For example, if LEEA uses MAR mode and HEEA uses HAR mode. In this case, PS_{LEEA} and PS_{HEEA} should be related by

$PS_{HEEA} = PS_{LEEA} + 2*n$

So a situation using those sweep modes, where $PS_{LEEA} = 63$ and $PS_{HEEA} = 89$, is acceptable. Note that this setup gives full energy range coverage, with minimal overlap of the sensor energy ranges.

6.4 Standard Science Operations

6.4.1 Standard Operations: Baseline Modes

6.4.1.1 Sensor Configuration

Baseline configurations

88m28-60m00	MAR mode with presets are 91 and 63;
88l28-60l00	LAR mode with presets are 91 and 63.

These configurations covers the full instrument energy range in MAR or LAR mode.

The use of MAR mode on both sensors favours neither the mutually incompatible options of highest energy resolution (LAR) or highest azimuthal angular resolution operation, but strikes a balance in between those extremes. A sensor in the Medium Angular Resolution sweep mode, makes measurements which divide the sky into 32 azimuthal segments and 12 polar segments (azimuthal resolution of 11.25° and polar resolution of 15°). The sensor energy range is sampled at a rate of two energy steps per accumulation bin, requiring 30 bins per sensor.

The LEEA sensor will cover the energy levels 00 to 60 (nominally 0.0 eV to 1,185.0 keV) - this is tbd during commissioning, depending on the quality of very low energy measurements.

The HEEA sensor will cover the energy levels 28 to 88 (nominally 34 eV to 26,460.0 eV).

In the energy range where the sensors overlap (levels 28 to 60) the time resolution of the moments and distributions is expected to be half-spin, while data from outside the overlap region will only have spin resolution.

It is possible that in regions of very high fluxes, the HEEA sensor will be saturated. If such saturation is found to be a regular occurrence, there may be a need to operate the sensor in a different way, so as to avoid premature aging of the MCP.

The sensor grid voltage will be set to zero in both sensors (subject to Commissioning experience).

6.4.1.2 Data Product Choice

The Baseline Mode will use the same data product choice in all spacecraft telemetry modes, so that there are no breaks in the data associated with altering the selected data products when there is a change in the available telemetry rate.

The data products to be calculated are the following, listed in order of transmission priority

MOM-D	(the moment sums produced onboard for both sensors - for energies above level 16)
SCP-S	(spacecraft potential estimate, from LEEA)
PAD-D	(the standard PEACE pitch-angle distributions for both sensors)
LER-S	(a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).

3DR-D (reduced resolution 3D distribution from each sensor - azi. res. = 22.5°, pol. res. = 30°, energy range divided into 15 bins per sensor)

In addition, each spacecraft will transmit an additional 3DX data product, also at spin resolution, containing low energy data. Ideally, the size of the 3DX data product will be optimised according to the spacecraft spin period, as follows;

	Spin Period	3DX description
a	between 4.40 sec and 4.36 sec	3DX-anl-22w00
b	between 4.36 sec and 4.16 sec	3DX-anl-20w00
c	between 4.16 sec and 3.97 sec (including the nominal 4.0 second spin period)	3DX-anl-18w00
d	between 3.78 sec and 3.97 sec	3DX-anl-16w00
e	between 3.60 (the lowest acceptable value) sec and 3.77 sec	3DX-anl-16w02

Normal Mode 1

In Normal Mode (NM1) operations, the outcome will be that the following data products will usually be transmitted at spin resolution, by all four spacecraft.

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

PAD-D (the standard PEACE pitch-angle distributions for both sensors)

LER-S (a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).

Note that the CORE data product contains MOM-D and SCP-S - they are treated separately here for clarity.

If the spacecraft spin period is shorter than about 3.9 seconds (i.e. a fast spin) then the lowest priority data product may not be produced on every spin.

The lowest priority data product is LER-S (although this could be altered by command, e.g. on the basis of Commissioning experience).

Burst Mode 1

In Burst Mode (BM1) operations, all the listed data products will always transmitted at spin resolution. The only exception could be the 3DX data product, if it has not been properly sized.

Burst Mode 3

PEACE receives a very restricted allocation (worse than NM1) during BM3 intervals. The outcome will be that only the following data products will usually be transmitted at spin resolution, by all four spacecraft.

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

and

PAD-D (the standard PEACE pitch-angle distributions for both sensors) will also be transmitted at a reduced rate.

6.4.1.3 Science Mode Names

For MAR mode:

SMN	**Spin Period**	**SCID**
STD-ALL-1a	4.36 ≤Tspin ≤ 4.4	88m28-60m00-cplrx-anl-22w00
STD-ALL-1b	4.16 ≤Tspin ≤ 4.36	88m28-60m00-cplrx-anl-20w00
STD-ALL-1c	3.97 ≤Tspin ≤ 4.16	88m28-60m00-cplrx-anl-18w00
STD-ALL-1d	3.78 ≤Tspin ≤ 3.97	88m28-60m00-cplrx-anl-16w00
STD-ALL-1e	3.6 ≤Tspin ≤ 3.78	88m28-60m00-cplrx-anl-16w02

For each spin rate example, the SCID is identical for all spacecraft telemetry rates.

For LAR mode:

SMN	**Spin Period**	**SCID**
STD-ALL-2a	4.36 ≤Tspin ≤ 4.4	88l28-60l00-cplrx-anl-22w00
STD-ALL-2b	4.16 ≤Tspin ≤ 4.36	88l28-60l00-cplrx-anl-20w00
STD-ALL-2c	3.97 ≤Tspin ≤ 4.16	88l28-60l00-cplrx-anl-18w00
STD-ALL-2d	3.78 ≤Tspin ≤ 3.97	88l28-60l00-cplrx-anl-16w00
STD-ALL-2e	3.6 ≤Tspin ≤ 3.78	88l28-60l00-cplrx-anl-16w02

For each spin rate example, the SCID is identical for all spacecraft telemetry rates.

6.4.1.4 Engineering Mode Names

EMN	**ECID**
EM-1	hf1-hf2-T1-SP0
EM-2	hf1-hf2-T2-SP0

The parameters hf1 and hf2 are the HEEA and LEEA MCP Operating levels (check that JSOC has them this way round).

6.4.1.5 Operating Modes

The SMN will be selected according to the spacecraft spin rate. The EMN will be EM-1 (subject to experience gained in Commissioning and early Operations).

The command sequences are identical for the Burst Mode 1 and the Normal Mode 1 case, for the same spin rate.

6.4.2 Default Instrument Mode

We are required to identify a default science mode.

This mode will fall within the standard operations regime.

The SMN is STD-ALL_1e.

The EMN is EM-1

6.4.3 Alternative Modes for BM3

In Burst Mode 3 (BM3) operations, the other experiments are downloading the contents of their High Time Resolution Snapshot Memories.

The BM3 interval will last about 6 minutes.

PEACE receives a very restricted allocation (worse than NM1) during BM3 intervals.

Note though that few other experiments will be recording data at this time.

An alternative BM3 data product selection could be implemented in which only CORE and 3DF are transmitted.

6.4.3.1 Data Collection In Support of Onboard Software Tests

It may occasionally be useful to collect 3DF-D data, simultaneously with Moments Sums. This will rarely be consistent with Science Data collection, due to the infrequent transmission of a spin of 3DF-D data, even in BM1. During an interval in which other instruments may not in any case be providing data, there will be little disadvantage to collecting 3DF-D.

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

and

3DF-D (the full resolution 3D distributions for both sensors)

A complete 3DF-D will be transmitted in about 32 spins; a little over 2 minutes, so there may only be 2 or 3 in the BM3 interval.

6.4.3.2 Single Sensor 3DX-se

An alternative mode might be

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA) and

3DX1-sp (3DX data, summed in polar, from one sensor, e.g. LEEA)

A complete 3DX-sp will be transmitted in about 8 spins; a little over 30 seconds, so there may only be of order 10 in the BM3 interval. If transmitted together with LER, the rate will be reduced to nearer one in 40 seconds

6.4.3.3 Science Mode Names

SMN	SCID
STD-BM3-2	88m28-60m00-cf
STD-BM3-3	88m28-60m00-clx-apl
STD-BM3-4	88m28-60m00-cx-apl

6.4.4 FGM Calibration During PEACE Science Data Collection

The FGM instrument will occasionally engage in an inflight calibration activity, during which the data transmitted on the IEL will be invalid.

The FGM activity could be during PEACE Startup/Shutdown, or during a PEACE Science Data Collection interval.

If PEACE is collecting science data, this will normally include PAD. The calculation of PAD will be incorrect if incorrect data is transmitted across the IEL due to FGM being in calibration mode. In this situation, transmission of the PAD data products will be disabled (tbc) using DPS while FGM IEL data is unreliable.

The parameters used in DPS to turn PAD transmission off (a few spins before FGM calibration starts) are:

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDDATS	0x0000	0x4300
ZEPDDATP	0x802f	0x802f

When the FGM instrument has finished calibration, the transmission of PAD can be restarted using DPS with the following parameters:

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDDATS	0x0000	0x4300
ZEPDDATP	0x8022	0x8022

6.5 Interference Campaign Operations

6.5.1 Interference Campaign: Default Intermediate State

The DIS will be identical to the Standard Science Mode.

6.5.2 Interference Campaign: PEACE-EDI

6.5.2.1 Sensor Configuration

The intention is to monitor the environment with one sensor and to seek to observe an EDI beam with the other sensor. The environment monitoring sensor uses HAR mode to spend more time looking at the beam energy. An EDI beam may flicker across a sensor quickly, so we need one sensor in fixed mode to maximise the time spent monitoring the (assumed) EDI beam energy. If there are problems seeing the beam, either EDI will alter their beam energy, or we will change the energy we monitor with the fixed mode sensor.

Baseline configurations

60h30-58f58	The correct presets are 61 and 58.
58f58-60h30	The correct presets are 58 and 61.

The sensor grid voltage will be set to zero in both sensors.

6.5.2.2 Data Product Choice

Burst Mode 1

We need BM1 for this. The intention is to maximise the amount of 3DF data returned.

The data products to be calculated are the following, listed in order of transmission priority

MOM-D	(the moment sums produced onboard for both sensors - for energies above level 16)
SCP-S	(spacecraft potential estimate, from LEEA)
PAD-D	(the standard PEACE pitch-angle distributions for both sensors)
LER-S	(a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).
3DF-D	(full resolution 3D distribution from each sensor - azi. res. = 5.625°, pol. res. = 15°, energy range divided into 15 bins per sensor)

6.5.2.3 Science Mode Names

SMN	SCID
IPE-BM1-1	58f58-60h30-cplf
IPE-BM1-2	60h30-58f58-cplf

6.5.2.4 Engineering Mode Names

EMN	ECID
EM-2	hf1-hf2-T2-SP0

6.5.2.5 Operating Modes

The SMN will be selected according to the stage in the Campaign (both are used).

6.5.3 Interference Campaign: PEACE-WHISPER, Electronic Noise

6.5.3.1 PEACE-WHISPER Sensor Configuration

The intention is to monitor the environment with both sensors, using HAR mode to spend more time per spin looking at the beam energy. The aim is to cover the full energy range, which can be achieved in three stages.

Baseline configurations

30h00-30h00 The correct presets are 31 and 31.

59h29-59h29 The correct presets are 60 and 60.

88h58-88h58 The correct presets are 89 and 89.

There is also a need for a wider energy range test.

60m00-60m00 The correct presets are 63 and 63.

The sensor grid voltage will be set to zero in both sensors.

6.5.3.1.1 Data Product Choice

All PEACE-WHISPER campaigns will be performed in BM1. The priority item is 3DF.

All the listed data products will always be transmitted at spin resolution

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

PAD-D (the standard PEACE pitch-angle distributions for both sensors)

LER-S (a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).

3DF-D (full resolution 3D distribution from each sensor)

6.5.3.1.2 Science Mode Names

SMN	SCID
IPW-BM1-1	30h00-30h00-cplf
IPW-BM1-2	59h29-59h29-cplf
IPW-BM1-3	88h58-88h58-cplf
IPW-BM1-4	60m00-60m00-cplf

6.5.3.1.3 Engineering Mode Names

EMN	ECID

EM-1	hf1-hf2-T1-SP0
EM-2	hf1-hf2-T2-SP0

6.5.3.1.4 Operating Modes

The SMN will be selected according to the stage in the Campaign (both are used). The EMN will be EM-1 (subject to experience gained in Commissioning and early Operations).

6.5.3.2 Electronic Noise Campaign Sensor Configuration

PEACE sensors will monitor the spacecraft noise environment while all instruments are turned on from a standby state. The sensors are in a standard mode:

88m28-60m00 The correct presets are 91 and 63

The test will be performed with combinations of MCP's off/on at level 2, sweeps on/off, grids on/off, and variable sweeps on/off.

6.5.3.2.1 Data Product Choice

The campaign will be carried out in NM1, and the NOI data product will be used to analyse noise. All data products telemetered are

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

NOI (noise distribution for both sensors)

LER-S (a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).

3DF-D (full resolution 3D distribution from each sensor)

6.5.3.2.2 Science Mode Names

SMN	**SCID**
INL-NM1-1	88m28-60m00-cnlf

6.5.3.2.3 Engineering Mode Names

EMN	**ECID**
EM-1	hf1-hf2-T1-SP0

6.5.4 Interference Campaign: Spacecraft Potential, CIS-ASPOC and EFW-Langmuir

6.5.4.1 Sensor Configuration

The intention is to monitor the environment with both sensors in a standard operating mode.

Baseline configurations

88l28-60l00 The correct presets are 91 and 63.

The sensor grid voltage will be set to zero in both sensors.

6.5.4.2 Data Product Choice

The priority item is 3DX data. The campaign is a BM1 activity.

Burst Mode 1

In Burst Mode (BM1) operations, all the listed data products will always transmitted at spin resolution. The only exception could be the 3DX data product, if it has not been properly sized.

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

3DR-H (reduced 3D display from the HEEA sensor)

3DX (a window of levels 0 to 40 from the LEEA sensor)

6.5.4.3 Science Mode Names

SMN	SCID
ISC-BM1-1	30h00-30h00-cplf
ISC-BM1-2	88l28-60l00-ctx-apl-40w00

6.5.4.4 Engineering Mode Names

EMN	ECID
EM-1	hf1-hf2-T1-SP0
EM-2	hf1-hf2-T2-SP0

The MCP grids are OFF.

6.5.4.5 Operating Modes

The mode used will be ISC-BM1-2 throughout – ISC-BM1-1 was the original mode but the test philosophy has changed. ISC-BM1-1 is kept as it still exists in earlier versions of the campaign drafts. The EMN will be EM-1 (subject to experience gained in Commissioning and early Operations).

6.5.5 Interference Campaign: PEACE-RAPID Intercalibration

6.5.5.1 Sensor Configuration

The aim is to cover the upper part of the energy range if an overlap with RAPID is possible, and to provide data from which a non-overlapping spectrum can be devised if it is not.

Baseline configurations

88l28-60l00 The correct presets are 63 and 91.

Presets tbc

The sensor grid voltage will be set to zero in both sensors.

6.5.5.2 Data Product Choice

The priority item is 3DF-D data. (to be reviewed). The campaign is a BM1 activity.

Burst Mode 1

In Burst Mode (BM1) operations, all the listed data products will always transmitted at spin resolution. The only exception could be the 3DX data product, if it has not been properly sized.

MOM-D (the moment sums produced onboard for both sensors - for energies above level 16)

SCP-S (spacecraft potential estimate, from LEEA)

PAD-D (the standard PEACE pitch-angle distributions for both sensors)

LER-S (a reduced angular resolution, full energy resolution 3D distribution from the LEEA sensor, nominally covering the lowest 16 energy steps of LEEA).

3DR-D (reduced resolution 3D distribution from each sensor - azi. res. = 22.5°, pol. res. = 30°, energy range divided into 15 bins per sensor)

In addition, each spacecraft will transmit an additional 3DX data product, also at spin resolution, containing low energy data. Ideally, the size of the 3DX data product will be optimised according to the spacecraft spin period, as follows;

	Spin Period	3DX description
a	between 4.40 sec and 4.36 sec	3DX-anh-88w66
b	between 4.36 sec and 4.16 sec	3DX-anh-88w68
c	between 4.16 sec and 3.97 sec (including the nominal 4.0 second spin period)	3DX-anh-88w70
d	between 3.78 sec and 3.97 sec	3DX-anh-88w72
e	between 3.60 (the lowest acceptable value) sec and 3.77 sec	3DX-anh-82w74

6.5.5.3 Science Mode Names

SMN	**Spin Period**	**SCID**
IPR-BM1-1a	4.36 ≤Tspin ≤ 4.4	88l28-60l00-cplrx-anh-88w66
IPR-BM1-1b	4.16 ≤Tspin ≤ 4.36	88l28-60l00-cplrx-anh-88w68
IPR-BM1-1c	3.97 ≤Tspin ≤ 4.16	88l28-60l00-cplrx-anh-88w70
IPR-BM1-1d	3.78 ≤Tspin ≤ 3.97	88l28-60l00-cplrx-anh-88w72
IPR-BM1-1e	3.6 ≤Tspin ≤ 3.78	88l28-60l00-cplrx-anh-88w74

6.5.5.4 Engineering Mode Names

EMN	**ECID**
EM-1	hf1-hf2-T1-S1
EM-2	hf1-hf2-T2-S1

The MCP grids are OFF.

6.5.5.5 Operating Modes

The SMN will be selected according to the stage in the Campaign (both are used). The EMN will be EM-1 (subject to experience gained in Commissioning and early Operations).

6.6 Special Science Operations

TBC

Includes

Eclipse ops
Boundary Crossings
Wave-particle Interaction

6.7 Commanding Parameters

6.7.1 JSOC Henceforth Parameters

The following parameters are considered to be "henceforth parameters", i.e. they are expected to change occasionally, though infrequently. For each spacecraft, we have

i) INTERFACE (Controls IELs etc)
ii) HEEA MCP Operational Level
iii) LEEA MCP Operational Level

Note that it may be decided that the MCP Operational Levels should be treated as a function of Plasma Environment, in which case it may be necessary to reconsider whether the henceforth parameter approach is the best approach.

The initial default value of the INTERFACE henceforth parameter is given in the following table

Spacecraft	1	2	3	4	spare
Instrument	FM09	FM06	FM07	FM08	FM10
Free Bit Pattern	0x00E6	0x00E6	0x00E6	0x00E6	0x00E6
Total Bit Pattern	0x4CE6	0x4CE6	0x4CE6	0x4CE6	0x4CE6

The initial default values for the MCP Operating Levels are given in the following tables

Spacecraft	1	2	3	4	spare
Sensor	HEEA 9	HEEA 6	HEEA 7	HEEA 8	HEEA 10
Level	17	17	17	15	17
Free Bit Pattern	0x0011	0x0011	0x0011	0x000F	0x0011
Total Bit Pattern	0x2051	0x2051	0x2051	0x204F	0x2051

Spacecraft	1	2	3	4	spare
Sensor	LEEA 9	LEEA 6	LEEA 7	LEEA 8	LEEA 10
Level	17	17	19	14	18
Free Bit Pattern	0x0011	0x0011	0x0013	0x000E	0x0012
Total Bit Pattern	0x0051	0x0051	0x0053	0x004E	0x0052

6.7.2 Parameters Files for setting up Science Modes

The format of the following tables is a listing of the input parameter as a hexadecimal number. Also given is the total bit pattern (in hexadecimal) that will be generated when the parameter is combined with the fixed bits of the appropriate command in the sequence: these are shown in italic and between the brackets ( ). These are included in the tables to allow ground checking of the uplinked commands.

Note that the parameters are sufficient to fully define an Operational Mode, but that they are spread over three command sequences.

6.7.3 Standard Operations

6.7.3.1 Burst Mode 1 and Normal Mode 1

CSEQ/Parameter	STD-ALL-1a	STD-ALL-1b	STD-ALL-1c	STD-ALL-1d	STD-ALL-1e
Setup_0,1,2,3/1	0x000F *(0x206F)*	0x000F *(0x206F)*	0x000F *(0x206F)*	0x000F *(0x206F)*	0x000F *(0x206F)*
Setup_0,1,2,3/2	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*
Setup_0,1,2,3/3	0x000F *(0x006F)*	0x000F *(0x006F)*	0x000F *(0x006F)*	0x000F *(0x006F)*	0x000F *(0x006F)*
Setup_0,1,2,3/4	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*
Setup_1,2,3/5	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*
Setup_1,2,3/6	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*
Setup_1,2,3/7	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*
Setup_1,2,3/8	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*
Setup_1,2,3/9	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*
Setup_2,3/10	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*
Setup_2,3/11	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*
Setup_2,3/12	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*
Setup_2,3/13	0x1520 *(0x1520)*	0x1620 *(0x1620)*	0x1720 *(01720)*	0x1820 *(0x1820)*	0x181f *(0x181f)*
Setup_3/14	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/15	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/16	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/17	Not Used	Not Used	Not Used	Not Used	Not Used
DPS/1	Not Used	Not Used	Not Used	Not Used	Not Used
DPS/2	Not Used	Not Used	Not Used	Not Used	Not Used
HV_both/1	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*
HV_both/2	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*

CSEQ/Parameter	STD-ALL-2a	STD-ALL-2b	STD-ALL-2c	STD-ALL-2d	STD-ALL-2e
Setup_0,1,2,3/1	0x0007 *(0x2067)*	0x0007 *(0x2067)*	0x0007 *(0x2067)*	0x0007 *(0x2067)*	0x0007 *(0x2067)*
Setup_0,1,2,3/2	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*
Setup_0,1,2,3/3	0x0007 *(0x0067)*	0x0007 *(0x0067)*	0x0007 *(0x0067)*	0x0007 *(0x0067)*	0x0007 *(0x0067)*
Setup_0,1,2,3/4	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*
Setup_1,2,3/5	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*
Setup_1,2,3/6	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*	0x02D5 *(0x02D5)*
Setup_1,2,3/7	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*
Setup_1,2,3/8	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*
Setup_1,2,3/9	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*
Setup_2,3/10	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*	0x0008 *(0x5608)*
Setup_2,3/11	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*	0x0002 *(0x0002)*
Setup_2,3/12	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*	0x000F *(0x560F)*
Setup_2,3/13	0x2a40 *(0x2a40)*	0x2c40 *(0x2c40)*	0x2e40 *(0x2e40)*	0x3040 *(0x3040)*	0x303e *(0x303e)*
Setup_3/14	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/15	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/16	Not Used	Not Used	Not Used	Not Used	Not Used
Setup_3/17	Not Used	Not Used	Not Used	Not Used	Not Used
DPS/1	Not Used	Not Used	Not Used	Not Used	Not Used
DPS/2	Not Used	Not Used	Not Used	Not Used	Not Used
HV_both/1	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*
HV_both/2	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*	*Hencforth (see 6.7.1)*

6.7.3.2 Burst Mode 3

The commanding is identical to that for Normal Mode 1. STD-NM1-1a = STD-BM3-1a etc

CSEQ/Parameter	STD-BM3-2	STD- BM3-3	STD- BM3-4		
Setup_0,1,2,3/1	0x000F *(0x206F)*	0x000F *(0x206F)*	0x000F *(0x206F)*		
Setup_0,1,2,3/2	0x0016 *(0x2096)*	0x0016 *(0x2096)*	0x0016 *(0x2096)*		
Setup_0,1,2,3/3	0x000F *(0x006F)*	0x000F *(0x006F)*	0x000F *(0x006F)*		
Setup_0,1,2,3/4	0x000F *(0x008F)*	0x000F *(0x008F)*	0x000F *(0x008F)*		
Setup_1,2,3/5	0x0000 *(0x4300)*	0x0000 *(0x4300)*	0x0000 *(0x4300)*		
Setup_1,2,3/6	0x0221 *(0x0221)*	0x0291 *(0x0291)*	0x0281 *(0x0281)*		
Setup_1,2,3/7	0x0008 *(0x4208)*	0x0008 *(0x4208)*	0x0008 *(0x4208)*		
Setup_1,2,3/8	0x0000 *(0x4400)*	0x0000 *(0x4400)*	0x0000 *(0x4400)*		
Setup_1,2,3/9	0x0000 *(0x4500)*	0x0000 *(0x4500)*	0x0000 *(0x4500)*		
Setup_2,3/10	Not Used	0x0008 *(0x5608)*	0x0008 *(0x5608)*		
Setup_2,3/11	Not Used	0x000c *(0x000c)*	0x000c *(0x000c)*		
Setup_2,3/12	Not Used	0x000F *(0x560F)*	0x000F *(0x560F)*		
Setup_2,3/13	Not Used	0x0220 *(0x0220)*	0x0220 *(0x0220)*		
Setup_3/14	Not Used	Not Used	Not Used		
Setup_3/15	Not Used	Not Used	Not Used		
Setup_3/16	Not Used	Not Used	Not Used		
Setup_3/17	Not Used	Not Used	Not Used		
DPS/1	Not Used	Not Used	Not Used		
DPS/2	Not Used	Not Used	Not Used		

6.7.4 Interference Campaign

Tables to be added

6.7.5 Special Operations

Tables to be added

6.8 Commanding using Macros

To be completed

Probably have single macro for each std science mode

Probably have pairs of macros to deal with Int Cam; sensor setups and DPU setups.

Have separate commands where time delays are important.

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PEACE USER MANUAL CHAPTER 7

Version 4.0
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<u>Change Sheet since Cluster 1</u>

Minor updates.

7. CRITICAL OPERATIONS

7.1 Short Eclipses

Details of short eclipse operations are described in Chapter 8 section "Operation without Sunpulse".

7.2 Long Eclipse

Operations in long eclipse are possible but spacecraft power restrictions may prevent this.

7.3 Perigee Passages

Details of perigee passages are described in Chapter 4 under "Radiation".

7.4 Manoeuvres

Instrument should be powered off during manoeuvres and assessment of possible contamination should be made before operating MCP's at full voltage see Chapter 4 under "Thruster Firing".

7.5 Software Patching

The PEACE instrument has the ability to uplink software patches by two methods. The first is a simple byte wide memory poke, the second uses a more comprehensive patch block method.

7.5.1 The Memory Poker.

The memory poker is available from mode **PEACE on**.

The poke operation will consist of an IPCH file containing blocks of the following commands:

(set LSB of poke address = LL)
ZEPDPLSB 0x00LL

(set MSB of poke address = MM)
ZEPDPMSB 0x00MM

(set data byte for current poke address, data byte = DD)
ZEPDPDAT 0x00DD

At the end of a memory poke the PEACE instrument returns to mode **PEACE on**.

The success of the patch will be checked by performing a memory dump (command sequences PMDR, PMD1 PMD2) or a peek memory operation (command sequence PEEK) depending on the size of the patch.

7.5.2 Software Patch Block uplink.

At the start of this operation the PEACE instrument will be in the **Executive mode.**

The IPCH files will consist of blocks as follows

(start patch block for page PP, where PP = 0,1 or 2)
ZEPDUPSO 0x00PP
(patch start address 0xAAAA)
ZEPUPAR 0xAAAA
(patch size 0xSSSS)
ZEPUPAR 0xSSSS
(patch data 0xDDDD word 1)
ZEPUPAR 0xDDDD
.
.
.
(patch data 0xDDDD word patch size)
ZEPUPAR 0xDDDD
(block checksum 0xCCCC)
ZEPUPAR 0xCCCC

The stages of the patch can be monitored by the HK parameter EPD_STAT (see Appendix C).

This monitoring includes checksum confirmation.

At the end of the patching process the PEACE instrument returns to the **Executive mode.**

After the complete patch has been uplinked the code directory may be updated from the **Executive mode** using blocks of the following commands:

(Select directory index II = 0 to 109)
ZEPDEDR1 0x00II
(new directory value = VVVV)
ZEPDEDR2 0xVVVV

At the end of the directory update process the PEACE instrument returns to the **Executive mode.**

In addition to the block checksum described above the patch will be checked by performing a memory dump (command sequences PMDR, PMD1, PMD2 in Chapter 3). When the DPU code is run (i.e. RA2 is run and the instrument enters STANDBY BOTH PRO) all modules are check-summed, which acts as an additional confirmation of patch success.

7.6 Trouble shooting.

The PEACE instrument has many facilities such as memory peeking, low level commanding, memory dumps, engineering mode and monitor set-up designed to aid in trouble shooting, the command sequences for these are given in Chapter 3.

7.7 New high level MCP setting.

Regular checks of MCP Operating Level are planned (see Chapters 3 and 6). If it becomes necessary to operate the LEEA or HEEA MCPs above the maximum level that they have previously been operated to, special care will be taken the first time the MCP is switched to the new maximum level.

7.8 Additional operations requiring PEACE support.

The following operations have been identified as possibly requiring PEACE team support.

1. Setting new monitor limits
2. First time Single Processor operations (see Chapter 8 and command sequence definitions Chapter 3).
3. First time Single Sensor operations (see Chapter 8 and command sequence definitions Chapter 3).

All required command sequences for these operations are defined in Chapter 3.

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PEACE USER MANUAL CHAPTER 8

Version 4.3
13th February 2001

Change Sheet since Cluster 1

Minor updates throughout.

Version 4.1

Added CTU reboot contingency, Section 8.4

Version 4.3

Corrected names of states, put in delays

8. CONTINGENCY OPERATIONS

8.1 Introduction

The possible methods for malfunction detection, response and malfunction tolerant operations are described.

Detailed contingency measures cannot, in general, be designed without knowledge of the actual malfunction.

The advantages and disadvantages of the various contingency measures are briefly described and will determine the methods applied to a given malfunction.

8.2 Malfunction Recognition and Reporting

8.2.1 ESOC Monitoring

8.2.1.1 ESOC use of PEACE Analogue Monitor Information

This system has the advantage that it constantly monitors the analogue parameters and therefore will be capable of determining the response of the PEACE instrument during all of the stages of the PEACE operations. The disadvantage is that it is non-real time.

PEACE analogue housekeeping checking, with the parameter database defined by PEACE, will be carried out by ESOC. The limits used in the database are defined in Chapter 2 of this User Manual. If an out of limits error occurs then action as defined in Chapter 2 of this User Manual should be performed.

(Note, we include all analogue monitors in this category at this stage, however, this situation may change following commissioning of the instrument at which time it will be possible to assess the monitor noise levels and may cause a more specific and narrower choice of analogue monitors to be chosen).

8.2.1.2 ESOC use of Thermistor Information

See Chapter 4 for limits and recommended actions

8.2.1.3 ESOC use of 28V Current and KAL Current Information

Limit values for the 28V current and KAL current are defined in Chapter 2, as are the appropriate actions for out of limit exceptions.

8.2.1.4 ESOC use of PEACE DPU status word EPD_STAT

The EPD_STAT parameter, or PEACE status word, is generated every format. EPD_STAT has about 100 possible values, each represents a different instrument state. Some of these values indicate malfunctions either in initialisation or at run time (see Appendix C). The EPD_STAT word is a powerful debugging tool as it can often give a good indication as to the cause of the problem. The numerical values are conveniently ordered to allow simple recognition of the class of failure mode.

ESOC should monitor the PEACE status word.

The expected value of this parameter in all of the modes following the execution of the following command sequences, PO, EE, RA2 (i.e. PEACE Off to STANDY BOTH PRO) is given in Appendix C.

If the mode change to STANDBY BOTH PRO is successful then EPD_STAT should be as follows

EPD_STAT = 98	IP processor only operation
EPD_STAT = 99	SP processor only operation
EPD_STAT= 100	Both processors operation

If EPD_STAT< 98 after the command sequences RA2 or RA1 have been sent (allowing for the proper delay time of 15 sec, see Chapter 3) then the instrument has NOT booted successfully and the action required is :

Execute Macro PMACPOFF to power down PEACE

ESOC to inform the PI.

Suspend further operations pending investigation.

EPD_STAT >100 occurs when the instrument has booted successfully and then subsequently failed. If this occurs then the following action is required:

Execute Macro PMACPOFF to power down PEACE

ESOC to inform the PI.

Suspend further operations pending investigation.

8.2.2 Onboard Monitoring

8.2.2.1 OBDH use of PEACE DPU status word EPD_STAT

Onboard monitoring by the OBDH of the EPD_STAT word offers the possibility of setting up contingency actions controlled by the OBDH which can be very specific to the problem that has occurred.

At the start of operations this facility should not to be used. However, in Chapter 3 (section 3.4) we give a series of example spacecraft macros that could in principle be used, e.g. after sufficient operational experience.

Although the EPD_STAT parameter is generated every format, the spacecraft monitoring system may take several formats to detect an EPD_STAT error.

8.2.2.2 Onboard Use of Analogue Monitors by the DPU

Monitoring of parameters by the DPU itself has the advantage that it can have the fastest possible response to an out of limit condition. The selected parameters are checked against the limits 4 times per format (5.15 seconds) and the response time is instantaneous. Hence this system can be used for detecting and responding to very fast transitions on the time scale of about 1 second.

The DPU has the optional facility to monitor any of the analogue monitors available in the housekeeping data. The facility can be activated by the use of the command sequences:

MO Monitor On
MF Monitor Off

If an out of limit condition is detected then the DPU will automatically carry out the action equivalent to the following command :

ZEPDSPWF (which has the fixed bit pattern 0x4800)

which switches off the 5V, +-8V and the 36V supply to both LEEA and HEEA sensors. This action can be detected in the housekeeping by the following:

EPD_MVAL	=	parameter id of tripped channel.
EPD_MVAL	=	value of monitor which caused trip to occur.
EPD_MTRP	=	flag which signifies that trip has occurred.
EPD_STAT	=	110 (or 105 / 106 as monitor trip will turn sensors power off).

It may be useful to respond to this event by use of an OBDH macro which is TBD (because it depends on exactly which analogue value is out of limits etc.). To use this facility in this manner the following steps need to be carried out:

(i) Assess the noise on the analogue monitor channels during the commissioning in space.
(ii) Choose the limits appropriately to account for the noise.
(iii) Implement the monitor in response to a problem e.g., a repeated out of limit detected by the ESOC system.
(iv) Implement the spacecraft macro.

It will also be necessary for ESOC to alter their system to implement a check for this event occurring. When a monitor trip, shown by parameter EPD_MTRP, has occurred, ESOC should report it to the PI.

8.2.3 PI Monitoring

8.2.3.1 MSSL Checking of the Housekeeping and Science Data on the DDS

It is understood that 10 Megabytes (tbc) of data per day can be requested from the ESOC Cluster Data Delivery System.

This service will be used by MSSL to collect HK and some Science Data for checking using the MSSL Operations computer system. Note that certain of the Science Data data products contain important data regarding instrument health (e.g. see Chapter 2).

8.2.3.2 MSSL Checking of the Housekeeping and Science Data on the RDM.

This will carried out on the MSSL operations system.

8.3 Fault tolerant Modes

Operational modes exist for PEACE which allow malfunction tolerant operations. These are briefly described as follows. Command Sequences referred to here are defined in Chapter 3 of the User Manual.

8.3.1 Single Processor Operation

This allows either the IP (Interface Processor) or the SP (Science Processor) to run in a stand alone manner. The processor not used is not powered and tri-stated off. This option is executed by the use of one of the low level commands sequences:

SPI Single processor identity
SPIP Single processor IP
SPSP Single processor SP

followed by :

RA1 Run Application (single processor)

8.3.2 Single Sensor Operation

This allows either the HEEA or LEEA sensor to be run alone, while the other sensor is powered off.

This option is executed by the use of command sequence:

LV_HEEA HEEA sensor Low Voltage Power Up

followed by the command sequences to select the desired science mode.

Or

LV_LEEA LEEA Sensor Low Voltage Power Up

followed by the command sequences to select the desired science mode.

Note that during single sensor operations the data return can be optimised by transmitting TCOR in place of CORE, and 3DR from the working sensor only. Similarly, it may be necessary to transfer LER to HEEA if LEEA is not working.

8.3.3 Operation without Sun Pulse

Limited operations are possible if the sun pulse is temporarily unavailable (and therefore PEACE could be used in eclipse). However, a complete failure of the spacecraft sun pulse would prevent operation of PEACE.

It is assumed that PEACE will not generally operate during eclipse, although there are scientific reasons for wishing to operate during the transition into (and out of) eclipse as well as during eclipse, and such operations may be written into the Master Science Plan after launch. We note that during short eclipses the spacecraft may at times also be within the radiation belts, and that during long eclipses, spacecraft engineering considerations may prevent payload operations.

In the event that operation without the Sun Pulse is attempted, the sequence of operations will be constrained by the following considerations:
(i) PEACE is unable to boot without sun pulse

(ii) By the use of science reset and specialised commands, it is possible that from a state in which PEACE is running in Science Mode, to switch over to what is effectively an internally generated sun pulse.

(iii) Once in this mode the operational options are very limited and therefore it is recommended that mode changes are not attempted.

Hence it may be possible, that PEACE can be switched into "operations without sun pulse" mode before a short eclipse begins, and at the end of this mode of operation the system should be powered down (with a time tagged command) and rebooted when the sun pulse is available.

8.4 CTU Reboot Contingency

8.4.1 Scenario

8.4.1.1 Trigger Event

The CTU unexpectedly reboots.

The payload 28V line is turned off without the standard turn off procedure being followed and potentially could suffer damage.

8.4.1.2 Overview of ESOC Response

At next contact opportunity, recover the spacecraft, reboot the CTU.

Activate the payload, perform PI-team specified health check, place in "outside acquisition interval mode" (which is OFF for PEACE). Provided payload is healthy, resume the Master Science Plan at next Acquisition Interval.

The PI Team specified instrument test procedure is described in the following section.

It is important to note that some 'henceforth' values will be used in this procedure – namely the voltage levels to be used on the MCP's. These vary according to spacecraft and sensors and it is very important to use the correct level on each sensor.

8.4.1.3 Overview of PEACE Recovery Procedure

There is no special requirement for any other instrument to be turned on prior to PEACE.

The test must not be performed within the time interval "perigee ±3 hours".

The test involves a careful turn on of the instrument, performing HK checks at each stage before progressing. The DPU is turned on first, then the sensor low voltages, then the science processing. Finally the HV subsystems are carefully turned on. At completion of the test the instrument is briefly operated in the default science mode. Then it is set to the "outside acquisition interval mode" which is "PEACE OFF" for PEACE

The default PEACE science mode is STD-ALL-1e.

If this procedure is carried out without incident, it will be sufficient to notify the PI of this within office hours. However, if there is a problem the instrument must be powered off using the procedure **PDP** (see 8.4.2.7) and the PI must be notified at once. In this circumstance, the instrument must not be powered on again until agreement is made with the PI.

8.4.2 PEACE Recovery and Test Procedure

If at any stage in the following procedure, telemetry values do not correspond to the expected values specified here, turn the instrument off and contact the PI.

IMPORTANT NOTE:

The DPU_BOOT_STATUS (1P_R02) is the best diagnostic tool for any PEACE operations. If at any time in this set of procedures after Section 8.4.2.1.3 it differs from 100 (dec), its value must be noted, the 28V current recorded, and the PI contacted. Until the PI gives further instructions, all further operations must cease (unless section instructions state that the instrument must be powered off, in which case the procedure PDP must be run).

NOTE ALSO: All ESOC parameter names used are for spacecraft 1.

Total Duration (estimated): 45 minutes

8.4.2.1 Step 1: Activate DPU

Duration

5 minutes

Initial State Requirement

PEACE OFF
Must have science telemetry
DPU temperature is between -5 degrees C and +30 degrees C.

Final State

STANDBY BOTH PRO

Description

PEACE OFF to STANDBY BOTH PRO
Power up DPU and check power consumption, status flags, counters etc.

Procedure

`8.4.2.1.1: Switch on PEACE 28V supply`

PO **Power On 28V**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
"Spacecraft macro to turn on 28 V to PEACE DPU"			
delay 5 seconds			
ZEPDLOWL	0x8000	0x0081	0x8081
delay 1 second			
ZEPDLOWL	0x8000	0x0001	0x8001
delay 20 seconds			

Parameter	Description	Expected	Seen?
	PEACE 28V current	96 ± 10 mA	
1P_R02	DPU_BOOT_STATUS	201 (Dec)	

8.4.2.1.2: Execute DPU Executive Code

EE **Execute Executive**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDBOOS	0x4D00	0x0001	0x4D01

delay 15 seconds

Parameter	Description	Expected	Seen?
1P_R02	DPU BOOT STATUS	3 (Dec)	

8.4.2.1.3: Run DPU Two Sensor Application Code

RA2 **Run Application (two processor)**

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDEAPP	0x5200	0x0091	0x5291

delay 30 seconds

Accumulate 30 seconds of data and check housekeeping parameters are as expected:

Parameter	**Description**	**Expected**	**Seen?**
1P_R02	(DPU BOOT STATUS	100 (Dec)	
1P_D02	HK format count	Incrementing	
1P_D03	HK sunpulse count	Incrementing	
1P_D06 (please record)	HK sunpulse offset	176 (Dec) – could be different as this is a henceforth parameter	
1P_025	Interface Mode	AUTO	
1P_028	Watchdog	ENABLED	
1P_005	H/K telemetry mode	NORMAL	
1P_011	FGM interface	Disabled	
1P_010	EDI interface	Disabled	
1P_009	DWP interface	Disabled	
1P_008	ASPOC interface	Disabled	
1P_D81 – 1P_D94	All command echoes	‘0’	
1P_020	DPU 5V voltage	Between 5.0 V to 5.3 V	
All other PEACE HK parameters are within limits.			
1P_ 004	DPU Temperature	-5°C - +30°C at turn on	

8.4.2.2 Step 2 : LEEA and HEEA Low Voltage Power Up

Duration

5 minutes

Aim

To power up +5V, ±8V on LEEA, then to send confirmer command to power up 36V. Process then repeated on HEEA.

Initial State Requirement

STANDBY BOTH PRO
Must have science telemetry
Check that HEEA & LEEA s/c powered thermistors temperature is between -10 degrees C and +40 degrees C (operating acceptance levels for sensors).

Final State

LV ON BOTH

Description

STANDBY BOTH PRO to READY BOTH SAFE
By checking the power consumption of the low voltage electronics the integrity of the subsystems can be established.

Procedure

8.4.2.2.1: Switch on LEEA 5V and ± 8V supply

(Part 1 LEEA)

Switch on LEEA 5V, ± 8V and service signals. (Confirmer command not yet issued, therefore 36V remains OFF)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDLPCN	0x4B00	0x0003	0x4B03

delay 25 seconds

Parameter	**Description**	**Expected**	**Seen?**
1P_067	LEEA 5V voltage	4.8 V to 5.2 V	
All other PEACE HK parameters are within limits.			
1P_070, 1P_066	HVs	OFF	

8.4.2.2.2: Switch on LEEA 36V supply

(Part 2 LEEA)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDCONF	0x4F55	0x0000	0x4F55

delay 30 seconds

Parameter	**Description**	**Expected**	**Seen?**
1P_050	LEEA 36V voltage	34 V to 38 V	
All other PEACE HK parameters are within limits.			
1P_070, 1P_066	HVs	OFF	

8.4.2.2.3: Switch on HEEA 5V and ± 8V supply

(Part 1 HEEA)

Switch on HEEA 5V, ± 8V and service signals. (Confirmer command not yet issued, therefore 36V remains OFF)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDHPCN	0x6B00	0x0003	0x6B03

delay 25 seconds

Parameter	Description	Expected	Seen?
1P_046	HEEA 5V voltage	4.8 V to 5.2 V	
All other PEACE HK parameters are within limits.			
1P045, 1P_049	HVs	OFF	

8.4.2.2.4: Switch on HEEA 36V supply

(Part 2 HEEA)

COMMAND NAME	FIXED BIT PATTERN	FREE BIT PATTERN	TOTAL BIT PATTERN
ZEPDCONF	0x4F55	0x0000	0x4F55

delay 30 seconds

Parameter	Description	Expected	Seen?
1P_029	HEEA 36V voltage	34 V to 38 V	
All other PEACE HK parameters are within limits.			
1P_045, 1P_049	HVs	OFF	

8.4.2.3 Step 3: Open IEL Interface

Duration

5 minutes

Aims

Open the IEL interfaces and confirm PEACE runs.

Sequence Description

Open IEL interfaces to FGM, ASPOC and DWP.

Initial State Requirement

LV ON BOTH
Must have science telemetry

Final State

READY BOTH SAFE

Procedure

INTERFACE **Spacecraft interface and watchdog**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDHWCE	0x00c6	0x4cc6	Open IEL's to FGM, ASPOC and DWP

delay 30 seconds

8.4.2.4 Step 4: Start Science Processing in Standard Operating Mode.

Duration

5 minutes

Aims

Set up instrument in standard operational mode and confirm correct system function.

Sequence Description

Demonstrate usual turn on.

Initial State Requirement

READY BOTH SAFE
Must have science telemetry

Final State

RUNNING SAFE

Procedure

`8.4.2.4.1: From READY BOTH SAFE to RUNNING SAFE (Standard Mode, STD-ALL-1e)`

SETUP_2 **Setup sensors and science configuration**

RUNSCI_BOTH **Start science processing**

Commands to turn MCP's to level zero

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHSMPS	0x000f	0x206f	HEEA Sweep mode + PS
delay 1 second			
ZEPHSPSS	0x0016	0x2096	HEEA Sweep PS
delay 1 second			
ZEPLSMPS	0x000f	0x006f	LEEA sweep mode + PS
delay 1 second			
ZEPLSPSS	0x000f	0x008f	LEEA sweep PS
delay 1 second			
ZEPDDATS	0x0000	0x4300	Datasets control
delay 1 second			
ZEPDDATP	0x02d5	0x02d5	Datasets setup
delay 1 second			
ZEPDHIPS	0x0008	0x4208	Correlator setup

delay 1 second			
ZEPDMAGS	0x0000	0x4400	Mag field selection
delay 1 second			
ZEPDSPOT	0x0004	0x4504	S/c Potential setup
delay 1 second			
ZEPDLPUE	0x0008	0x5608	3DX 1 control
delay 1 second			
ZEPDPUPS	0x0002	0x0002	3DX 1 setup
delay 1 second			
ZEPDLPUE	0x000f	0x560f	3DX 1 energy limits ctrl
delay 1 second			
ZEPDPUPS	0x1720	0x1720	3DX 1 energy limits
delay 1 second			
ZEPDPRCN	0x0000	0x4700	Start science processing
delay 20 seconds			
ZEPHMCPS	0x0000	0x2040	HEEA MCP level zero
delay 5 seconds			
ZEPLMCPS	0x0000	0x0040	LEEA MCP level zero
delay 5 seconds			

8.4.2.5 Step 5: HV Sweep check

Duration

5 minutes

Aim

To demonstrate correct function of the HV Sweep generator.

Initial State Requirement

RUNNING SAFE
Must have science telemetry

Final State

RUNNING HV ON

Description

Turn on sweep and MCP HVs (MCP's are at level zero)

HV_MEL_BOTH **HV MCP enable at op. level: BOTH sensors**

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHHVGE	0x0003	0x20C3	Enable HV's
delay 120 seconds			
ZEPLHVGE	0x0003	0x00C3	Enable HV's
delay 120 seconds			

8.4.2.6 Step 6: MCP Commissioning

Duration

10 minutes

Aim

To switch on the high voltage supply of each sensor and increase the high voltage to establish:

- That the integrity of the high voltage supply has been maintained
- That the integrity of the MCP has been maintained

Initial State Requirement

READY BOTH HV ON
Must have science telemetry

Final State

READY BOTH HV ON

Description

MCP voltages are raised, one sensor at a time, to their normal operational limit. The total counts on the test sensor (1P_D04 and 1P_D05) must be observed at all times.

For the commissioning the MCP level will be increased to a predefined value as determined during the calibration, as follows

Spacecraft Number	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 1**
Sensor	LEEA 6	LEEA 7	LEEA 8	LEEA 9
Level	15	16	13	16
Sensor	HEEA 6	HEEA 7	HEEA 8	HEEA 9
Level	15	15	13	15

These values MUST be observed. A sensor MCP voltage raised past its operational limit could cause damage to the sensor.

Procedure

Commands to turn MCP's to henceforth value

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPHMCPS	0x00uu	0x20ML*	HEEA MCP level
delay 30 seconds			
ZEPLMCPS	0x00uu	0x00ML*	LEEA MCP level
delay 120 seconds			

wait 6 minutes to accumulate data

* henceforth value

8.4.2.7 Step 7: Turn PEACE Off

Duration

10 minutes

Aims

Turn PEACE Off

Sequence Description

N/A

Initial State Requirement

READY BOTH HV ON
Must have science telemetry

Final State

PEACE OFF

Procedure

`8.4.2.7.1: From PEACE READY BOTH HV ON to OFF`

HS Halt science

Commands to turn MCP's to zero

PDP Power Down PEACE

COMMAND NAME	FREE BIT PATTERN	TOTAL BIT PATTERN	DESCRIPTION
ZEPDPRCN	0x00ff	0x47ff	Turn off science processing
delay 20 seconds			
ZEPHMCPS	0x0000	0x2040	HEEA MCP level zero
delay 5 seconds			
ZEPLMCPS	0x0000	0x0040	LEEA MCP level zero
delay 120 seconds			
ZEPHHVGD	No parameter	0x20C0	
delay 5 seconds			
ZEPLHVGD	No parameter	0x00C0	
delay 120 seconds (allows MCP power capacitors to decay)			
ZEPDRSET	No parameter	0x48A5	
delay 120 seconds (allows sensor power capacitor discharge)			
"Spacecraft macro to turn off 28 V supply to PEACE DPU"			
delay 25 seconds			

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DPU COMMANDING SYSTEM SPECIFICATION

Version 1.6
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Contents

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Revisions

V0.1 - First version.
V0.2 - Restructured and extra information.
V1.0 - Added 3 new commands:
1. Spacecraft potential calculation control
2. Instrument closedown
3. Uplink FGM calibration values

- Changes/corrections made to the following commands:
1. Sensor power & service signals control
2. IEL event control
3. SMU commands (IMPORTANT WARNING)
4. Correlator dataset control
5. Uplink dead-time correction factor (typing correction only)
6. Uplink parameter

V1.1 - 06-May-92. Changed loader programs and terminology.
- Added PEACE DPU internal architecture block diagram.
- Changed HLPUCs.
- Generalised 'HV Sensor Enable command' to 'Security Confirmer Command'
- Added confirmer command to 'Keep Alive Initialisation' command.
- Incorporated 'IEL Event Control' command into 'DPU Hardware Control' command.
- Restructured document.

V1.2 - 20-Apr-94. Major update.
V1.3 - 09-Dec-94. Changed Datasets telemetered command, other minor changes.
V1.4 - 01-Jul-98. Update for ClusterII
V1.5 - 01-Jun-99. Updated references.
- Updated Table 32 "Uplink Dead-Time Correction Factor"

v1.6 - 03-Jun-99. Updated Table 32 "Uplink Dead-Time Correction Factor"

Distribution List

1.	A. Fazakerley	MSSL
2.	A. M. James	MSSL
3.	P. J. Carter	MSSL
4.	B. K. Hancock	MSSL
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Glossary

ASPOC	Active Spacecraft Potential Control experiment
CMD	Command
COR	CORe dataset
def	Default
dtf	Dead-Time correction Factor
DPU	Data Processing Unit
DWP	Digital Wave Processing experiment
EEPROM	Electrically Erasable PROM
EDI	Electron Drift Instrument on Cluster
EGSE	Electrical Ground Support Equipment
EID	Experiment Interface Document (ESA)
ESA	European Space Agency
FIFO	First In, First Out stack system
FGM	Flux Gate Magnetometer experiment
GF	Geometric Factor
HEEA	High Energy Electron Analyser
H/K	Housekeeping data
HLC	High Level Command
HLEC	High Level Engineering Command
HLEXC	High Level Executive Command
HLIC	High Level Initialisation Command
HLSC	High Level Science Command
HLPUC	High Level Power-Up Command
HLRTC	High Level Run-Time Command
HIP	HIgh Polar resolution (fine anode) dataset
HV	High Voltage
id	IDentification number
IEL	Inter-Experiment Link
IP	Interface Processor (board)
LAR	Low Angular Resolution
LEEA	Low Energy Electron Analyser
LEF	Low Energy Full resolution distribution
LER	Low Energy Reduced resolution distribution
LLC	Low Level Command
LS	Least Significant
LSB	Least Significant Byte/Bit
MAR	Medium Angular Resolution
MAX	MAXimum
MEM	Memory downlink packet
MIN	MINimum
ML	Memory Load (command)
MLC	Memory Load Command
MOM	Moments dataset
MS	Most Significant
MSB	Most Significant Byte/Bit
NDRE	Norwegian Defense Research Establishment
OBDH	On-Board Data Handling System
PAD	Pitch Angle Distribution
PEACE	Plasma Electron And Current Experiment
PROM	Programmable Read Only Memory
RAM	Random Access Memory

Red	Reduced
ROM	Read Only Memory
SCP	SpaceCraft Potential dataset
SCI	SCIence parameters dataset
SLC	Spacecraft Level Command
SMU	Sensor Management Unit
SP	Science Processor (board)
SPAD	Super PAD
SSCP	Spin Segment Clock Pulse
stim	Stimulator (Produces test pulses for PEACE exp checking)
STSP	Solar Terrestrial Physics Program
S/W	Software
TBC	To Be Confirmed
TBD	To Be Defined
UT	Universal Time (ESA definition)
WHISPER	Sounder and High-Frequency Wave Analyser Experiment on Cluster
Word	16 bits = 2 bytes
3DF	3D Full resolution distribution
3DR	3D Reduced resolution distribution
3DX	3D variable resolution distribution

1 INTRODUCTION

1.1 PURPOSE

The aim of this document is to provide a sufficiently accurate specification of the onboard commanding system in the CLUSTER-PEACE DPU, and its commands, for the following purposes:

1. To enable the onboard DPU command system design to be evaluated for security, flexibility, completeness, and conformance to ESA requirements.
2. To provide a list of commands which may be applied to the PEACE instrument.
3. To enable each of the commands to be constructed in the correct format.
4. To help establish the required command sequences for PEACE instrument turn-on, operations, and turn-off.
5. To enable the implementation to be tested against the specification. (*e.g.* using an EGSE.)
6. To provide an agreed permanent record of the system design, commands and their formats.

This document will NOT describe either the hardware or software implementation of the above design structure in the DPU.

It will also NOT specify the design or implementation of the non-DPU components of the command system (*i.e.* it will not include the ground system, OBDH or PEACE SMU components of the PEACE commanding system).

Additionally, helpful information is also included which does not form part of the specification and this is indicated by being enclosed in brackets.

1.2 INPUTS

An outline input to this task comes from the 'Scientific Specification' [1] and 'Operational Modes' [2] documents by A. D. Johnstone and A. Fazakerley.

Some initial development of the outline requirements were presented in the 'DPU Software Study' document by R. A. Gowen [3], from which the recommended selections were taken as the basic input to this document.

Command system requirements were also taken from Section 3 of the ESA Cluster 'EID PART-A' document [4].

In addition, further development work on the PEACE DM, EM and FM models by P. Carter and B. Hancock [10] helped to establish many of the commands required, and the system structure outlined here.

1.3 COMMANDING SYSTEM

The system which allows an experiment to be controlled is called the commanding system. These controls include switching the experiment on and off, setting parameters, changing operational modes, and uplinking new data and software.

The commanding system must allow the full range of controls which may be needed. It must also consider safety of the instrument so that it cannot be damaged by reception of corrupted commands, or perhaps more likely by accidental sending of critical commands at the wrong time.

The commanding system involves a chain of different components, from ground system command selection and verification, uplink to the spacecraft OBDH, transmission to the PEACE experiment, execution by the experiment and echoing the command and its effects back down to the ground via the OBDH, and ground verification of the commands sent and their effects.

This document will only describe the DPU component of the PEACE experiment component of the commanding chain in detail, and its interfaces to the other components as necessary.

For the PEACE experiment onboard Cluster, spacecraft level commands will be used for turning the PEACE experiment on and off, and all other commanding will be via 16-bit Memory Load Commands (MLC). These MLCs will be received by PEACE from the On-Board Data Handling (OBDH) system.

During flight operations, 16-bit MLCs will be uplinked to the spacecraft OBDH which decides whether to process each command immediately (direct commanding), or store it for processing at a specified time (time tagged commanding). The OBDH processing of the command may simply consist of passing it directly to the experiment, or may trigger the passing of a pre-stored sequence of commands to the experiment (macro commanding). Such pre-stored command macros may be changed during flight.

Once the command has been passed to the experiment, it will then execute the command, and normally echo it back to ground to allow verification of command reception. Also, the effects of the command on the experiment are also usually echoed back to ensure the desired effects have been achieved.

The normal telemetry stream which is specifically designed for instrument health and command verification monitoring is the housekeeping stream, and for this stream ESA can perform some automatic command verification functions. Any command effects telemetered in the science telemetry stream would require the experimenter for verification.

The experiment will also be commanded prior to flight during ground development and testing.

1.4 DATA NOTATION AND COORDINATE CONVENTIONS

1.4.1 Data Notation

Unless otherwise stated, lower indices refer to the lower order bits (*e.g.* 'a0' will be the lowest order bit for parameter 'a').

Similarly bit 0 will be the lowest order bit of a byte or word.

Hexadecimal numbers will be preceded by a '#' character.

1.4.2 PEACE Spacecraft Coordinate System

The polar direction will be denoted using θ.

The polar origin ($\theta = 0$) will lie along the spacecraft spin axis, in the positive ESA spacecraft x-direction, and be common to both HEEA and LEEA.

$\theta = 0$ will coincide with anode number=11, and θ will decrease in the direction of increasing anode number [0-11].

The azimuth direction will be denoted using ϕ.

The azimuth origin ($\phi = 0$) will occur at the time of reception of the rephased sun reference pulse, and be taken to be the direction at which the HEEA sensor is looking at that time.

ϕ will increase in the same direction as the spin of the satellite.

2 SCOPE

The scope of this document will be as follows:

1. This document will define the design structure for the PEACE DPU onboard commanding system, but not its hardware and software implementation.
2. It will define all the 16-bit ML commands which may be sent to the Cluster PEACE instrument, and their format.
3. It will include considerations for a secure commanding system which protects against instrument damage, due to command corruption or reception at the wrong time.
4. It will include considerations of both hardware and software instrument malfunctions.
5. It will include considerations for the command sequences required for instrument turn-on, operations, and turn-off.

3 METHOD

The general method by which the commanding system will be implemented will be as follows:

1. Command Interface
   Commanding of the PEACE instrument shall be only via the spacecraft OBDH interface via the PEACE DPU.
2. Spacecraft Command Types
   Only two types of command will be used:
   (a) Spacecraft Level Commands for turning PEACE (28V) on and off.
   (b) Memory Load Commands for all other functions.
3. PEACE Commands
   'PEACE' commands will be defined which consist of single or multiple MLCs. Two levels of PEACE commands will be defined as follows:

(a)	Low Level Commands	-	which are single MLCs and are acted on by the DPU electronics hardware.
(b)	High Level Commands	-	which are single or multi-word MLCs and are acted on by the DPU processing system.

4. Command System Security
   This will be provided by:
   (a) A 'confirmer' command which has to be sent immediately after certain sensitive commands. This can help to prevent accidental damage to the instrument.
   (b) Echoing the commands, when possible, and their effects down to the ground in the h/k telemetry normally, and science telemetry for uplinked software.
   This will allow the ground system to verify the commanded state for PEACE in real-time.

4 ARCHITECTURE

4.1 GENERAL COMMAND SYSTEM ARCHITECTURE

The major components of the overall PEACE commanding system, their functions and interrelationships will be as shown in Figure 1.

The functions of these elements are discussed in more detail below:

1. Command selection
   A command is selected for transmission to the instrument, and passed to the ESA ground command processing system.

2. The ESA Ground Command Processing System
   The command is received by the ESA ground command processing system where:
   (a) The command is verified as valid.
   (b) The command is recorded for later comparison with downlinked echo of command in the experiment housekeeping data.
   (c) If the command is a critical one, then either appropriate authorisation is checked, or confirmation is requested.
   (d) The command is protected by insertion of error correction coding.
   (e) The protected command is transmitted to the desired spacecraft.

3. The Cluster Spacecraft
   The command is received by the desired spacecraft where:
   (a) The command is unwrapped from its protection.
   (b) If the command is a time-tagged command, then it will be stored until the desired time is reached. At that time the next step will be executed.
   (c) If it is a macro command, then either the pre-stored macro commands are modified, or simply accessed, and passed on to the PEACE experiment.
   (d) If it is not a macro command, then it is passed directly onto the PEACE experiment.

4. The PEACE Experiment - Electronics Hardware
   (a) The DPU receives the command from the OBDH system.
   (b) If the low-level command processing is enabled, then the command will be checked to see if it is a low level command.
   If the command is a low level command it will be executed by the electronics.
   The latest low level command will be stored awaiting start up of the main application processing program which will echo it in the h/k telemetry.
   (c) All commands are also routed onto the DPU processing system.

5. The PEACE Experiment - DPU Commanding System
   (a) The DPU processing system will receive the command word.
   (b) If the command word is a high level command which initiates the execution of the executive program, then low level commanding will be disabled before the executive program is executed.
   This is in order to avoid misinterpretation of the argument words of multi-word high level commands as low level commands.
   Until that time, low level commanding will be able to be sent and will be operated on.
   (Only basic power instrument power switch-on will enable low level commanding.)
   (Normally, it would be recommended to send all low level commands before any high level commands.)

   (c) The DPU processing system will then enter the command onto a FIFO command stack.
   (d) Eventually the command will be read from the command stack, fully decoded, and verification testing performed.
   (e) If the command is to the high level application program, it will be echoed into the housekeeping stream.

       (Only the last low level command will be echoed, but no high level commands to the level-2 loader or executive will be echoed.)
   (f) The command will then be passed to the appropriate system for execution, or thrown away if not a valid command.

6. The ESA Ground System
   (a) This receives the echoed commands from the PEACE experiment onboard the satellite in the housekeeping telemetry system.
   (b) It can then compare the echoed commands with those transmitted in order to verify their correct reception by the experiment.
   (c) For macro commands, the ground system will keep tables of the macro expansions, so that verification of each of the individual commands forming the macro can be performed.
   (d) At a later time the expected effects of the command can be checked against the downlinked h/k data.

7. The PEACE Ground System

   This will receive any downlinked memory packets in the PEACE science data stream and compare with the expected memory state.

   This would be performed in near real-time by the PEACE EGSE, either at the operations control centre or connected to it via a remote electronic link.

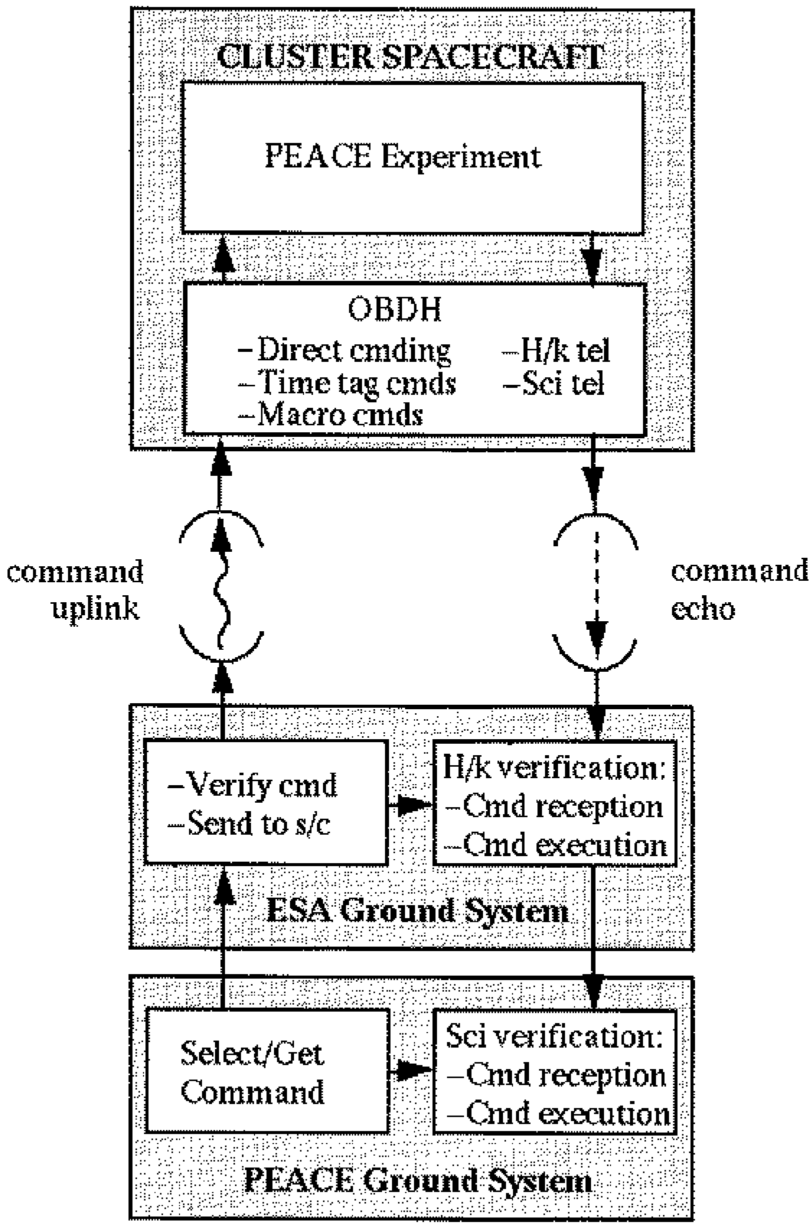

Figure 1: General PEACE Commanding System Architecture

4.2 PEACE DPU COMMAND SYSTEM ARCHITECTURE

This section specifies, in more detail, the internal architecture of the commanding system specific to the DPU of the onboard PEACE instrument.

This includes the parts of the PEACE DPU involved with commanding, and the types of commands involved.

The detailed architecture internal to the PEACE DPU is shown in Figure 2, and is discussed in more detail as follows:

4.2.1 External Interface

The external command interface to the PEACE instrument shall be only via the spacecraft OBDH system interface to the PEACE DPU, and will consist of only two types of command:

1. Spacecraft Level Commands (SLCs) (TBC)
   - These will only be used to turn PEACE on and off (28V).
2. 16-bit Memory Load Commands (MLCs)
   - These will be used for all other command functions.

(At the ground level many types of commands may be sent to the spacecraft OBDH system, such as spacecraft level, time-tag, macro commands, and 16-bit Memory Load Commands. However, the OBDH will convert time-tag and Macro commands to MLCs, so that only SLCs and MLCs are ever received by PEACE.)

4.2.2 Internal Command Interfaces

Once a command has been received by the PEACE DPU, only one of 4 components of the DPU will be involved in executing the command as follows:

1. The DPU electronics hardware
   - To enable commanding when the processing system is not running, to allow reconfiguration of the processing hardware system.
2. The DPU level-2 loader program
   - To enable low level peeking and pokeing of memory locations.
3. The DPU executive
   - To enable commanding before an application program is loaded, to allow loading of different application programs (*e.g.* the main science processing program) and changes to be made to memory.
4. A DPU application program:
   - Initialisation phase
     - To enable the scientific set-up control of the instrument.
   - Run-time phase
     - To enable a limited amount of run-time modications to the system.

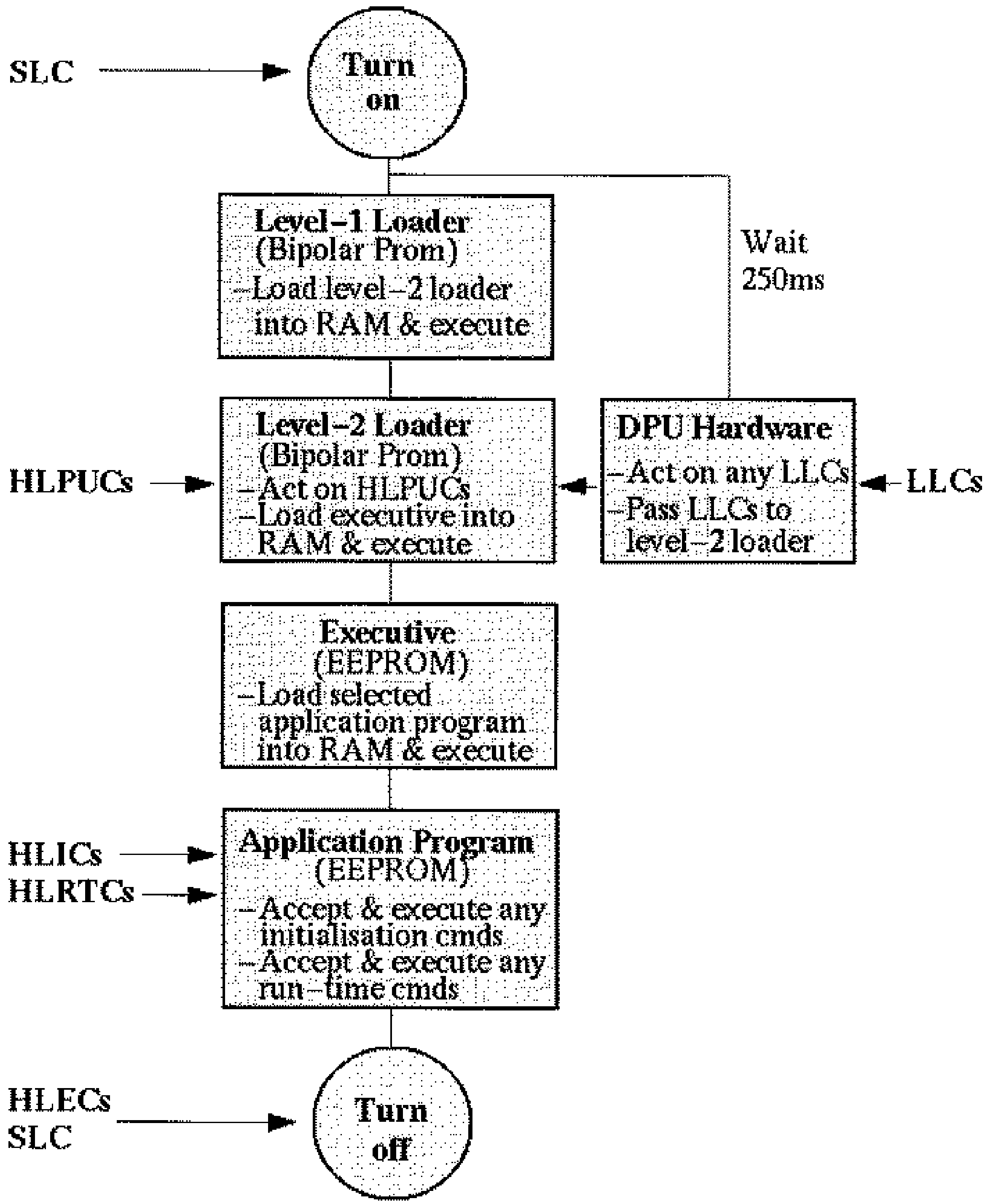

Figure 2: PEACE DPU Internal Commanding System Architecture

4.2.3 PEACE Commands

In order to enable commanding of the above components of the PEACE DPU, 'PEACE' commands will be constructed from one or more MLCs.

In order to differentiate between commanding to the electronic and processing components of the DPU system, 2 levels of commanding will be defined:

1. Low Level Commands (LLCs)
   - These will only be acted upon by the DPU electronics hardware.
2. High Level Commands (HLCs)
   - These will be acted upon by the processing components of the DPU electronics hardware.

4.2.4 Low Level Commands

1. Purpose
   The Low Level Commands will allow reconfiguration of the PEACE hardware system in the event of a hardware or processor malfunction.
2. Operation
   The Low Level Commands will be able to be performed from hardware turn-on until the high level command which initiates the execution of the executive program is received. Upon reception of that command the low level commanding will be disabled.

   The 'low level command enable' will be set to the default state of 'enabled' at turn-on.
3. Low Level Command Decoding
   The Low Level Commands will be decoded by the DPU electronics hardware.
4. Low Level Command Structure
   All Low Level Commands will consist of single MLCs.
5. Low Level Command Security
   In the event of a corrupted command, either by bit faults or loss of words, it is noted that no damage can occur to the PEACE instrument by execution of any low level command [5]. For such a case, the PEACE instrument would be set to an incorrect state until the problem could be detected in the h/k command echo on the ground, or the instrument turned off.

   If h/k data is being received in real-time, the time to correct such a problem could be very quick if detected by the ESA h/k monitoring system.

   If, however, the satellite is out of ground contact, then detection of the problem could not be possible until ground contact was established. This could be several hours.
6. Downlink Echo
   The last uplinked Low Level Command will be stored in memory so that it can be accessed by the DPU processing system, for later echo downlink in the h/k telemetry. This is designed to allow the Low Level Command status of the instrument to be known on the ground.

4.2.5 High Level Commands

1. High Level Commands will consist of single and multiple MLCs.

2. High Level Commands will be acted upon by the DPU interface processing (IP) system and therefore require the processing system to be operable.

3. The High Level Commands will be decoded by one of the following 3 programs:

   (a) the 'level-2 loader program'
   or (b) the 'executive program'
   or (c) an 'application program'

4. The 'level-2 loader program' is a low level program whose job is to load the 'executive program' into memory and run it.

   The 'level-2 loader program' will run on both the IP and SP boards which will both receive the 'level-2 loader program' commands, and act on them independently of each other.

5. The 'executive program' is a low level program whose job is to load an 'application program' into memory and run it.

   PEACE commands to this program are designed to allow loading of different 'application programs' or modification of EEPROM memory.

   The 'executive program' will run on both the IP and SP boards which will both receive commands, and act on them independently of each other.

6. An 'application program' is a main processing program which *e.g.* may perform the mainstream science and h/k data processing and interfacing tasks.

   PEACE commands to this program allows some normal hardware control, software operating control, and also some h/w and s/w control in the event of problems.

   The 'application program' commands will only be received by the IP board which will decode and route them to the SP board and LEEA and HEEA sensors as necessary.

7. In order to prevent accidental damage to the instrument by reception of corrupted, out of order, or accidently sent High Level Commands, a 'confirmer' HLC will be required immediatedly after reception of any sensitive operational HLC.

8. Onboard command verfication will be performed where possible before execution of high level commands, and commands which fail verification will not be executed.

9. Ground command verification will normally be performed by echoing commands received down the h/k telemetry.

   This will consist of the last LLC command and all the 'application program' commands.

   Earlier LLCs commands will not be echoed, and no 'level-2 loader commands' will be echoed.

4.2.6 Command Types

Although low and high level commands differentiate between whether the command will be acted upon by the electronics hardware or software, further differentiation is made by grouping the commands according to which component of the DPU they apply to as shown in Table 1.

This grouping is not detectable by any bit pattern in the command, but is used to help select appropriate commands according to the particular phase of instrument operations (*e.g.* turn-on, science observing).

Phase	Acronym	Command Type	Decoded by
1. Turn on/off	SLC	Spacecraft Level Commands	H/W
2. H/W config	LLC	Low Level Commands	H/W
3. Loader control	HLPUC	High Level Power-up Commands	Level-2 Loader Program
4. Prog loading	HLEXC	High Level Memory control	Executive Program
5. Initialisation	HLIC	High Level Initialisation Commands	Application Program
		HLECs - High Level Eng Commands	Application Program
		HLSCs - High Level Sci Commands	Application Program
6. Run-Time	HLRTC	High Level Run-Time Commands (HLECs)	Application Program

Table 1: PEACE Command Types

Notes:

1. Application program initialisation phase commands (HLICs) are composed of two types of commands, *i.e.* the High Level Engineering Commands (HLECs) and the High Level Science Commands (HLSCs).

2. Application program run-time phase commands (HLRTCs) consist of HLECs.

5 COMMAND SEQUENCING

5.1 TURN-ON SEQUENCE

5.1.1 Generic Turn-on Sequence

The general sequencing for the PEACE instrument turn-on, and at which times the particular types of commands may be sent, will be as follows:

1. POWER IS SWITCHED ON
   - From SLC.
   - LLCs are now possible to the hardware.
2. LEVEL-1 LOADER PROGRAM IS RUN FROM BIPOLAR ROM TO LOAD 'LEVEL-2 LOADER' PROGRAM INTO RAM
   - HLPUCs are now possible to the 'level-2 loader' program.
3. 'LEVEL-2 PROGRAM LOADER' IS NOW USED TO LOAD AND EXECUTE THE TRANSPUTER 'EXECUTIVE' PROGRAM
   - HLEXCs are now possible to the executive program.
4. THE EXECUTIVE PROGRAM WILL NOW LOAD AND EXECUTE A SELECTED APPLICATION PROGRAM (*e.g.* THE MAIN SCIENCE PROCESSING PROGRAM)
   - HLICs are now possible to the application program initialisation code.
   - HLRTCs are now possible to the application program run-time code.

Note: For ground testing only, there will be a LLC which can select 'load from link', in which case HLPUCs and HLEXCs may not be applicable.

More detailed explanation of each stage with reference to the commanding follows:

5.1.2 Switch-On Commanding

Reception of a SLC will cause 28V power to be applied to the PEACE instrument.

1. The Power converter will then start.
2. A DPU global power-up reset will occur.
3. The IP & SP boards will power up in the default low-level command (LLC) configuration.
   (Def = boot from Bipolar ROM [*i.e.* not from Link].)
4. The IP & SP boards each independently start execution of the level-1 program loader stored in their own bipolar ROM.
5. The level-1 program on each processor will load their own level-2 loader program from their own Bipolar ROM to their own RAM, and pass program execution to the level-2 loader programs now in RAM.

5.1.3 Low Level Commanding

The low level commands are interpreted by the DPU hardware, and can be used to configure the DPU hardware differently to the nominal configuration.

1. 250ms must elapse after switch-on before any LLCs should be sent to the instrument.

   (This is in order for the switch-on operations to complete, otherwise an unknown state for the instrument may result. It also allows sufficient time for the level-2 loader to be loaded and executed so that it is ready to process any LLCs as described by the next item.)

2. The level-2 loader will process all LLCs and store latest one for subsequent echo in h/k telemetry.

3. (It is advised that at least one LLC is sent to the instrument, even though a default state exists.)

5.1.4 High Level Power-Up Commanding

The HLPUCs are decoded by the level-2 loader program, and operate on the DPU memory system to allow coping with abnormal situations.

For normal operation an HLPUC is however still required which only causes loading of the nominal executive programs from EEPROM to RAM for both processors and execution of them.

For abnormal operations the HLPUCs allow peeking and pokeing of EEPROM memory.

The system is ready for HLPUCs at the same time as the LLCs.

5.1.5 High Level Executive Commanding

The HLEXCs are decoded by the executive program, and operate on the DPU memory system to allow for loading main code applications and coping with abnormal situations including software uplink and memory dumps.

1. The level-2 loader program will now process all memory editing HLPUCs until reception of a 'load' HLPUC which will then cause the selected application processing code to be loaded and execution to begin.

2. Upon reception of the HLPUC which causes application program execution, the low level commanding will be disabled.

   The LLC will not be re-enabled.

5.1.6 High Level Initialisation Commanding

The HLICs are decoded by the selected application 'main' program and have two purposes:

1. Hardware control
   e.g. Power turn-on/off to the sensors, IEL, etc.

2. Science processing control

Only HLICs supported by the particular main program loaded will be supported.

1. A time delay of 5.15 seconds must elapse before the main IP program is ready to receive HLICs, since just after beginning execution the program will go into a general initialisation phase before HLIC commanding is enabled.

2. Can now receive High Level Initialisation Commands (HLICs) and execute them.

   But note that the maximum amount of HLCs which can be stored by the DPU is limited to the command stack size of 100 commands. This means that if more than 100 commands are to be sent to the DPU, they should not be sent until the command stack is known to have sufficient space to store them. This can be determined by counting on the ground the number of commands echoed by the instrument, as these will all have been processed and therefore cleared from the command stack.

The rate of echoing commands by the DPU is limited to 14 command words every 5.15 seconds. The DPU will limit its command processing rate so that all commands get echoed. (Assuming turn-on commanding requires up to 28 command words then this processing can be completed in 10.3 seconds.)

3. The appropriate housekeeping processing and h/k telemetry downlink will now operate simultaneously to the ability to receive the HLICs.

   The last LLC which was stored at the end of the LLC commanding will now be echoed in the h/k telemetry.

4. The appropriate science processing and SCI telemetry downlink will also now operate simultaneously, but be filled with empty packets.

5. Initialisation commanding will cease upon receipt of the High Level 'begin execution' command.

6. The main program will now go through its 'science initialisation' phase, and begin its 'run-time science processing' phase.

7. The h/k and science telemetry downlink will begin to be filled with h/k and science data from the 'run-time science processing' tasks.

5.1.7 High Level Run-Time Commanding

Run-time commands will be a sub-set of the initialisation commands.

After reception of the 'begin execution' command, only run-time commands will be operable.

Change of science processing mode can now only be made by reseting the science processing.

5.1.8 Nominal Turn-on Sequence

The nominal turn on-sequence of the PEACE instrument shall be as follows:

1. SWITCH-ON
   This will switch on the 28V power to the PEACE instrument.

2. LOW LEVEL COMMANDING
   After waiting 250ms one LLC which confirms the default hardware configuration should be sent [5].

3. HIGH LEVEL POWER-UP COMMANDING
   A single HLPUC will then be sent requesting to boot the executive program.

4. HIGH LEVEL EXECUTIVE COMMANDING
   A single HLEXC will then be sent requesting to boot the normal science processing program.

5. HIGH LEVEL INITIALISATION COMMANDING
   After waiting 5.15s, the individual command words (< 80) will be sent, to set up the PEACE normal science processing configuration.

   The first of these will be to power on the LEEA and HEEA sensors.
   The next ones will be to specify the scientific operating mode.
   The last one of these will be the 'begin science execution' HLIC.

6. HIGH LEVEL RUN-TIME COMMANDING
   During run-time, only certain HLRTCs will be executed.

5.2 TURN-OFF SEQUENCE

When it is desired to turn-off the PEACE instrument (whether during run-time processing or at other times), it must be commanded to be shut down in a controlled manner.

The HLEC command for this has the following action:

1. Turn-off HEEA 36V power, wait 100 ms.
2. Turn-off LEEA 36V power, wait 100 ms.
3. Turn-off HEEA ±8V power, wait 100 ms.
4. Turn-off LEEA ±8V power, wait 100 ms.
5. Tri-state LEEA HEEA service signals.
6. Turn-off LEEA and HEEA 5V power, wait 100 ms.
7. Turn-off PEACE (28V) power using a Spacecraft Level Command.

6 COMMAND STRUCTURE

6.1 General Command Structure

A common structure will be applied to all the PEACE commands so that there is a unique bit pattern for each PEACE command even if it is decoded by different programs or hardware.

The general form of this structure will be as shown by Figure 3.

This shows that the PEACE commands are constructed from one or more 16-bit Memory Load Commands, headed by a control word and followed by a number of argument words.

The number of argument words expected is determined by the command function which is given in the control word.

For single word commands there will be no argument words.

The control word contains control and data information, and the argument words contain additional data for those cases where a single word command is insufficient.

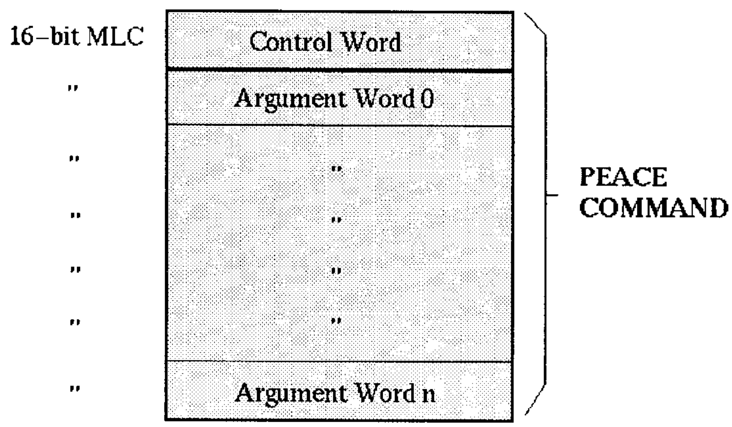

Figure 3: PEACE Memory Load Command Structure

The detailed format of the command control word is shown in Table 2.

This shows that the control word is divided into 2 parts, the control byte and the control argument, whose purpose is shown below:

1. The Control Byte
   This determines the command level, destination, sensor, and function.

2. The Control Argument
   This contains either data or additional control information according to the particular function selected.

	Control byte		Control argument	
Command Control Word:	l d s f4	f3 f2 f1 f0	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Name	Meaning
15	l	Level	0 = High level command 1 = Low level command
14	d	Destination	0 = SMU 1 = DPU
13	s	Sensor id	0 = LEEA 1 = HEEA
12-8	f's	Function	(used for function id)
7-0	a's	Control Argument	(Depends upon Function code)

Table 2: PEACE Command Control Word Format

6.2 Low Level Command Structure

All low level commands will be single word commands.

These commands will be recognised by the DPU hardware electronics by identification of bit 15 in the control byte as one.

No further control byte bits are used.

The control argument bits are used to specify all 8 Low Level Command function bits.

(See section 7.1 'LOW LEVEL COMMANDS' for the details of each function.)

6.3 High Level Command Structure

These are composed of both single word and multi-word commands.

These commands will be recognised by the DPU hardware electronics by identification of bit 15 in the control byte as zero.

These are commands which are acted on by the DPU processing system.

The format of these High Level Commands is shown below, according to whether the destination code is set to either an SMU or the DPU.

1. High Level SMU Commands
   These are commands which will be routed through to the particular LEEA or HEEA SMU according to the sensor-id bit, and are all single word commands.

   They may only be sent to the 'main program' and are only applicable for High Level Initialisation and High Level Run-time Commanding.

   (See 'SMU commands' (subsection 7.5.1) within the 'High Level Initialisation Commands' section for detailed formatting for these commands.)

2. High Level DPU Commands

These are commands which will not be communicated to the sensors, and these may be single or multi-word commands.

These include commands which may be sent to the level-2 loader, executive or 'main' application program.

The format for the DPU High Level Commands is shown in Table 3.

A list of the DPU function codes and their meanings is given in Table 4.

A detailed explanation of the command format for each function and their associated control argument bits, and argument words is given in the sections on the High Level Commands following (7.2 to 7.6).

	Control byte		Control argument	
DPU Control Word:	0 1 s f4	f3 f2 f1 f0	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	s	Sensor id, can be either to LEEA or HEEA
12-8	f's	Function code bits
7-0	a's	DPU argument bits (Meaning depends upon function)

Table 3: DPU Command Format

Function code		Number words in cmd	Cmd Type	Command Function
Dec	Binary			
0	00 000	1	HLSC	Initialise Keep Alive Memory
1	00 001	1	HLPUC	Poke data byte
2	00 010	1	HLSC	Correlator dataset control
3	00 011	2	HLSC	Select Datasets to be telemetered (LER/3DF/3DR/LEF)
4	00 100	1	HLSC	Select Magnetic field Source (use PEACE/FGM)
5	00 101	1	HLSC	Spacecraft Potential Calculation Control
6	00 110	1	HLSC	OBDH Telemetry Mode
7	00 111	1	HLSC	Start processing
8	01 000	1	HLSC	Sensors closedown
9	01 001	1	HLPUC	Load Peek/Poke address LS byte
10	01 010	1	HLPUC	Load Peek/Poke address MS byte
11	01 011	1	HLEC	Sensor Power & Service Signals Control
12	01 100	1	HLEC	DPU Hardware Control
13	01 101	1	HLPUC	Execute Executive
14	01 110	1	HLEC	Engineering Mode Select
15	01 111	1	HLEC	Security Confirmer Command
16	10 000	1	HLPUC	Peek data byte
17	10 001	1	HLEXC	Perform memory dump
18	10 010	1	HLEXC	Run main code application
19	10 011	2	HLEXC	Update directory
20	10 100	2	HLEC	Change Monitor Control Parameters
21	10 101	2	HLEC	Set Sun-pulse Re-phase
22	10 110	2	HLSC	Uplink parameter
23	10 111	2	HLSC	Uplink Dead Time Correction Factor
24	11 000	3	HLSC	Uplink Reduced Polar Geometric Factor
25	11 001	3	HLSC	Uplink Basic Energy Step Table Value
26	11 010	3	HLSC	Uplink Energy Efficiency Factor
27	11 011	3	HLSC	Uplink FGM Calibration Value
28	11 100	3		
29	11 101	3		
30	11 110	n	HLSC	Uplink/launch macro command
31	11 111	n	HLEXC	Uplink Software

Table 4: DPU High Level Commands Summary

7 COMMANDS

The following describes all the possible ML commands to the PEACE instrument.

7.1 LOW LEVEL COMMANDS

7.1.1 Unique Command (8 functions)

These are generally hardware control functions which relate to configuring the DPU system, and are expected only to be performed at hardware turn-on.

Low level commanding will be enabled at 'turn-on' and disabled after the HLPUC which requests execution of the selected application program.

There is only one low level command, which is a single word command, and its format is shown in Table 5. However, this single command supports 8 functions as shown in Table 6 [5].

	Control byte		Control argument	
LLC Command:	1 x x x	x x x x	L7 L6 L5 L4	L3 L2 L1 L0

Bits	Value	Meaning
15	1	Low Level Command
14-8	x	Not used
7-0	L7-L0	LLC function bits

Table 5: Low Level Command Format

NAME	BIT	FUNCTION	DEFAULT
B_CON	L0	EEPROM hardware write inhibit. 0 = enabled. 1 = inhibit.	1
SPARE	L1	SPARE	0
BFL	L2	Boot from link 0 = boot from ROM. 1 = boot from Link.	0
CCON_IP	L3	Select IP board boot prom. 0 = select EEPROM. 1 = select Bipolar.	0
CCON_SP	L4	Select SP board boot prom. 0 = select EEPROM. 1 = select Bipolar.	0
IOCON	L5	I/O Bus 0 = IP board controls I/O bus. 1 = SP board controls I/O bus.	0
LSEL	L6	Link select 0 = SP board drives sensors link. 1 = IP board drives sensors link.	0
RESET	L7	Processor board reset A reset reboots both IP and SP boards. 2 commands must be sent in the following order to perform a reset. 1 = enable reset circuit. 0 = disable reset circuit	0

Table 6: PEACE Low Level Commands.

7.2 HIGH LEVEL POWER-UP COMMANDS

The High Level Power-Up Commands (HLPUC), are decoded by the level-2 program loader.

These are all single word commands, designed to allow different system boot options, and modifications to the EEPROM memory areas.

For normal operations, a single HLPUC would be sent which requests booting the executive program.

These HLPUC's will not be echoed in the h/k telemetry.

7.2.1 Load Peek/Poke Address LS Byte Command

This is a single word command which specifies the LS physical address of the peek/poke register [10].

The format for this HLPUC is shown in Table 7.

	Control byte		Control argument	
HLPUC cmd:	0 1 0 0	1 0 0 1	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	01001	Function = Load peek/poke LS byte
7-0	a7-a0	LS address of byte to be peeked/poked (def=0).

Table 7: HLPUC - Load Peek/Poke Adress Least Significant Byte Command.

7.2.2 Load Peek/Poke Address MS Byte Command

This is a single word command which specifies the MS physical address of the peek/poke register [10].

The format for this HLPUC is shown in Table 8.

	Control byte		Control argument	
HLPUC cmd:	0 1 0 0	1 0 1 0	a15 a14 a13 a12	a11 a10 a9 a8

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	01010	Function = Load peek/poke MS byte
7-0	a15-a8	MS address of byte to be peeked/poked (def=0).

Table 8: HLPUC - Load Peek/Poke Address Most Significant Byte Command.

7.2.3 Poke Data Byte Command

This is a single word command which loads a given data byte into the memory location given by the current peek/poke address register [10].

The format for this HLPUC is shown in Table 9.

	Control byte		Control argument	
HLPUC cmd:	0 1 0 0	0 0 0 1	d7 d6 d5 d4	d3 d2 d1 d0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	00001	Function = Poke data byte.
7-0	d7-d0	Data byte to be poked into address given by current poke address register.

Table 9: HLPUC - Poke Data Byte Command.

7.2.4 Peek Byte Command

This is a single word command which peeks the data byte at the memory location set by the current peek/poke address register. The data byte is downlinked in the 2nd byte of the housekeeping.

The format for this HLPUC is shown in Table 10.

	Control byte		Control argument	
HLPUC cmd:	0 1 0 1	0 0 0 0	x x x x	x x x x

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	10000	Function = Peek data byte.
7-0	x's	Not used

Table 10: HLPUC - Peek Data Byte Command.

7.2.5 Execute Executive Command

This is a single word command which causes the executive to be checksummed and if no error occurs loaded from EEPROM into RAM and executed, or executed directly from RAM. [10].

The format for this HLPUC is shown in Table 11.

	Control byte		Control argument	
HLPUC cmd:	0 1 0 0	1 1 0 1	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	01101	Function = Execute Executive
7-0	a7-a0	Source of executive, = 0 Boot from RAM = n Boot from EEPROM page 1.

Table 11: HLPUC - Execute Executive Command.

7.3 EXECUTIVE LEVEL COMMANDS

The Executive Commands (HLEXC), are decoded by the executive program that is run after the level-2 program loader but before a main application program.

7.3.1 Perform memory dump

This is a single word command which instructs the executive code to dump the contains of the lower memory page and selected upper memory page to the science telemetry stream.

The format for this HLEXC is shown in Table 12.

	Control byte		Control argument	
HLEXC cmd:	0 1 0 1	0 0 0 1	p7 p6 p5 p4	p3 p2 p1 p0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	10001	Function = Perform memory dump
7-0	p7-p0	Upper memory page selection
		= 1 Select EEPROM page 1.
		= 2 Select EEPROM page 2.
		= n Select RAM page 2.

Table 12: HLEXC - Memory dump Command.

7.3.2 Run application Command

This is a single word command which causes the executive to checksum the directory stored in the specified page of memory and if no error occurs load the directory into the lower page of RAM. The information contained in the directory is then used to checksum and if no errors occur load into the lower page of RAM code modules that make up an applications program [10].

The format for this HLEXC is shown in Table 13.

7.3.3 Update directory Command

This is a two word command which allows the IP directory to be updated.

The format for this command is shown in Table 14.

	Control byte		Control argument	
HLEXC cmd:	0 1 0 1	0 0 1 0	s3 s2 s1 s0	i3 i2 i1 i0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	0	(Not used)
12-8	10010	Function = Run application.
7-0		Application source
	i1-i0	= 0 Use directory in lower IP RAM page.
		= 1 Use directory in IP EEPROM page 1.
		= 2 Use directory in IP EEPROM page 2.
		= 3 Use directory in IP RAM page 2.
	i2-i0	= 0 Checksum and run code currently in IP RAM.
		= n Use IP directory information to load code.
	i3	= Not used.
	s1-s0	= 0 Use directory in lower SP RAM page.
		= 1 Use directory in SP EEPROM page 1.
		= 2 Use directory in SP EEPROM page 2.
		= 3 Use directory in SP RAM page 2.
	s2-s0	= 0 Checksum and run code currently in SP RAM.
		= n Use SP directory information to load code.
	s3	= 0 Checksum and run SP executive from RAM.
		= n Checksum and run SP executive from EEPROM page 1.

Table 13: HLEXC - Run application Command.

	Control byte		Control argument	
Ctrl Word:	0 1 0 1	0 0 1 1	i7 i6 i5 i4	i3 i2 i1 i0
Arg Word:	a15 a14 a13 a12	a11 a10 a9 a8	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	10011	Function = Update directory.
7-0	i7-i0	Index in directory, 0 to 109.
		ARGUMENT WORD
15-0	a's	Value to be inserted at position index.

Table 14: Directory Update Command

7.3.4 Uplink software command

This is a multi word command which allows software patching to be performed on the processor that is controling the telemetry interface.

The format for this command is shown in Table 15.

	Control byte		Control argument	
Ctrl Word:	0 1 0 1	1 1 1 1	p7 p6 p5 p4	p3 p2 p1 p0
Arg Word 0:	a15 a14 a13 a12	a11 a10 a9 a8	a7 a6 a5 a4	a3 a2 a1 a0
Arg Word 1:	n15 n14 n13 n12	n11 n10 n9 n8	n7 n6 n5 n4	n3 n2 n1 n0
Arg Word 2:	d15 d14 d13 d12	d11 d10 d9 d8	d7 d6 d5 d4	d3 d2 d1 d0
Arg Word n:	d15 d14 d13 d12	d11 d10 d9 d8	d7 d6 d5 d4	d3 d2 d1 d0
Arg Word n+1:	c15 c14 c13 c12	c11 c10 c9 c8	c7 c6 c5 c4	c3 c2 c1 c0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	11111	Function = Uplink software
7-0	p7-p0	Destination page for patch. = 1 Select EEPROM page 1. = 2 Select EEPROM page 2. = n Select RAM page 2.
		ARGUMENT WORD 0
15-0	a's	Start address of code patch
		ARGUMENT WORD 1
15-0	n's	Number of 16 bit words in patch, 1 to 256.
		ARGUMENT WORD 2
15-0	d's	First code patch word.
		ARGUMENT WORD n
15-0	d's	Last code patch word. Note: n less than 256.
		ARGUMENT WORD n+1
15-0	c's	Checksum from control word to argument word n.

Table 15: Uplink Software Command

7.4 HIGH LEVEL ENGINEERING COMMANDS

These are commands which will be decoded by the main DPU application program, and are echoed in the h/k telemetry.

These are high level, 1 or 2 word commands.

They may be sent at any time, either at the initialisation or run-time phases.

7.4.1 Sun-Pulse Re-phase

This is a two word command which allows the phasing of the sun-pulse to be changed.

This determines the time phasing of the high voltage energy sweeps and the direction that the PEACE sensors are looking at the start of each spin.

The format for this command is shown in Table 16.

		Control byte	Control argument	
Ctrl Word:	0 1 x 1	0 1 0 1	x x x x	x x x x
Arg Word:	u x a13 a12	a11 a10 a9 a8	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	10101	Function = Change Sun-pulse Phasing
7-0	x's	Not used
		ARGUMENT WORD
15	u	1 = auto sunpulse generated after 16382 SSCP. 0 = use spacecraft sunpulse (def).
14	x's	Not used
13-0	a's	Sun-pulse phase (integer) (units of 2*SSCP) Commanded phase will be taken as a +ve phase offset (ie later) than s/c supplied sun-pulse. Range: [2-16382] (even numbers only: Odd numbers are invalid - if received, will be truncated to number minus 1) Value = 0 is invalid (if received will be ignored)

Table 16: Sun-pulse Re-phase Command

WARNING: Sending this command whilst the science processing is running could easily cause a short spin to result. This would mean that telemetered science moments parameters from that spin would be incorrect, and also other count values would need to be corrected for the shorter observation time. Also, the science processing would probably have to resynchronise to the new spin phase.

7.4.2 Sensor Power & Service Signals Control

This is a single word command which controls power on/off switching to the sensors and service signals tri-state.

It is required in order to arrange for a controlled power off situation for the sensors.

The format for this command is shown in Table 17.

	Control byte		Control argument	
Ctrl Word:	0 1 s 0	1 0 1 1	x x x x	x m n p

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	s	Sensor id. (0=LEEA, 1=HEEA)
12-8	01011	Function = Sensor Power Control
7-3	x's	Not used
2	m	Sensor output or fail (1=off, 0=on [def])
1	n	Low voltage & sevice signals, (0=off [def], 1=on) Low voltage = 5V & ±8V, Rephase sun-pulse & spin segment clock
0	p	36V, (0=off [def], 1=on)

Table 17: Sensor Power Control Command

<u>WARNINGS:</u>

1. If the 36V on option is set in this command, then the 'security confirmer command' must be sent as the very next command, in order to confirm that this operation is really meant.

   This is in order to prevent accidental 36V switch on to the sensors.

   Note that this 36V on command AND the security command SHOULD NOT be placed together as part of command macro in a command control file, as this would make it more likely that the 36V on command could be sent accidently.

2. This command, which turns the sensors on, should be sent BEFORE any of the sensor SMU control commands, otherwise the SMU's will not be on to receive and interpret them.

3. Turning a sensor off whilst science processing is underway would cause the science processing to deadlock.

   This is not important if this command is used as part of the normal instrument turn-off procedure.

   However, it will not work for modifying the processing to cope with just a single sensor, because of the resulting deadlock. In that case the instrument would have to be completely turned off and a careful restart sequence sent.

NOTES:

1. The low voltage and service turn-on sequence will be as follows:
   a) 5V on, followed by 100ms wait,
   b) ±8V on, followed by 100ms wait,
   c) Enable service signals.

2. The nominal turn-off sequence should be carried out using the 'sensors closedown' command. However, for testing or abnormal operations, the current command may be used, and will cause the following turn-off sequence:
   a) ±8V off, followed by 100ms wait,
   b) Disable service signals,
   c) 5V off, followed by 100ms wait.

7.4.3 Change Monitor Control Parameters

This is a two word command which allows changes to be made of onboard control monitoring of the h/k parameters [5].

The onboard monitoring of the h/k parameters looks for out of limit conditions, and in the event of an out of limit occurring both LEEA and HEEA sensor power is turned off and the service signal interfaces tri-stated [5]. This command allows changes to the limit conditions applied, in order to respond to possible onboard changes in the hardware.

The format for this command is shown in Table 18.

	Control byte		Control argument	
Ctrl Word:	0 1 x 1	0 1 0 0	e x p c4	c3 c2 c1 c0
Arg Word:	u7 u6 u5 u4	u3 u2 u1 u0	l7 l6 l5 l4	l3 l2 l1 l0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	10100	Function = Change Monitor Control Parameters
7	e	1 = enable channel.
		0 = disable channel (default).
6	x's	Not used
5	p	1 = update monitor limits.
		0 = do not update monitor limits.
4-0	c's	Id of h/k channel to be changed. [0-31]
		ARGUMENT WORD
15-8	u's	New Upper Limit, updated if p = 1.
7-0	l's	New lower Limit, updated if p = 1.

Table 18: Change Monitor Control Parameters Command

NOTE:A list of the h/k channels is given in Appendix B.

7.4.4 DPU Hardware Control

This is a single word command which allows control of the watchdog, IEL, and the telemetry interface. The format for this command is shown in Table 19.

	Control byte		Control argument	
Ctrl Word:	0 1 x 0	1 1 0 0	i3 i2 i1 i0	x w a s

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	01100	Function = DPU Hardware Control
		(1) IEL Link Events Control
7	i3	FGM 0=disabled (def), 1 = enabled
6	i2	DWP 0=disabled (def), 1 = enabled
5	i1	EDI 0=disabled (def), 1 = enabled
4	i0	ASP 1=disabled (def), 0 = enabled
3	x	not used
		(1) Watchdog Control
2	w	0 = disabled, 1 = enabled (def)
		(2) Spacecraft Telemetry Interface Control
1	a	Auto 'prime/redundant interface' select 0 = disabled, 1 = enabled (def)
0	s	Manual select (if auto select disabled) 0 = prime (def), 1 = redundant

Table 19: DPU Hardware Control Command

7.4.5 Engineering Mode Select

This is a single word command which allows selection of a particular h/k channel for engineering mode output [5].

The format for this command is shown in Table 20.

	Control byte		Control argument	
Ctrl Word:	0 1 x 0	1 1 1 0	x x e c4	c3 c2 c1 c0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	01110	Function = Engineering Mode Select
7-6	x's	Not used
5	e	1 = channel enabled, 0 = disabled (def)
4-0	c's	Id of Channel

Table 20: Engineering Mode Select Command

A list of the h/k channels is given in appendix B.

7.4.6 Security Confirmer Command

This is a single word SECURITY command which MUST immediately follow the following sensitive commands:

1. The +36V switch on in the HLEC 'Sensor Power and Service Signals' command.

   This is to help prevent accidental switch-on of high voltages within the sensors, by essentially CONFIRMING that a high voltage on command was really meant.

   That is, that the high voltage on command was not sent accidently or a result of a command corruption (*e.g.* loss of a command word, *e.g.* causing the argument of a multi-word command to be misinterpreted as a high voltage turn on command).

2. Sensor MCP levels greater than 24.

   This is to help prevent accidentally setting the sensor MCP high voltages to a level that could cause degradation of the MCP life time.

The format for this command is shown in Table 21.

	Control byte		Control argument	
Ctrl Word:	0 1 x 0	1 1 1 1	0 1 0 1	0 1 0 1

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used (set to 0)
12-8	01111	Function = Security Confirmer Command
7-0	#55	Security code

Table 21: Security Confirmer Command

<u>WARNING:</u> This security command SHOULD NOT be placed in a control file command macro, since that would make accidental sending of the above sensitive commands too likely.

7.5 HIGH LEVEL SCIENCE COMMANDS

These are science commands which are acted on by the DPU main processing application program. They will be echoed in the h/k telemetry for verification of the commands.

They are composed of both single word and multi-word commands.

The format of all the High Level Science Commands will be as follows:

7.5.1 SMU Commands

These are all single word commands.

They will be sent to either the LEEA or HEEA SMU according to the sensor id bit.

The format for the command is as shown below in Table 22.

	Control byte		Control argument	
SMU Command:	0 0 s x	x x x x	a2 a1 a0 c4	c3 c2 c1 c0

Bits	Value	Meaning
15	0	High level command
14	0	Destination is to SMU
13	s	Sensor id, can be either to 0 = LEEA or 1 = HEEA
12-8	x	Not used
7-5	a's	SMU command address
4-0	c's	SMU command function bits

Table 22: SMU Command Format

The meaning of the 3 SMU address bits and 5 function bits is shown in Table 23. This information is taken from the SMU design requirements document [6].

IMPORTANT NOTE No sweep preset greater than level 64, is allowed for the non-sweeping mode (mode=0). This has 2 consequences:

1. If attempt to command preset>64 whilst in non-sweeping mode, the sweep preset will be set to 64.
2. If attempt to command non-sweeping mode whilst preset>64, the preset sweep preset will be set to 64.

The default turn-on state is non-sweeping mode, preset=0. Therefore, to command to a sweeping mode it is IMPORTANT to change sweep mode BEFORE changing the preset.

If an attempt to command the MCP preset>24 is made the confirmer command should be the next command sent.

Note on Table 23: the sweep modes (CMD address 3) correspond to:

control number 0 = Mode 0 = no sweep
control number 1 = Mode 1 = LAR = long sweep
control number 2 = Mode 3 = HAR = short sweep
control number 3 = Mode 2 = MAR = medium sweep

CMD addr (a2-a0)	CMD bits (c4-c0)	Command	Default state at power up	Destination
0	c3-c0	Coincidence channel control	15	SMU
		0 - 11 = Select channel 0-11		
		12 - 15 = Disabled		
	c4	Grid voltage control		SMU
1	c3-c0	Correlator channel control	15	SMU HEEA
		0 - 11 = Select channel 0-11		
		12 - 15 = Disabled		
2	c4-c0	MCP high voltage control (5 bit)	0	Sensor
3	c3-c2	Sweep mode control	0	SMU
		0 = no sweep		
		1 = long sweep		
		2 = short sweep		
		3 = medium sweep		
	c1-c0	Sweep preset control (2 lsb)	0	SMU
4	c4-c0	Sweep preset control (5 msb)	0	SMU
5	c2-c0	Monitor channel select control	0	SMU
6	c0	MCP HV on/off control	0	Sensor
		cmd = 0 = off		
		cmd = 1 = on		
	c1	Sweep HV on/off control	0	Sensor
		cmd = 0 = off		
		cmd = 1 = on		
7	c0	Stim generator enable/disable	0	SMU
		0 = Disable		
		1 = Enable		
	c1	Stim generator amplitude	0	SMU
		0 = Variable		
		1 = Constant high		

Table 23: SMU Control Argument Functions

7.5.2 Initialise Keep Alive Memory

This is a single word command which will initialise the keep alive memory.

Initialisation of the keep-alive RAM memory sets it to a state which indicates that no values have been uplinked (*e.g.* dead-time factors, energy step values, software version, calibration index, etc.) After this command has been sent the DPU will then use the default values which are stored in ROM.

This is necessary just after first turn-on, since at that time the RAM keep-alive memory will not be set to any known values.

This command may sent subsequently also if one wishes to eradicate all previously uplinked values which are stored in keep-alive memory.

The format for this command is shown in Table 24.

	Control byte		Control argument	
Keep-Alive Init Cmd:	0 1 x 0	0 0 0 0	x x x x	x x x x

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00000	Function = Initialise Keep Alive Memory
7-0	x's	Not used

Table 24: Keep Alive Memory Initialisation

7.5.3 Correlator Control

This is a single word command which controls how the correlator zone is calculated.

The format for this command is shown in Table 25.

	Control byte		Control argument	
Correlator Dataset Control Cmd:	0 1 x 0	0 0 1 0	x x x x	f c s1 s0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00010	Function = Correlator Dataset Control
7-4	x's	Not used
3	f	1 = swap LEEA and HEEA magnetic field coarse zones after half a spin
		0 = do not swap coarse zones
2	c	Correlator control
		0 = set correlator zone to selected polar zone (def)
		1 = do not set correlator zone to selected polar zone.
1-0	s's	Correlator Dataset control modes:
		00 = Use magnetic field direction. (See 'Select Magnetic Field Source' command)
		01 = Use polar zone uplinked from ground. (See 'SMU' commands)
		10 = Increment polar coarse zone once per spin.

Table 25: Correlator Control

7.5.4 Select Datasets to be Telemetered

This is a two word command which selects which distributions will be included in the priority list for telemetry transmission.

It can also be used to change the priority of a particular distribution.

The format for this command is shown in Table 26.

	Control byte		Control argument	
Control word:	0 1 x 0	0 0 1 1	f x x x	x x x l
Argument word:	p c14 c13 c12	c11 c10 c9 c8	c7 c6 c5 c4	c3 c2 c1 c0

Bits	Value	Meaning
Control Word		
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00011	Function = Select datasets to be telemetered
7	f	f=0 - Insert FGM data in core
		f=1 - Insert EDI data in core
6-1	x	Not used
0	l	l=0 - used LEEA data in the LER dist
		l=1 - used HEEA data in the LER dist
Argument Word		
15	p	**1 - change priority**
14-8	c14-c8	Not used
7-4	c7-c4	Dataset priority, where:
		0 = COR
		1 = TCOR
		2 = PAD
		3 = NOI
		4 = LER
		5 = 3DF
		6 = 3DR
		7 = 3DX1
		8 = 3DX2
		9 = init packets
3-0	c3-c0	New priority level 0-15
15	p	**0 - dataset switching**
14	c14	SPAD 3DX2 switch mode: 1=on, 0=off
13-12	c13-c12	3DR mode:
		0 = LEEA and HEEA 3DR
		1 = LEEA only 3DR
		2 = HEEA only 3DR
11	c11	3DX2 SPAD: 1=on, 0=off
10	c10	3DX1 SPAD: 1=on, 0=off
9	c9	init packets sent: 1=yes, 0=no
8	c8	3DX2 sent: 1=yes, 0=no
7	c7	3DX1 sent: 1=yes, 0=no
6	c6	3DR sent: 1=yes, 0=no
5	c5	3DF sent: 1=yes, 0=no
4	c4	LER sent: 1=yes, 0=no
3-2	c3-c2	1 = PAD sent
		2 = NOI sent
		0 = neither sent
1-0	c1-c0	1 = COR sent
		2 = TCOR sent

Table 26: Select Datasets to be telemetered

7.5.5 Select Source of Magnetic Field

This is a single word command which controls whether the onboard software will take the magnetic field direction from the PEACE computed value or from FGM.

This will affect the data collected for the PAD distribution, and may also affect the polar zone from which the correlator data are selected.

The format for this command is shown in Table 27.

	Control byte		Control argument	
Control Word:	0 1 x 0	0 1 0 0	x x x x	x c2 c1 c0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00100	Function = Select Source of Magnetic Field.
7-1	x's	Not used
0	c2-c0	Data to be used to determine magnetic field direction 000 = Use FGM data (def). 1 - 7 = Use PEACE data 001 = Top region. 010 = Bottom region. 011 = LEEA overlap 1 + LEEA overlap 2. 100 = HEEA overlap 1 + HEEA overlap 2. 101 = LEEA overlap 1 + HEEA overlap 1. 110 = LEEA overlap 2 + HEEA overlap 2. 111 = spare.

Table 27: Select Source of Magnetic Field

7.5.6 Spacecraft Potential Calculation Control

This is a single word command which will determine whether LEEA or HEEA data are to be used for the determination of the spacecraft potential, or whether it is to be set to a constant value, or not computed at all.

The format for this command is shown in Table 28.

	Control byte		Control argument	
Control Word:	0 1 x 0	0 1 0 1	x x x x	x s2 s1 s0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00101	Function = Spacecraft Potential Calculation Control
7-3	x's	Not used
2-0	s1-s0	=000 Use LEEA data
		=001 Use HEEA data
		=010 Set to constant value
		=011 Generate IEL test spacecraft potential data pattern
		= n No calculation performed [def]

Table 28: Spacecraft Potential Calculation Control

NOTES:

1. The default constant value is 5 for the 'set to constant value' command.

   The uplink of the constant value is an option in the 'uplink parameter' commmand.

2. The 'no calculation performed' command will cause zero value for the spacecraft potential to be downlinked.

   Also, for this case, no value of spacecraft potential will be transmitted to ASPOC.

3. The generation of IEL test spacecraft potential values is to be used to test the PEACE-ASPOC IEL, and is defined as follows.

   The telemetered spacecraft potential value is incremented from 0 to 255 by one every spin. When the value is 255, it then is reset to 0 at the next spin, and the sequence continues as before.

7.5.7 OBDH Telemetry Mode

This is a single word command which should not be issued by PEACE users, but only from the spacecraft OBDH system.

The purpose of this command is for the spacecraft to let PEACE know which telemetry mode it is operating in.

The format for this command is shown in Table 29.

	Control byte		Control argument	
Cntrl Word:	0 1 x 0	0 1 1 0	x x x x	t t t t

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00110	Function = OBDH Telemetry Mode.
7-4	x's	Not used
3-0	t's	Spacecraft Telemetry Mode. 000 = normal mode 1 (Is assumed default mode) 001 = normal mode 2 010 = normal mode 3 011 = normal mode 4 100 = burst mode 1 101 = burst mode 2 110 = burst mode 3 111 = burst mode 4

Table 29: OBDH Telemetry Mode Command

7.5.8 Start Processing

This is a single word command which will cause the DPU to exit its initialisation command state and to start science processing.

The nature of the processing performed will be according to total current commanded state of the PEACE instrument.

The format for this command is shown in Table 30.

	Control byte		Control argument	
Start Processing Cmd:	0 1 x 0	0 1 1 1	p7 p6 p5 p4	p3 p2 p1 p0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	00111	Function = Start Processing.

7-0	p's	Science processing setup.
		1 = Process LEEA sensor data only.
		2 = Process HEEA sensor data only.
		#FF = Reset science processing.
		n = Process both sensors data.

Table 30: Start Processing Command

7.5.9 Sensors Closedown

This is a single word command which will cause PEACE to close down both sensors operations, including power-down, in a controlled fashion.

The format for this command is shown in Table 31.

	Control byte		Control argument	
Cntrl Word:	0 1 x 0	1 0 0 0	c7 c6 c5 c4	c3 c2 c1 c0

Bits	Value	Meaning
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	01000	Function = Sensors Closedown.
7-0	c's	Reset control. #A5 = Enable low level commands and reset DPU. #00 = Do not reset DPU.

Table 31: Sensors Closedown Command

NOTES:

1. The sequencing of the closedown will be as follows:
   3. Turn-off HEEA 36V, wait 100ms,
   4. Turn-off LEEA 36V, wait 100ms,
   5. Turn-off HEEA ±8V, wait 100ms,
   6. Turn-off LEEA ±8V, wait 100ms,
   7. Disable HEEA and LEEA service signals,
   8. Turn-off HEEA and LEEA 5V.
2. Note that after this command the DPU will still be powered on.

7.5.10 Uplink Dead-Time Correction Factor

This is a two word command which will allow uplink of a dead-time correction factor (dtf) τ_d.

An explanation of the onboard dead-time correction process and the dead-time factors is given in reference [7].

The format for this command is shown in Table 32.

	Control byte		Control argument	
Uplink dtf Ctrl Word:	0 1 x 1	0 1 1 1	x x x a4	a3 a2 a1 a0
Uplink dtf Arg Word:	tf te td tc	tb ta t9 t8	t7 t6 t5 t4	t3 t2 t1 t0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	not used
12-8	10111	Function = Uplink Dead-Time Correction Factor
7-5	x's	Not used
4-0	a's	Anode-id [0-31] [0-11] = LEEA coarse zones [12-15] = LEEA fine zones (not used for Cluster II) [16-27] = HEEA coarse zones [28-31] = HEEA fine zones (not used for Cluster II)
		ARGUMENT WORD
15-0	t's	Dead-time factor τ_d (in units of 0.1μsecs)

Table 32: Uplink Dead-Time Correction Factor Command

Notes:

1. Example:
   To uplink a value of $\tau_d = 2.0e-6$ secs, the argument word must be set to the integer value of 20.
2. Validation:
   Onboard validation of the input τ_d value is made.

   If $\tau_d < 2$ then τ_d is set = 2.

   (*i.e.* the minimum value of τ_d is 0.2μs.)

7.5.11 Uplink Parameter

This is a two word command which will allow uplink of a specified parameter.

The format for this command is shown in Table 33.

	Control byte		Control argument	
Uplink Parameter Ctrl Word:	0 1 s 1	0 1 1 0	x x x x	c3 c2 c1 c0
Uplink Parameter Arg Word:	a15 a14 a13 a12	a11 a10 a9 a8	a7 a6 a5 a4	a3 a2 a1 a0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	s	0=LEEA, 1=HEEA
12-8	10110	Function = Uplink Parameter
7-4	x's	Not used
3-0	c's	Sub-Function:
		0000 = not used
		0001 = SPOT variance
		0010 = SCP Start azimuth angle [0-360] (integer degs)
		0011 = SCP Start Polar zone [0-8].
		0100 = FGM Azimuth angle offset [0-360] (integer degs)
		0101 = FGM Polar angle offset [0-180] (integer degs)
		0110 = Calibration id
		0111 = SPOT constant value
		1000 = 3DX setup parameters
		1001 = SP KAL array checksum
		1010 = IP KAL array 1 checksum
		1011 = IP KAL array 2 checksum
		1100 = not used
		1101 = not used
		1110 = Command block checksum
		1111 = 3DX window limits (start a15-a8, end a7-a0)
		ARGUMENT WORD
15-0	a's	Uplinked value (ie integer angle in degs, or coarse zone)

Table 33: Uplink Angle Command

An explanation of the sub-functions follows:

1. SPOT - Variance
   The SPOT variance will specify the upper limit on the variance of the spacecraft potentials calcuated by the DPU. Above this limit the average spacecraft potential value will not be sent to ASPOC.

   Default value is 1000.

2. SCP - Start Azimuth Angle
   The uplinked angle will specify the start azimuth angle for data to be included in the spacecraft potential determination.

   The default value is 0.

3. SCP - Start Polar Zone
   The uplinked value will be the start coarse polar zone for data to be included in the spacecraft potential determination.

   Note that if the uplinked value is set greater than 8, then it will be reset to 8.

   The default value is 4.

4. FGM - Azimuth Angle Offset
   The uplinked value will be the azimuth angle offset between the FGM and PEACE instrument coordinate systems [9].

   The default value is 354 degrees.

5. FGM - Polar Angle Offset
   The uplinked value will be the polar angle offset between the FGM and PEACE instrument coordinate systems [9].

   The default value is 0 degrees.

6. Calibration ID
   The calibration ID will be a number that is unique to a given set of calibration parameters stored within the DPU. It will be updated as part of the calibration value uplink procedure. This value will be under configuration control.

   Default value is 0.

7. SPOT constant value
   This is the value that the spacecraft potential is set to when the spacecraft potential algorithm is in contant potential mode.

   Default value is 5.

8. 3DX setup parameters

a15	= 0	command applies to 3DX1
a15	= 1	command applies to 3DX2
a0	= 0	use coarse zone data
a0	= 1	use fine zone data (fine zones not present for Cluster II)
a1	= 0	do not window
a1	= 1	select data between (and including) start energy to (end energy - 1)
a2	= 0	do not sum bins
a2	= 1	sum bins: a3=0: sum bins over energy a3=1: sum bins over polar
a4-a5	= 0	use LEEA data
	= 1	use HEEA data
	= 2 or 3	use first 1/2 spin of both LEEA and HEEA data

9. SP KAL Array Checksum
   This value must be updated whenever an SP KAL variable is changed.

   When the science processing is started the SP KAL array is checksummed to ensure the integrity of the KAL variables. If an error is produced the science processing will not start.

10. IP KAL Array 1 Checksum
    This value must be updated whenever an FGM calibration value is changed.

    The calibration tables are checksummed before enabling the FGM interface, if an error occurs the interface will not be opened.

11. IP KAL Array 2 Checksum
    This value must be updated whenever a monitor limit is changed.

    The limit tables are checksummed before enabling limit checking, if an error occurs limit checking will not be enabled.

12. Command Block Checksum
    After this command is sent all subsequent commands will be added to a rolling checksum until this command is sent a second time. The value of the rolling checksum will then be compared to the argument word of the second command, if an error occurs this is reported in the housekeeping telemetry.

13. 3DX window limits
    These specify the start and end energy bins used for the energy windowing option of the 3DX distribution.

    Default start is 0, end is 64.

a15 = 0	command applies to 3DX1
a15 = 1	command applies to 3DX2
a14 - a8	is start bin
a7 - a0	is end bin

    Note: data is taken from (start bin) to (end bin - 1) inclusive.

7.5.12 Uplink Reduced Polar Geometric Factor

This is a 3 word command which will allow uplink of a reduced polar geometric factor.

Polar geometric factors are used in the conversion of counts to physical units for the onboard moment computations.

For each sensor, data from 12 polar coarse zones are used in the onboard moment computations. However, data from adjacent anodes are combined, so that the moment computations has only to be performed on 6 'reduced' polar bins. This command allows the uplinking of the polar geometric factor for any one of these reduced polar bins.

The format for this command is shown in Table 34.

	Control byte		Control argument	
Ctrl Word:	0 1 s 1	1 0 0 0	x x x x	x a3 a1 a0
Arg-0 Word:	s m22 m21 m20	m19 m18 m17 m16	m15 m14 m13 m12	m11 m10 m9 m8
Arg-1 Word:	m7 m6 m5 m4	m3 m2 m1 m0	e7 e6 e5 e4	e3 e2 e1 e0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	s	Sensor-id: 0=LEEA, 1=HEEA
12-8	11000	Function = Uplink Reduced Polar Geometric Factor
7-3	x's	Not used
2-0	a's	Reduced Anode id, [0-5].
		ARGUMENT WORD-0
15	s	Sign of number (0=-ve, 1=+ve)
14-0	m's	Mantissa (high order bits)
		ARGUMENT WORD-1
15-8	m's	Mantissa (low order bits)
7-0	e's	Exponent

Table 34: Uplink Reduced Polar Geometric Factor Command

Notes:

1. Sensor-id
   This identifies which sensor the uplinked value is to be applied.
2. Reduced Anode-id
   This identifies which 'reduced anode' *ipr* (polar bin) the uplinked value applies.

   The reduced anode *ipr* for which the uplinked value applies, is given by:

$$ia = ipr * 2 \quad (1)$$

where ia is the coarse anode number, where $(0 < ia < 11)$ and $(0 < ipr < 5)$.

3. The Reduced Geometric Factor
   The geometric factor for the reduced anode ipr should be computed as:

$$gfr(ipr) = gf(ia) + gf(ia + 1) \tag{2}$$

   (Note: Do NOT average $gf(ia)$ and $gf(ia + 1)$. The program really does require the sum.)

   The reduced geometric factor is uplinked in the argument-0 and argument-1 command words, and has to be put in the appropriate exponent, mantissa, sign format as described in Appendix-A.

   The units for the reduced geometric factor should be $(m^2 sr\, eV/eV)$

4. Validation Range
   The uplinked reduced geometric factor gfr should lie in the range:

$$(4.4 * 10^{-10} < gfr < 2.2 * 10^{-5}) \qquad (m^2 sr\, eV/eV)$$

   If values are uplinked outside this range, they will be reset to the particular limit exceeded.

7.5.13 Uplink Basic Energy Step Table Value

This is a 3 word command which will allow uplink of an energy value for a particular step in either the HEEA or LEEA energy step tables.

There are 93 energy steps for each sensor, and this command replaces the existing value with this uplinked value.

These energy steps are used onboard in order to compute moment values.

The format for this command is shown in Table 35.

	Control byte		Control argument	
Ctrl Word:	0 1 s 1	1 0 0 1	x E6 E5 E4	E3 E2 E1 E0
Arg-0 Word:	s m22 m21 m20	m19 m18 m17 m16	m15 m14 m13 m12	m11 m10 m9 m8
Arg-1 Word:	m7 m6 m5 m4	m3 m2 m1 m0	e7 e6 e5 e4	e3 e2 e1 e0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	s	Sensor-id: 0=LEEA, 1=HEEA
12-8	11001	Function = Uplink Basic Energy Step Value
7	x	Not used
6-0	E's	Energy Step, [0-92].
		ARGUMENT WORD-0
15	s	Sign of number (0=-ve, 1=+ve)
14-0	m's	Mantissa (high order bits)
		ARGUMENT WORD-1
15-8	m's	Mantissa (low order bits)
7-0	e's	Exponent

Table 35: Uplink Basic Energy Step Value Command

Notes:

1. Sensor-id
   This identifies which sensor the uplinked value is to be applied.
2. Energy Step
   This identifies which energy step in the range [0-92] the uplinked value replaces.
3. The Energy Step Value
   This is to be coded in the argument-0 and argument-1 words as indicated and as further explained in Appendix-A.

   It must be in units of eV, and represent the start energy of the step.

Step 0 is the lowest energy step.

4. Validation Range for Energy Step
   The energy value 'E' uplinked should lie in the range $(0 < E < 60 * 10^4)$ (eV).

   If values are uplinked outside this range, they will be reset to the particular limit exceeded.

7.5.14 Uplink Energy Efficiency Factor

This is a 3 word command which will allow uplink of an energy efficiency factor corresponding to a particular step in either the HEEA or LEEA energy step tables.

There are 93 energy steps for each sensor, and this command replaces the existing energy efficiency factor for the particular step with this uplinked value.

These energy efficiency values are used onboard in order to compute the moments.

The format for this command is shown in Table 36.

	Control byte		Control argument	
Ctrl Word:	0 1 s 1	1 0 1 0	x E6 E5 E4	E3 E2 E1 E0
Arg-0 Word:	s m22 m21 m20	m19 m18 m17 m16	m15 m14 m13 m12	m11 m10 m9 m8
Arg-1 Word:	m7 m6 m5 m4	m3 m2 m1 m0	e7 e6 e5 e4	e3 e2 e1 e0

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	s	Sensor-id: 0=LEEA, 1=HEEA
12-8	11010	Function = Uplink Basic Energy Efficiency Factor
7	x	Not used
6-0	E's	Energy Step, [0-92].
		ARGUMENT WORD-0
15	s	Sign of number (0=-ve, 1=+ve)
14-0	m's	Mantissa (high order bits)
		ARGUMENT WORD-1
15-8	m's	Mantissa (low order bits)
7-0	e's	Exponent

Table 36: Uplink Energy Efficiency Factor Command

Notes:

1. Sensor-id
   This identifies which sensor the uplinked value is to be applied.
2. Energy Step
   This identifies which energy step in the range [0-92] which the uplinked factor replaces the energy efficiency.
3. The Energy Efficiency Factor
   This is to be coded in the argument-0 and argument-1 words as indicated, and as further explained

in Appendix-A. It is dimensionless, and represents the energy efficiency for the particular energy step. Step 0 is the lowest energy step.

4. Validation Range for Energy Efficiency Factor
   The energy efficiency factor *Eff* uplinked, should lie in the range ($0.0 < Eff < 1.0$).

   If values are uplinked outside this range, they will be reset to the particular limit exceeded.

7.5.15 Uplink FGM Calibration Value

This is a 3 word command which will allow uplink of FGM calibration parameters.

These calibration values are used onboard in order to compute the magnetic field direction as determined by FGM.

The format for this command is shown in Table 37.

	Control byte		Control argument	
Ctrl Word:	0 1 x 1	1 0 1 1	x x F2 F1	F0 R2 R1 R0
Arg-0 Word:	V31 V30 V29 V28	V27 V26 V25 V24	V23 V22 V21 V20	V19 V18 V17 V16
Arg-1 Word:	V15 V14 V13 V12	V11 V10 V09 V08	V07 V06 V05 V04	V03 V02 V01 V00

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is to DPU
13	x	Not used
12-8	11011	Function = Uplink FGM Calibration Factor
7-6	x's	Not used
5-3	F's	000 = Minimum value for range
		001 = Step for range
		010 = X calibration value for range
		011 = Y calibration value for range
		100 = Z calibration value for range
2-0	R's	Range [0-7]
		ARGUMENT WORDS
31-0	V31-V00	Integer value in PEACE units of 1/32 nT, where:
31	V31	Sign bit, where 0=+ve, and
30-0	V30-V00	Integer value, where V30 is msb and V00 is lsb.

Table 37: Uplink FGM Calibration Factor

For minimum value of range, argument<0, and for step size of range argument<4096.

7.5.16 Uplink or Launch PEACE Macro

The format for this command is shown in Table 38.

	Control byte		Control argument	
Ctrl Word:	0 1 x 1	1 1 1 0	u x x m4	m3 m2 m1 m0
Arg-0 Word:	s7 s6 s5 s4	s3 s2 s1 s0	p7 p6 p5 p4	p3 p2 p1 p0
Arg-1 Word:	d15 d14 d13 d12	d11 d10 d09 d08	d07 d06 d05 d04	d03 d02 d01 d00
Arg-n Word:	d15 d14 d13 d12	d11 d10 d09 d08	d07 d06 d05 d04	d03 d02 d01 d00
Arg-(n+1) Word:	c15 c14 c13 c12	c11 c10 c09 c08	c07 c06 c05 c04	c03 c02 c01 c00

Bits	Value	Meaning
		CONTROL WORD
15	0	High level command
14	1	Destination is DPU
13	x	Not used
12-8	11110	Function = macro
7	u	u=1 - uplink macro u=0 - launch macro
6-5	x	Not used
4-0	m4-m0	Macro number
		ARGUMENT WORD 0
15-8	s7-s0	macro size
7-0	p7-p0	macro position
		ARGUMENT WORD 1
15-0	d15-d0	commands
		ARGUMENT WORD n
15-0	d15-d0	commands
		ARGUMENT WORD n+1
15-0	c15-c0	macro checksum

Table 38: Uplink or launch PEACE macro

To launch a macro only the control word with update set to zero (*i.e.* bit 7 = 0) needs to be sent.

7.6 HIGH LEVEL RUN-TIME COMMANDS

These are commands which may be sent to the 'main program' during its scientific operations phase.

They are a subset of the all the High Level Commands already listed, but do not include the High Level Power-Up Commands or Executive comands as at this stage the 'program loader' programs is not operating.

Those which may be sent are listed in Table 39.

The status column shows two conditions with meaning as follows:

pos - Possible to send as a HLRTC.
(Recommend reading these commands individually for possible consequences of sending as a HLTRC.)
no - Not possible to send as a HLRTC.
(Will be ignored - not executed).

Command Type	HLRTC Status	Command
HLEC	pos	Set Sun-Pulse Rephase
HLEC	pos	Sensor Power & Service Signals Control
HLEC	pos	Change Monitor Control Parameters
HLEC	pos	DPU Hardware Control
HLEC	pos	Engineering Mode Select
HLEC	pos	Security Confirmer Command
HLSC	pos	Uplink or launch PEACE macro
HLSC	pos	SMU commands
HLSC	no	Initialise Keep Alive Memory
HLSC	no	Correlator control
HLSC	pos	Select Dataset to be telemetered
HLSC	no	Select Magnetic field Source (use PEACE/FGM)
HLSC	pos	OBDH Telemetry Mode
HLSC	pos	Start processing (reset science processing)
HLSC	no	Uplink Dead-time Correction Factor
HLSC	no	Uplink Parameter
HLSC	no	Uplink Reduced Polar Geometric Factor
HLSC	no	Uplink Basic Energy Step Table Value
HLSC	no	Uplink Energy Efficiency Factor

Table 39: High Level Run-Time Commands

Note: SMU commands will be able to be sent in the run-time phase, but will have different effects upon the science processing according to the SMU command sent.

APPENDIX-A:

32-Bit Floating Point Representation for Real Number Uplink

This will be the number representation scheme used to uplink real, floating point numbers to the PEACE instrument.

The bit arrangement for the number will be as shown in Table 40:

Cmd Arg-0:	s m22 m21 m20	m19 m18 m17 m16	m15 m14 m13 m12	m11 m10 m9 m8
Cmd Arg-1:	m7 m6 m5 m4	m3 m2 m1 m0	e7 e6 e5 e4	e3 e2 e1 e0

Bits	Value	Meaning
		COMMAND ARGUMENT-0 WORD
15	s	Sign of number (0=-ve, 1=+ve)
14-0	m's	Mantissa (high order bits)
		COMMAND ARGUMENT-1 WORD
15-8	m's	Mantissa (low order bits)
7-0	e's	Exponent

Table 40: 32-Bit Floating Point Number Representation.

So, given a number R to be uplinked, its relationship to the sign, mantissa, and exponent components to be uplinked, must be as follows:

$$R = (sign) * 2^{(exponent+mantissa)} \qquad (1)$$

where, if sign bit $s = 0$ then sign is set to +1
if sign bit $s = 1$ then sign is set to -1.

and sign = sign of number R
exponent = integer part of $(\log_2 R)$ & $(-127 < exp < +126)$
mantissa = fractional part of $\log_2 R$, and takes the same sign as the exponent.

A.1 Obtaining Sign, Exponent and Mantissa

The following explains how to determine the sign, exponent, and mantissa:

1. To Determine the SIGN bit:

```
if( R < 0 )
   s = 0
else
   s = 1
endif
```

2. To Determine the EXPONENT:

$$\begin{aligned} \text{Let} \quad & R_0 && = \|R\| \\ \text{and} \quad & \log_2 R_0 && = R_0 int \; + \; R_0 fract \end{aligned}$$

where both $R_0 int$ and $R_0 fract$ have the same sign.

If $R_0 int$ is greater than or equal to 0, then the exponent = $R_0 int$.

If $R_0 int$ is less than 0, then exponent = $R_0 int \; + \; 256$.

Bits e7-e0 are set to the integer part of the exponent.

3. To Determine the MANTISSA:
From above:

$$\begin{aligned} R_0 fract \quad & = \text{fractional part of } \{\log_2 R\} \\ & = mantissa_0 \end{aligned}$$

where $mantissa_0$ is the full precision mantissa.

However, for our representation, only (15+8)=23 bits are available in which to store the mantissa, and therefore some precision will be lost.

For our case:

$$mantissa = \left|\frac{\text{integer part of}\{mantissa_0 * 2^{23}\}}{2^{23}}\right| \qquad (2)$$

$$= \left|\frac{\text{integer part of}\{mantissa_0 * 8388608\}}{8388608}\right| \qquad (3)$$

which, since $(0 \leq mantissa < 1)$ will be containable within 23 bits.

Note: If $|R_0| < 1$, both the exponent and mantissa will be -ve. In this case the sign of the mantissa is not coded but is taken to be the same as that of the exponent. However, for our purposes it is more convenient to treat the mantissa value as an integer, as this is an easy representation to break up and insert into the command argument words. Because of this one does not need to perform the division by 8388608 in equation 2, thus making the job that much easier.

A.2 Range of Numbers Which Can Be Represented

1. Max Value:

   $$\begin{aligned} \text{Max value} &= 2^{(+126\ +\ 1.0)} \\ &= 2^{+127} \\ &= 1.7 * 10^{+38} \end{aligned}$$

   Note: the exponent value has to be less than 256.

2. Min Value:

   $$\begin{aligned} \text{Min value} &= 2^{(-127\ -\ 1.0)} \\ &= 2^{-128} \\ &= 2.9 * 10^{-39} \end{aligned}$$

A.3 Precision of Representation

$$\begin{aligned} 1 \text{ part in } 2^{23} &= 1 \text{ part in } 8.38 * 10^{6} \\ &= 1 \text{ part in } 8388608 \\ &= \text{i.e. about 7 decimal places.} \end{aligned}$$

A.4 Representation of Zero

This will be the bit pattern used for the smallest value representable,

as follows : -mantissa = 0
exponent = -127
so,

$$\begin{aligned} R_{zero} &= 2^{-127} \\ &= 5.8 * 10^{-39} \end{aligned}$$

Any input value $< R_{zero}$ will be set to this representation and treated as zero precisely.

APPENDIX-B:

House-keeping telemetry analogue channel id's.

The HouseKeeping analogue parameter channel id's are shown in Table 41.

ID	Parameter	Channel
0	EPL SWE	LEEA HV sweep monitor.
1	EPL MCP	LEEA HV MCL monitor.
2	EPL HVEN	LEEA HV plug monitor.
3	EPL STIM	LEEA stim monitor.
4	EPL P5VV	LEEA 5 volts monitor.
5	EPL M8VV	LEEA minus 8 volts monitor.
6	EPL P8VV	LEEA plus 8 volts monitor.
7	EPL 36VV	LEEA 36 volts monitor.
8	EPH SWE	HEEA HV sweep monitor.
9	EPH MCP	HEEA HV MCL monitor.
10	EPH HVEN	HEEA HV plug monitor.
11	EPH STIM	HEEA stim monitor.
12	EPH P5VV	HEEA 5 volts monitor.
13	EPH M8VV	HEEA minus 8 volts monitor.
14	EPH P8VV	HEEA plus 8 volts monitor.
15	EPH 36VV	HEEA 36 volts monitor.
16	EPD P5VV	DPU 5 volts monitor.
17	EPD P8VV	DPU plus 8 volts monitor.
18	EPD M8VV	DPU minus 8 volts monitor.
19	EPD 36VV	DPU 36 volts monitor.
20	EPD P5VI	DPU 5 volts current monitor.
21	EPD P8VI	DPU plus 8 volts current monitor.(TBD)
22	EPD 36VI	DPU 36 volts current monitor.
23	EPD M8VI	DPU total 8 volts current monitor.(TBD)
24	EPD DTMP	DPU temperature monitor.
25	EPD TELM	DPU telemetry interface monitor.

Table 41: HouseKeeping telemetry analogue channel IDs.

References

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[5] Private communication, with B.K.Hancock, Dec, 1991.

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[9] 'CLUSTER/PEACE: Extracting the Magnetic Field Direction from FGM Data', by P.J.Carter, 02/Mar/92.

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OPERATIONAL HOUSEKEEPING TELEMETRY DATABASE

Version 2.0
02-Jun-1999

EPD 36VI

SHORT_DESCRIPTION-char(16)
DPU 36V I MON
FUNCTION-char(128)
DPU 36 VOLT CURRENT MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD 36VV

SHORT_DESCRIPTION-char(16)
DPU 36V VOLT MON
FUNCTION-char(128)
DPU 36 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, EPD_FCNT INCREMENTING
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPH_36VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL_36VV
REDUNDANT_PARAMETER-char(8)
NONE

EPD BFLK

SHORT_DESCRIPTION-char(16)
CODE SOURCE SELT
FUNCTION-char(128)
CODE SOURCE: 0 IF CODE WAS RUN FROM ROM OR RAM, 1 IF CODE WAS RUN FROM LINK
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD01
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-01
FUNCTION-char(128)
ECHO OF THE LAST COMMAND RECEIVED AT THE DPU
VALIDITH-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD02
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-02
FUNCTION-char(128)
ECHO OF THE SECOND LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD03
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-03
FUNCTION-char(128)
ECHO OF THE THIRD LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD04
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-04
FUNCTION-char(128)
ECHO OF THE FOURTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD05
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-05
FUNCTION-char(128)
ECHO OF THE FIFTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD06
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-06
FUNCTION-char(128)
ECHO OF THE SIXTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD07
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-07
FUNCTION-char(128)
ECHO OF THE SEVENTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD08
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-08
FUNCTION-char(128)
ECHO OF THE EIGHTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD09
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-09
FUNCTION-char(128)
ECHO OF THE NINTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD10
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-10
FUNCTION-char(128)
ECHO OF THE TENTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD11
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-11
FUNCTION-char(128)
ECHO OF THE ELEVENTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD12
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-12
FUNCTION-char(128)
ECHO OF THE TWELFTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD13
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-13
FUNCTION-char(128)
ECHO OF THE THIRTEENTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD CD14
SHORT_DESCRIPTION-char(16)
ECHO COMMAND-14
FUNCTION-char(128)
ECHO OF THE FOURTEENTH LAST COMMAND RECEIVED AT THE DPU
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD DTMP
SHORT_DESCRIPTION-char(16)
DPU TEMP MONITOR
FUNCTION-char(128)
DPU TEMPERATURE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD FCNT
SHORT_DESCRIPTION-char(16)
VCO_FRAMECOUNTER
FUNCTION-char(128)
VCO-FRAMECOUNTER WHICH INITIALISES AT ZERO AND INCREMENTS TO ZERO ON OVERFLOW-16
BIT COUNTER
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD HKTM
SHORT_DESCRIPTION-char(16)
DPU HK TELM MODE
FUNCTION-char(128)
DPU STATUS: HK TELEMETRY MODE: 0 = NORMAL MODE, 1 = ENGINEERING MODE
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD IBUS
SHORT_DESCRIPTION-char(16)
IOBUS CONTROLLER
FUNCTION-char(128)
IOBUS CONTROLLER: 0 = INTERFACE PROCESSOR (IP), 1 = SCIENCE PROCESSOR (SP)
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EDP IPCL
SHORT_DESCRIPTION-char(16)
DPU IP CLK SPEED
FUNCTION-char(128)
DPU STATUS: IP CLOCK SPEED. 1 = 2.5MHz, 0 = 5MHz
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD ISAS
SHORT_DESCRIPTION-char(16)
ASPOC IEL STATUS
FUNCTION-char(128)
DPU STATUS: IEL STATUS ASPOC 0 = ENABLED, 1 = DISABLED
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD ISDW
SHORT_DESCRIPTION-char(16)
DWP IEL STATUS
FUNCTION-char(128)
DPU STATUS: IEL STATUS DWP 1 = ENABLED, 0 = DISABLED
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD ISED
SHORT_DESCRIPTION-char(16)
EDI IEL STATUS
FUNCTION-char(128)
DPU STATUS: IEL STATUS EDI 1 = ENABLED, 0 = DISABLED
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD ISFG
SHORT_DESCRIPTION-char(16)
FGM IEL STATUS
FUNCTION-char(128)
DPU STATUS: IEL STATUS FGM 1 = ENABLED, 0 = DISABLED
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD LSEL
SHORT_DESCRIPTION-char(16)
LINK DRIVER
FUNCTION-char(128)
LINK DRIVER: 0 FOR SCIENCE PROCESSOR, 1 FOR INTERFACE PROCESSOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD M8VI
SHORT_DESCRIPTION-char(16)
DPU -8V AMPS MON
FUNCTION-char(128)
DPU MINUS 8 VOLT CURRENT MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD M8VV
SHORT_DESCRIPTION-char(16)
DPU -8V VOLT MON
FUNCTION-char(128)
DPU MINUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPH_M8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL_M8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPD MACT
SHORT_DESCRIPTION-char(16)
DPU MON ON/OFF
FUNCTION-char(128)
ON BOARD MONITOR IS 1=ON/0=OFF FOR THIS FORMAT
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD MCHN
SHORT_DESCRIPTION-char(16)
ID OF TRIP CHNL
FUNCTION-char(128)
IDENTITY OF CHANNEL WHICH HAS EXCEEDED ITS LIMITS AND TRIPPED MONITOR
VALIDITY-char(128)
EPD_MACT = 1
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD MTRP
SHORT_DESCRIPTION-char(16)
TRIP STATUS
FUNCTION-char(128)
ON BOARD MONITOR STATUS: 1 = TRIPPED, 0 = NOT TRIPPED
VALIDITY-char(128)
EPD_MACT=1
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD MVAL
SHORT_DESCRIPTION-char(16)
OUT OF LIMIT VAL
FUNCTION-char(128)
VALUE OF CHANNEL WHICH TRIPPED OUT OF LIMIT MONITOR
VALIDITY-char(128)
EPD_MACT =1
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD P5VI
SHORT_DESCRIPTION-char(16)
DPU +5V AMP MON
FUNCTION-char(128)
DPU PLUS 5 VOLT CURRENT MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD P5VV
SHORT_DESCRIPTION-char(16)
DPU +5V VOLT MON
FUNCTION-char(128)
DPU PLUS 5 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPH_P5VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL_P5VV
REDUNDANT_PARAMETER-char(8)
NONE

EPD P8VI
SHORT_DESCRIPTION-char(16)
DPU +8V AMP MON
FUNCTION-char(128)
DPU PLUS 8 VOLT CURRENT MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD P8VV
SHORT_DESCRIPTION-char(16)
DPU +8V VOLT MON
FUNCTION-char(128)
DPU PLUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPH P8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL P8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPD RSET
SHORT_DESCRIPTION-char(16)
RESET BIT
FUNCTION-char(128)
RESET BIT SHOWS IF A LOW LEVEL COMMAND RESET HAS OCCURRED SINCE POWERUP
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD SCCT
SHORT_DESCRIPTION-char(16)
SCI PROC SPIN CT
FUNCTION-char(128)
SCIENCE PROCESSING SPIN COUNTER-COUNT PROCESSED SPINS OF DATA
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON AND/OR LEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

<u>EPD SCIM</u>
SHORT_DESCRIPTION-char(16)
SC INTRFACE MODE
FUNCTION-char(128)
DPU STATUS: SPACECRAFT INTERFACE MODE: 1 = REDUNDANT, 0 = PRIME
VALIDITY-char(128)
EPD_STAT>=98, EPD_SIAM <> 1
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

<u>EPD SIAM</u>
SHORT_DESCRIPTION-char(16)
SC INTRFACE MODE
FUNCTION-char(128)
SPACECRAFT INTERFACE MODE: 1 = USING AUTO SELECT, 0 = USING MANUAL SELECT
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

<u>EPD SPCL</u>
SHORT_DESCRIPTION-char(16)
SP CLOCK SPEED
FUNCTION-char(128)
DPU STATUS: SCIENCE PROCESSOR CLOCK SPEED: 1 = 2.5MHz, 0 = 5MHz
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD SPCT
SHORT_DESCRIPTION-char(16)
SPIN_COUNTER
FUNCTION-char(128)
SPIN COUNTER RECORDS NUMBER OF SPINS ELAPSED SINCE INITIALISATION WITH 16 BIT RESOLUTION & INCREMENTS TO ZERO ON OVERFLOW
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD SPOS
SHORT_DESCRIPTION-char(16)
SUN_REF_OFFSET
FUNCTION-char(128)
OFFSET OF REPHASED SUN REFERENCE PULSE IN SPIN SEGMENT CLOCK PULSES
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD STAT
SHORT_DESCRIPTION-char(16)
PEACE STATUS
FUNCTION-char(128)
STATUS OF PEACE INSTRUMENT, LEVEL OF CODE RUNNING AND CHECKSUM STATUS
VALIDITY-char(128)
SPACECRAFT IN NOMINAL CONFIGURATION
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD TELM
SHORT_DESCRIPTION-char(16)
DPU TELE I/F MON
FUNCTION-char(128)
DPU TELEMETRY INTERFACE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)
EPD-SCIM IS ALTERNATIVE ONLY IF EPD_SIAM =0
ALTERNATIVE_PARAMETER_1-char(8)
EPD_SCIM
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPD WDST
SHORT_DESCRIPTION-char(16)
WATCHDOG STATUS
FUNCTION-char(128)
DPU STATUS: WATCHDOG STATUS: 1 = ENABLED, 0 = DISABLED
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPEAHE T
SHORT_DESCRIPTION-char(16)
EX PEACE HEEA TH
FUNCTION-char(128)
Experiment PEACE HEEA thermistor powered and read out from S/C as separate channel
VALIDITY-char(128)
WHENEVER SPACECRAFT THERMISTORS ARE VALID (?)
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
ANOTHER SPACECRAFT THERMISTOR (?)
ALTERNATIVE_PARAMETER_2-char(8)
ANOTHER SPACECRAFT THERMISTOR (?)
REDUNDANT_PARAMETER-char(8)
NONE

EPEALE T
SHORT_DESCRIPTION-char(16)
EX PEACE LEEA TH
FUNCTION-char(128)
Experiment PEACE LEEA thermistor powered and read out from S/C as separate channel
VALIDITY-char(128)
WHENEVER SPACECRAFT THERMISTORS ARE VALID (?)
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
ANOTHER SPACECRAFT THERMISTOR (?)
ALTERNATIVE_PARAMETER_2-char(8)
ANOTHER SPACECRAFT THERMISTOR (?)
REDUNDANT_PARAMETER-char(8)
NONE

EPH 36VV
SHORT_DESCRIPTION-char(16)
HEEA +36V V MON
FUNCTION-char(128)
HEEA PLUS 36 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA01
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT01
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 01
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA02
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT02
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 02
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA03
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT03
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 03
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA04
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT04
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 04
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA05
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT05
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 05
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA06
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT06
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 06
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA07
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT07
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 07
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA08
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT08
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 08
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA09
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT09
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 09
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA10
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT10
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 10
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA11
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT11
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS 11
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HA12
SHORT_DESCRIPTION-char(16)
HEEA_ANODE_CNT12
FUNCTION-char(128)
HEEA COMPRESSED ANODE COUNTS
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HBIN
SHORT_DESCRIPTION-char(16)
HEEA BIN NUMBER
FUNCTION-char(128)
ACCUMULATION BIN NUMBER OF COMPRESSED ANODE DATA IN H/K TELEMETRY
ORIGINATING FROM HEEA
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HTOT
SHORT_DESCRIPTION-char(16)
TOTAL HEEA COUNT
FUNCTION-char(128)
TOTAL NUMBER OF COUNTS AFTER DEAD TIME CORRECTION RECEIVED BY HEEA SENSOR ABOVE 11.4eV
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH HVEN
SHORT_DESCRIPTION-char(16)
HEEA_HVENABLEMON
FUNCTION-char(128)
HEEA HIGH VOLTAGE ENABLE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH M8VV
SHORT_DESCRIPTION-char(16)
HEEA -8V V MON
FUNCTION-char(128)
HEEA MINUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD_M8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL_M8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPH MCP
SHORT_DESCRIPTION-char(16)
HEEA MCP HV MON
FUNCTION-char(128)
HEEA MCP HIGH VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON, MCP ENABLED
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH P5VV
SHORT_DESCRIPTION-char(16)
HEEA +5V V MON
FUNCTION-char(128)
HEEA PLUS 5 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD P5VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL P5VV
REDUNDANT_PARAMETER-char(8)
NONE

EPH P8VV
SHORT_DESCRIPTION-char(16)
HEEA +8V V MON
FUNCTION-char(128)
HEEA PLUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD_P8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPL_P8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPH STIM
SHORT_DESCRIPTION-char(16)
HEEA STIM AMP
FUNCTION-char(128)
HEEA ON BOARD STIM AMPLITUDE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPH SWE
SHORT_DESCRIPTION-char(16)
HEEA SWEEP HVMON
FUNCTION-char(128)
HEEA HIGH VOLTAGE SWEEP MONITOR
VALIDITY-char(128)
EPD_STAT>=98, HEEA SENSOR ON, SWEEP ENABLED
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL 36VV
SHORT_DESCRIPTION-char(16)
LEEA +36V V MON
FUNCTION-char(128)
LEEA PLUS 36 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD_36VV
ALTERNATIVE_PARAMETER_2-char(8)
EPH_36VV
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA01
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT01
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 01
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA02
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT02
FUNCTION-char(128)
LEEA COMPRESSED ANODES COUNTS 02
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA03
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT03
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 03
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA04
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT04
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 04
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA05
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT05
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 05
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA06
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT06
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 06
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA07
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT07
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 07
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA08
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT08
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 08
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA09
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT09
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 09
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA10
SHORT-DESCRIPTION-char(16)
LEEA_ANODE_CNT10
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 10
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA11
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT11
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS 11
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LA12
SHORT_DESCRIPTION-char(16)
LEEA_ANODE_CNT12
FUNCTION-char(128)
LEEA COMPRESSED ANODE COUNTS
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LBIN
SHORT_DESCRIPTION-char(16)
LEEA BIN NUMBER
FUNCTION-char(128)
ACCUMULATION BIN NUMBER OF COMPRESSED ANODE DATA IN H/K TELEMETRY ORIGINATING FROM LEEA
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL LTOT
SHORT_DESCRIPTION-char(16)
TOTAL LEEA COUNT
FUNCTION-char(128)
TOTAL NUMBER OF COUNTS AFTER DEAD TIME CORRECTION RECEIVED BY LEEA SENSOR ABOVE 11.4eV
VALIDITY-char(128)
EPD_STAT>=98, EPD_SCCT>0
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL HVEN
SHORT_DESCRIPTION-char(16)
LEEA_HVENABLEMON
FUNCTION-char(128)
LEEA HIGH VOLTAGE ENABLE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA SENSOR ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL M8VV
SHORT_DESCRIPTION-char(16)
LEEA -8V V MON
FUNCTION-char(128)
LEEA MINUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98,
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD M8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPH M8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPL MCP
SHORT_DESCRIPTION-char(16)
LEEA MCP HV MON
FUNCTION-char(128)
LEEA MCP HIGH VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA SENSOR ON, MCP ENABLED
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL P5VV
SHORT_DESCRIPTION-char(16)
LEEA +5V V MON
FUNCTION-char(128)
LEEA PLUS 5 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD_P5VV
ALTERNATIVE_PARAMETER_2-char(8)
EPH_P5VV
REDUNDANT_PARAMETER-char(8)
NONE

EPL P8VV
SHORT_DESCRIPTION-char(16)
LEEA +8V V MON
FUNCTION-char(128)
LEEA PLUS 8 VOLT VOLTAGE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
EPD P8VV
ALTERNATIVE_PARAMETER_2-char(8)
EPH P8VV
REDUNDANT_PARAMETER-char(8)
NONE

EPL STIM
SHORT_DESCRIPTION-char(16)
LEEA STIM AMP
FUNCTION-char(128)
LEEA ON BOARD STIM AMPLITUDE MONITOR
VALIDITY-char(128)
EPD_STAT>=98, LEEA ON
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

EPL SWE
SHORT_DESCRIPTION-char(16)
LEEA SWEEP HVMON
FUNCTION-char(128)
LEEA HIGH VOLTAGE SWEEP MONITOR
VALIDITY-char(128)
EPD_STAT>=98
REMARK_DRAWING-char(128)

ALTERNATIVE_PARAMETER_1-char(8)
NONE
ALTERNATIVE_PARAMETER_2-char(8)
NONE
REDUNDANT_PARAMETER-char(8)
NONE

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DPU
HOUSEKEEPING TELEMETRY FORMAT
SPECIFICATION

Version 7.0
02-Jun-1999

1. HOUSEKEEPING DATA TRANSMISSION

The spacecraft samples PEACE Housekeeping (HK) data during the HK data period VC0. Forty nine 16 bit words are sampled between reset pulses. HK data is requested in three blocks of 38,12 and 46 bytes. The time period between telemetry formats is 5.152222 seconds. Each VC0 period is synchronised with the S/C reset pulse (RES).

The DPU has two HK telemetry modes :

- NORMAL MODE - a selection of preprogrammed HK parameters is transmitted

- ENGINEERING MODE - one analogue data channel is selected for high time resolution diagnostics, DPU digital parameters as transmitted in normal mode. This mode is selected by telecommand.

2. HOUSEKEEPING PARAMETERS AND DATA

2.1 DPU DIGITAL HK PARAMETERS

EPD_STAT	16 bit	instrument status see (Appendix A).
EPD_FCNT	16 bit	The instrument frame counter initialises to zero and increments to zero on overflow.
EPD_SPCT	16 bit	The spin counter records the number of spins since initialisation, increments to zero.
EPD_SCCT	16 bit	Science processing spin counter.
EPD_SPOS	16 bit	The current value of sun reference pulse offset (if negative DPU is in auto impulse mode)
EPD_DPST	16 bit	DPU H/W status (see Appendix A).
EPD_CD01 - EPD_CD14	16 bit * 14	High level command echo, commands are entered into buffer in received sequence.
EPD_MCON	8 bit	DPU onboard monitor control (see Appendix A).
EPD_MVAL	8 bit	DPU monitor trip value (see Appendix A) .

2.2 SENSOR DIGITAL HK PARAMETERS: ANODE COUNT DATA

2.2.1 EPD_LA1...,EPD_HA1....

The Anode count data plus 32 is compressed into 8 bits using a quasi-log compression scheme utilising a 5 bit mantissa and 3 bit exponent. Each accumulation bin is identified by an accumulation bin counter. The DPU will sample one accumulation bin per HK telemetry format. The accumulation bin will be sampled from the first sweep after the rephased sun reference pulse.

2.2.2 EPD_LT1,EPD_LT2 and EPD_HT1,EDP_HT2

The total LEEA and HEEA counts are totals from the previous spin (from energy bins above 10.7 eV). The data is compressed using the moments real 32 to 16 bit integer compression scheme. See "DPU Science Telemetry Format Specification" CL /PE-MSSL-DS-0050.

2.3 ANALOGUE HK DATA

Analogue HK data is digitised within the DPU to 8 bit resolution. Data transmitted will have been collected in the previous VC0 period. The conversions shown here are for theoretical ouputs.

2.3.1 HEEA Analogue Parameters

EPH_SWP_	HEEA HV sweep monitor
upper limit	4400 V
lower limit	0 V
O/P value	adc o/p x 20.5216

EPH_MCP_	HEEA HV MCP monitor
upper limit	3800 V
lower limit	0 V
O/P value	adc o/p x 20.5216

EPH_HVEN	HEEA HV H/W enable status monitor
upper limit	>= 1 V HV (enabled MCP and sweep)
lower limit	< 1 V HV disabled
O/P value	adc o/p x 0.2052

EPH_STIM	HEEA HV stim amplitude monitor
upper limit	180 mV
lower limit	15 mV
O/P value	adc o/p x 0.6576

EPH_P5VV	HEEA 5 V monitor
upper limit	5.5 V
lower limit	4.5 V
O/P value	adc o/p x 0.04132

EPH_M8VV	HEEA -8 V monitor
upper limit	-8.8 V
lower limit	-7.2 V
O/P value	adc o/p x 0.1224

EPH_P8VV	HEEA +8 V monitor

upper limit	8.8 V
lower limit	7.2 V
O/P value	adc o/p x 0.04167

EPH_36VV	HEEA 36 V monitor
upper limit	38V
lower limit	32V
O/P value	adc o/p x 0.2209

2.3.2 LEEA Analogue Parameters

The conversion to engineering units and parameter limits are identical to HEEA .

EPL_SWE_
EPL_MCP_
EPL_HVEN
EPL_STIM
EPL_P5VV
EPL_M8VV
EPL_P8VV
EPL_36VV

2.3.3 DPU Analogue Parameters

EPD_P5VV	DPU 5 V monitor
upper limit	5.40 V
lower limit	5.00 V
O/P value	adc o/p x 0.02250

EPD_M8VV	DPU -8V monitor
upper limit	-8.40 V
lower limit	-7.60 V
O/P value	adc o/p x -0.03555

EPD_P8VV	DPU +8 V monitor
upper limit	8.40 V
lower limit	7.60 V
O/P value	adc o/p x 0.04061

EPD_36VV	DPU 36 V monitor
upper limit	34.0 V
lower limit	38.0 V

O/P value	adc o/p x 0.1553

EPD_P5VI	DPU 5V current monitor
range	0 to 1000 mA
upper limit	600 mA
lower limit	200 mA
O/P value	adc o/p x 4.367

EPD_M8VI	DPU total 8V current monitor (see note below)
range	100 mA
upper limit	44 mA
lower limit	0 mA
O/P value	adc o/p x 0.4375

EPD_P8VI	DPU +8 V current monitor *1
range	100 mA
upper limit	77 mA
lower limit	0 mA
O/P value	adc o/p x 0.422

EPD_36VI	DPU 36 V current monitor
range	0 to 100 mA
upper limit	50 mA
lower limit	0 mA
O/P value	adc o/p x 0.422

EPD_DTMP	DPU temperature monitor
range	-30 to +60
upper limit	+40 deg C
lower limit	-10deg C
O/P value in deg K	adc o/p + 130

EPD_TELM	DPU prime/redundant tele I/F monitor
upper limit	>= 2.5 V then prime i/f selected
lower limit	< 2.5 V then redundant i/f selected
O/P value	adc o/p x 0.2035

Note: To generate the current drawn by the DPU -8V rail it is necessary to perform the following calculation.

-8V current = EPD_P8VI - EPD_M8VI.

This calculation is not performed by the DPU.

3 NORMAL MODE TELEMETRY FORMAT

3.1 SECTION 1: NORMAL MODE DPU DIGITAL PARAMETERS

packet location (byte)	**parameter name**	**description**	**parameter type A= analogue R= register C=counter**
0,1	**EPD_STAT**	instrument status	R
2,3	**EPD_FCNT**	frame counter	C
4,5	**EPD_SPCT**	spin count	C
6,7	**EPD_DPST**	DPU H/W status	R
8,9	**EPD_CD01**	command echo	R
10,11	**EPD_CD02**		R
12,13	**EPD_CD03**		R
14,15	**EPD_CD04**		R
16,17	**EPD_CD05**		R
18,19	**EPD_CD06**		R
20,21	**EPD_CD07**		R
22,23	**EPD_CD08**		R
24,25	**EPD_CD09**		R
26,27	**EPD_CD010**		R
28,29	**EPD_CD011**		R
30,31	**EPD_CD012**		R
32,33	**EPD_CD013**		R
34,35	**EPD_CD014**		R

3.2 SECTION 2: NORMAL MODE SPECIFIC PARAMETERS/DATA

packet location (byte)	**parameter name**	**description**	**parameter type A= analogue R= register C=counter**
36/37	**EPD_SCCT**	SP spin counter *2	C
38/39	**EPD_LBIN/HBIN**	LEEA/HEEA bin number	C
40/41	**EPL_LA1/LA2**	LEEA compressed anode counts	R
42/43	**EPL_LA3/LA4**		R
44/45	**EPL_LA5/LA6**		R
46/47	**EPL_LA7/LA8**		R
48/49	**EPL_LA9/LA10**		R
50/51	**EPL_LA11/LA12**		R
52/53	**EPH_HA1/HA2**	HEEA compressed anode counts	R
54/55	**EPH_HA3/HA4**		R
56/57	**EPH_HA5/HA6**		R
58/59	**EPH_HA7/HA8**		R
60/61	**EPH_HA9/HA10**		R
62/63	**EPH_HA11/HA12**		R
64/65	**EPL_LT1/LT2**	total LEEA counts	R
66/67	**EPH_HT1/HT2**	total HEEA counts	R
68/69	**EPL_SWP_/MCP_**	LEEA sweep and MCP monitor	A,A
70/71	**EPL_HVEN/STIM**	LEEA HV and stim monotor	A,A
72/73	**EPL_P5VV/M8VV**	LEEA voltage monitors	A,A
74/75	**EPL_P8VV/36VV**		A,A
76/77	**EPH_SWP_/MCP_**	HEEA sweep and MCP monitor	A,A
78/79	**EPH_HVEN/STIM**	HEEA HV and stim monotor	A,A
80/81	**EPH_P5VV/M8VV**	HEEA voltage monitors	A,A
82/83	**EPH_P8VV/36VV**		A,A
84/85	**EPD_P5VV/P8VV**	DPU voltage and current monitors	A,A
86/87	**EPD_M8VV/36VV**		A,A
88/89	**EPD_P5VI/M8VI**		A,A
90/91	**EPD_36VI/P8VI**		A,A
92/93	**EPD_DTMP/TELM**	DPU temperature and tele monitor	A,A
94/95	**EPD_MVAL/MCON**	DPU monitor channel *3	A,A
96/97	**EPD_SPOS**	sun reference pulse offset	R

*2 initialised on starting science processing.
*3 EPD_MVAL desribed in Appendix A.

4. ENGINEERING MODE TELEMETRY FORMAT

4.1 SECTION 1: ENGINEERING MODE DPU DIGITAL PARAMETERS

In engineering mode the DPU digital parameters are identical to normal mode. HK telemetry words 36/37 contains the analogue channel ID and words 38/39 to 92/93 contain 56 samples of a single analogue parameter, time between samples is ~32 mS. For information on commanding into engineering mode see
"DPU Commanding System Specification" CL/PE-MSSL-DS-0051.

4.2 SECTION 2: ENGINEERING MODE SPECIFIC PARAMETERS/DATA

Packet location (byte)	**parameter name**	**description**	**parameter type A= analogue R= register C=counter**
36/37	**EPD_CHID**	analogue channel ID	R
38/39	**EPD_ENG1/ENG2**		A
40/41	**EPD_ENG3/ENG4**		A
42/43	**EPD_ENG5/ENG6**		A
44/45	**EPD_ENG7/ENG8**		A
46/47	**EPD_ENG9/ENG10**		A
48/49	**EPD_ENG11/ENG12**		A
50/51	**EPD_ENG13/ENG14**		A
52/53	**EPD_ENG15/ENG16**		A
54/55	**EPD_ENG17/ENG18**		A
56/57	**EPD_ENG19/ENG20**		A
58/59	**EPD_ENG21/ENG22**		A
60/61	**EPD_ENG23/ENG24**		A
62/63	**EPD_ENG25/ENG26**		A
64/65	**EPD_ENG27/ENG28**		A
66/67	**EPD_ENG29/ENG30**		A
68/69	**EPD_ENG31/ENG32**		A
70/71	**EPD_ENG33/ENG34**		A
72/73	**EPD_ENG35/ENG36**		A
74/75	**EPD_ENG37/ENG38**		A
76/77	**EPD_ENG39/ENG40**		A
78/79	**EPD_ENG41/ENG42**		A
80/81	**EPD_ENG43/ENG44**		A
82/83	**EPD_ENG45/ENG46**		A
84/85	**EPD_ENG47/ENG48**		A
86/87	**EPD_ENG49/ENG50**		A
88/89	**EPD_ENG51/ENG52**		A
90/91	**EPD_ENG53/ENG54**		A
92/93	**EPD_ENG55/ENG56**		A
94/95	**EPD_MCON/MVAL**	DPU monitor channel	R, A
96/97	**EPD_SPOS**	sun reference pulse offset	R

APPENDIX A

A.1. DPU Status Word EDP_DPST

bit	description
0	EEPROM H/W write inhibit 1= inhibit (default) 0 = write enabled
1	unused
2	IP and SP boot type 0=boot from ROM (default) 1=boot from link *4
3	IP boot source 0=EEPROM (default) 1=bipolar PROM
4	SP boot source 0=EEPROM (default) 1=bipolar PROM
5	IOBUS control 0=IP control (default) 1=SP control
6	sensor comms control 0=SP control (default) 1=IP control
7	DPU reset bit 1=reset
8	spacecraft I/F mode 0=prime (default) 1=redundant
9	spacecraft pri/red I/F select 1 = auto (default) 0 = manual
10	watchdog status 1= enabled (default) 0=disabled
11	HK telemetry mode 0=normal (default) 1=engineering
12	ASPOC event enable default = 1 off
13	EDI event enable default = 0 off
14	DWP event enable default = 0 off
15	FGM event enable default = 0 off

*4 boot from link is only for diagnostic/test purposes.

A.2. Monitor Control Byte EPD_MVAL

bit	description
0	channel ID bit 0
1	channel ID bit 1
2	channel ID bit 2
3	channel ID bit 3
4	channel ID bit 4
5	1 = previously tripped
6	1 = monitor tripped this format
7	1 = monitor enabled

A.3. DPU Instrument Status EPD_STAT

EPD_STAT (decimal)	definition
01	biploar boot code level 2 execution
02	checksum error in executive
03	executive execution
04	patch mode : waiting for address
05	patch mode : waiting for number of words
06	patch mode : waiting for patch data
07	patch mode : waiting for path checksum
08	patch mode : patching complete
09	patch mode : patch checksum error
10	waiting for second word of directory update
11	directory update complete
12	memory dump being performed
14	memory dump complete
15	preparing to run application
20	directory checksum error in IP RAM
21	checksum error in module in IP RAM module 1
22	checksum error in module in IP RAM module 2
23	checksum error in module in IP RAM module 3
24	checksum error in module in IP RAM module 4
25	checksum error in module in IP RAM module 5
26	checksum error in module in IP RAM module 6
27	checksum error in module in IP RAM module 7
28	checksum error in module in IP RAM module 8
29	checksum error in module in IP RAM module 9
30	checksum error in module in IP RAM module 10
40	directory checksum error in IP EEPROM
41	checksum error in module in IP EEPROM module 1
42	checksum error in module in IP EEPROM module 2
43	checksum error in module in IP EEPROM module 3
44	checksum error in module in IP EEPROM module 4
45	checksum error in module in IP EEPROM module 5
46	checksum error in module in IP EEPROM module 6
47	checksum error in module in IP EEPROM module 7
48	checksum error in module in IP EEPROM module 8
49	checksum error in module in IP EEPROM module 9
50	checksum error in module in IP EEPROM module 10
58	SP processor not responding to link communication
59	SP status word not sent from SP executive
60	directory checksum error in SP RAM
61	checksum error in module in SP RAM module 1
62	checksum error in module in SP RAM module 2
63	checksum error in module in SP RAM module 3

64	checksum error in module in SP RAM module 4
65	checksum error in module in SP RAM module 5
66	checksum error in module in SP RAM module 6
67	checksum error in module in SP RAM module 7
68	checksum error in module in SP RAM module 8
69	checksum error in module in SP RAM module 9
70	checksum error in module in SP RAM module 10
80	directory checksum error in SP EEPROM
81	checksum error in module in SP EEPROM module 1
82	checksum error in module in SP EEPROM module 2
83	checksum error in module in SP EEPROM module 3
84	checksum error in module in SP EEPROM module 4
85	checksum error in module in SP EEPROM module 5
86	checksum error in module in SP EEPROM module 6
87	checksum error in module in SP EEPROM module 7
88	checksum error in module in SP EEPROM module 8
89	checksum error in module in SP EEPROM module 9
90	checksum error in module in SP EEPROM module 10
91	to many HK samples
94	FGM minimum value invalid
95	FGM step invalid
98	IP single processor code executing
99	SP single processor code executing
100	main code application executing
101	science KAL memory checksum failed
102	FGM KAL memory checksum failed
103	monitor KAL memory failed
104	blocking checksum failed
105	* LEEA communications failed
106	* HEEA communications failed
107	* RSP S/W watchdog trip and LEEA comms failed
108	* RSP S/W watchdog trip and HEEA comms failed
109	* RSP S/W watchdog trip
110	* HK monitor trip
112	macro exceeds end of buffer
113	macro is zero words long
114	macro checksum failure
201	EEPROM boot code level execution IP bus master
202	EEPROM boot code level execution SP bus master

* = LEEA and HEEA power switched off and signals tri-stated. NOTE it is not possible to power the sensors with EPD_STAT => 105. The sensor power must be turned off with 0x4800 first (or run control file EPAFT_SNPOFF).

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DPU SCIENCE TELEMETRY FORMAT SPECIFICATION

Version 2.4
01-Jun-99

Contents

List of Tables

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Glossary

a	azimuth (spin) bin
ASPOC	Active Spacecraft POtential Control experiment
CDHF	Central Data Handling Facility
CIS	Ion experiment on Cluster
COR	CORe dataset
cts	counts (number of counts recorded in a bin)
dist	a Distribution of particle counts
DM	Development Model
DPU	Data Processing Unit
DUM	DUMmy packet
e	energy (bin)
EID	Experiment Interface Document (ESA)
EDI	Electron Drift Instrument on Cluster
ESA	European Space Agency
exp	Experiment
FGM	FluxGate Magnetometer experiment on Cluster
Format	Amount of telemetry data between consecutive reset pulses
HAR	High Angular Resolution
Hi	High
HIP	HIgh Polar resolution distribution
HEEA	High Energy Electron Analyser
IEL	Inter-Experiment Link
LAR	Low AngularResolution
LEEA	Low Energy Electron Analyser
LEF	Low Energy Full resolution distribution
LER	Low Energy Reduced resolution distribution
LSB	Least Significant Byte/Bit
MAR	Medium Angular Resolution
MEM	Memory downlink packet
MOM	Moments dataset
MSB	Most Significant Byte/Bit
OBDH	On-Board Data Handling System
occam	Computer language for transputer, used in PEACE DPU
na	number of azimuth bins
ne	number of energy bins
np	number of polar bins
p	rolar bin
PAD	Pitch Angle Distribution
PEACE	Plasma Electron And Current Experiment
PEACE Telemetry block	Continuous portion within the ESA VC science block containing PEACE science data [4]
PEACE Telemetry packet	Independent unit of PEACE science data contained within synchronisation pattern and checksum
RAM	Random Access Memory
red	reduced
REM	Occam remainder function
res	resolution
ROM	Read Only Memory
SPC	Spacecraft Potential dataset
SCI	SCIence parameters dataset
stim	Stimulator (Produces test pulses for PEACE exp checking)

S/W	Software
TBC	To Be Confirmed
TBD	To Be Defined
UT	Universal Time (ESA definition)
VC	Virtual Channel
WHISPER	Sounder and High-Frequency Wave Analyser Experiment on Cluster
Word	16 bits = 2 bytes
3DF	3D Full resolution distribution
3DR	3D Reduced resolution distribution

Revisions

V0.1 - First version.
V0.2 - Included IEL EDI and Whisper blanking pulses.
- Modified format, frame structure and data timing method.
- Updated Evaluation Of Format section.
- Included distribution list section.

V0.3 - Major update.
V0.4 - Major update.
- Single byte Format number changed to 2 byte format counter.
- Format counter moved to 2nd word in 1st PEACE block.
- Data component 'id's changed and moved to Packet 'id'.
- Byte positions in most packets have changed.
- Spin number changed to 2 bytes.
- Included detailed structure of packet items and interpretation.

V1.0 - SCI packet expanded to 3 packets.
- LEFpackets changed from 6 to 8.
- HIP packets table contents description improved, & bug fixed.

V1.1 - Changed position of format counter to 3rd word after reset pulse.
- Improved moments data description in core packet table.

V2.0 - 08-Feb-93. Upgraded spacecraft potential dataset.
- Upgraded 'Method' section to include priority system, packets size limits and telemetering policy for non-core datasets.
- Minor typing error in HIP layout Table 10, byte 2, bit 3-6.
- Minor changes to 'Evaluation of Format' section.

V2.1 - 19-Apr-94. PJC. Explain use of telemetry mode, and dataset monitor in core.
- Upgraded memory dump and science general parameters.
- Upgraded PAD, spacecraft potential and explained data monitor added to core.

V2.2 - 13-Dec-94. PJC. Included 3DX distribution, and other minor updates.
V2.3 - 01-Jul-98. SS. Update for ClusterII
v2.4 - 01-Jun-99. ANF/SS
- Updated Table 8
- Updated references

Distribution List

1.	A. Fazakerley	MSSL
2.	P.J.Carter	MSSL
3.	B.K.Hancock	MSSL
4.	A.Spencer	MSSL
5.	G. Watson	MSSL
6.	M. Birdseye	MSSL
7.	S. Szita	MSSL

1 INTRODUCTION

1.1 Purpose

The aim of this document is to provide a sufficiently accurate specification of the science data telemetry format for the following purposes:

1. To describe the format to be used by the flight level software.
2. To enable the implementation to be tested against the specification (*e.g.* using an EGSE)
3. To enable ground data analysis to be implemented.
4. To provide an agreed permanent record of the desired task.

1.2 Inputs

An outline input to this task comes from the 'Scientific Specification' [1] and 'Operational Modes' [2] documents by A. D. Johnstone and A. Fazakerley.

Some initial development of the outline requirements were presented in the 'DPU Software Study' document by R. A. Gowen [3], from which the recommended selections were taken as the basic input to this document.

1.3 Science Telemetry Format

In order to interpret the telemetered science data, the format of that data must be known.

With Cluster, the onboard data handling (OBDH) system has been designed to take pre-defined sizes of blocks of PEACE science data at pre-defined intervals. The OBDH block size depends on the telemetry mode of the satellite. The sequential ordering of the blocks collected can be considered to make up a continuous telemetry stream.

PEACE collects and produces data at a rate synchronised with the spin of the satellite and not with the size or collection rate of the OBDH data blocks.

This means that the PEACE data production rate does not match the satellite telemetry data taking rate. This becomes even more difficult when the satellite telemetry rates and block sizes change, and also when the spin rate of the satellite changes.

Because of the above, the adopted approach is to construct 'PEACE science telemetry packets' which can be identified anywhere within the satellite telemetry stream. This is achieved by inserting synchronisation byte patterns into the telemetry stream which can be identified, and by knowing the format of the data which follow these synchronisation patterns, the PEACE science data can be extracted and interpreted.

2 SPECIFICATION

The purpose of this section is to present the formal specification for the described task. However, helpful information is also included which does not form part of the specification, and this is indicated by being enclosed in brackets.

2.1 Data Notation and Ordering Conventions

This presents the bit, byte, and data matrix ordering conventions adopted throughout the rest of this document with respect to the data organisation within the PEACE telemetry packets and the format counter.

In all cases the order of the bits and bytes, unless otherwise stated, will be low order bits and bytes first.

The following convention is used to denote 3-dimensional arrays of data. These will be designated as (np*ne*na) which means np polar bins by ne energy bins by na azimuth bins. For example, (12p*30e*32a) would give a total of 12*30*32=11520 data values. The convention of the ordering of the elements in the arrays is that leftmost indices will vary fastest. In the above example this means that the ordering of the elements will be (0,0,0), (1,0,0), (2,0,0), ..., (11,0,0), (0,1,0), (1,1,0), ...etc.

The data which correspond to the indices will be in the following order:

ip - polar	index **ip**=0 is bin which ends at $\theta = 180°$ (TBC)
ie - energy	index **ie**=0 is highest energy bin
ia - azimuth	index **ia**=0 is bin which starts at $\phi = 0°$

In addition, it should be noted that with telemetered compressed data values using an exponent and mantissa, the exponent will occupy the least significant bit positions (lsb) and the mantissa the most significant bit positions (msb).

2.2 Scope

This document will define the structure of the data telemetered in the science telemetry stream. It will not consider the structure of the data telemetered in the housekeeping telemetry stream.

2.3 Method

1. The PEACE science telemetry data will be constructed into PEACE defined science telemetry *packets*.
2. The PEACE packets will be consecutively entered into the ESA OBDH defined science telemetry blocks, abutting one another in the telemetry stream.
3. The PEACE packets may start at any point within a block, and because of this they will commence with a synchronisation byte pattern in order that their start point may be identified.

   (Because the PEACE packets will be collected synchronised to the spin of the satellite, and not the telemetry blocks, they could not easily be arranged to begin at the start point of the telemetry blocks.)
4. Time stamping of the PEACE data:
   In order to provide high precision time stamping of the PEACE data, a 'format counter' will be placed in the third 16-bit word of the first telemetry block after the reset pulse in order to identify the particular reset pulse.

(This format counter also enables a check to be made of the continuity of reception of the PEACE data on the ground.)

5. Priority ordering of PEACE datasets:
   Each type of PEACE dataset will be assigned a priority for telemetering in order that packets from the higher priority datasets is always telemetered first.

   This is primarily designed to allow the CORE datasets to queue jump so that they can always be telemetered for every spin whatever the current PEACE telemetry rate.

   This happens even if lower priority data becomes available first. The lower priority datasets will have to wait for sufficient telemetry allocation to become available.

   The priority of an individual data product can however be changed by ground command, allowing the list given in section 2.4.2 to be re-ordered. Setting to the lowest priority can effectively prevent transmission of unwanted data products.

6. Packet size limits
   So that core data can be always telemetered in every spin, the size of this packet must be less than the smallest PEACE telemetry allocation in the shortest spin: if this were not so then un-telemetered core data would build up until the internal data buffers were exceeded.

   This packet size limit is also applied to all the other PEACE packets so that any intervening telemetered non-core packets do not cause pile up of non-telemetered core packets and the consequential exceeding of buffer limits.

   Large PEACE datasets are handled by dividing the datasets into a number of packets, each of which is smaller than the above limit. Such datasets will be transmitted by telemetering each packet component in turn, until the whole dataset is completely telemetered.

7. Telemetering non-core datasets:
   Since non-core datasets may not be able to be telemetered every spin, no new dataset will be able to be entered into the telemetry buffer system until a previous particular dataset is completely telemetered.

   This means that on the ground, such datasets may only be obtained for occasional spins. The actual number of such datasets obtained per minute will depend upon the amount of spare telemetry left over after higher priority datasets have been telemetered, which will depend heavily upon the particular telemetry mode.

2.4 Architecture

The general architecture of the PEACE science telemetry system, with PEACE packets and format counter, and its interface with the OBDH system is given in Figure 1.

Each of these components is explained further below:

2.4.1 PEACE Telemetry Packets

First, the PEACE dpu will construct packets of science data.

Each PEACE science telemetry packet will be constructed from the following three components (as shown by Figure 2):

1. A header component
   This starts with a synchronisation pattern in order that the start of packet may be identified in the telemetry stream.

   It also includes an identification 'id' parameter which allows different types of science datasets to be downlinked in different packets.

   It furthermore includes a size parameter so that the different packet types can contain different amounts of data.

2. A data component
   This contains the science dataset identified by the id parameter contained in the header component. This can include a packing byte (see section 2.5).

3. A checksum component
   This component enables a simple check to be made to ensure that the packet has been correctly received after downlinking.

The components will be in the above order within the packet.

2.4.2 Priority Ordering of PEACE packets.

The constructed PEACE telemetry packets will be entered consecutively into the OBDH telemetry stream.

The packets will be constructed on a priority basis, so that the most important datasets are telemetered first in preference to other data even if the other data is ready earlier.

The priority ordering for the PEACE packets datasets is as follows, where 1 is top priority and 11 bottom priority :

1. MEM - Memory downlink
2. COR - Core data:
   MOM - Moments
   SCP - Spacecraft potential
3. PAD - Pitch angle distribution
4. NOI - Noise floor distribution
5. LER - Low Energy Reduced resolution distribution
6. 3DF - 3D Full Resolution distribution
7. 3DR - 3D Reduced Resolution distribution
8. 3DX1 - Variable Size 3d distribution
9. 3DX2 - Variable Size 3d distribution
10. SCI - Science Parameters
11. DUM - Dummy packets

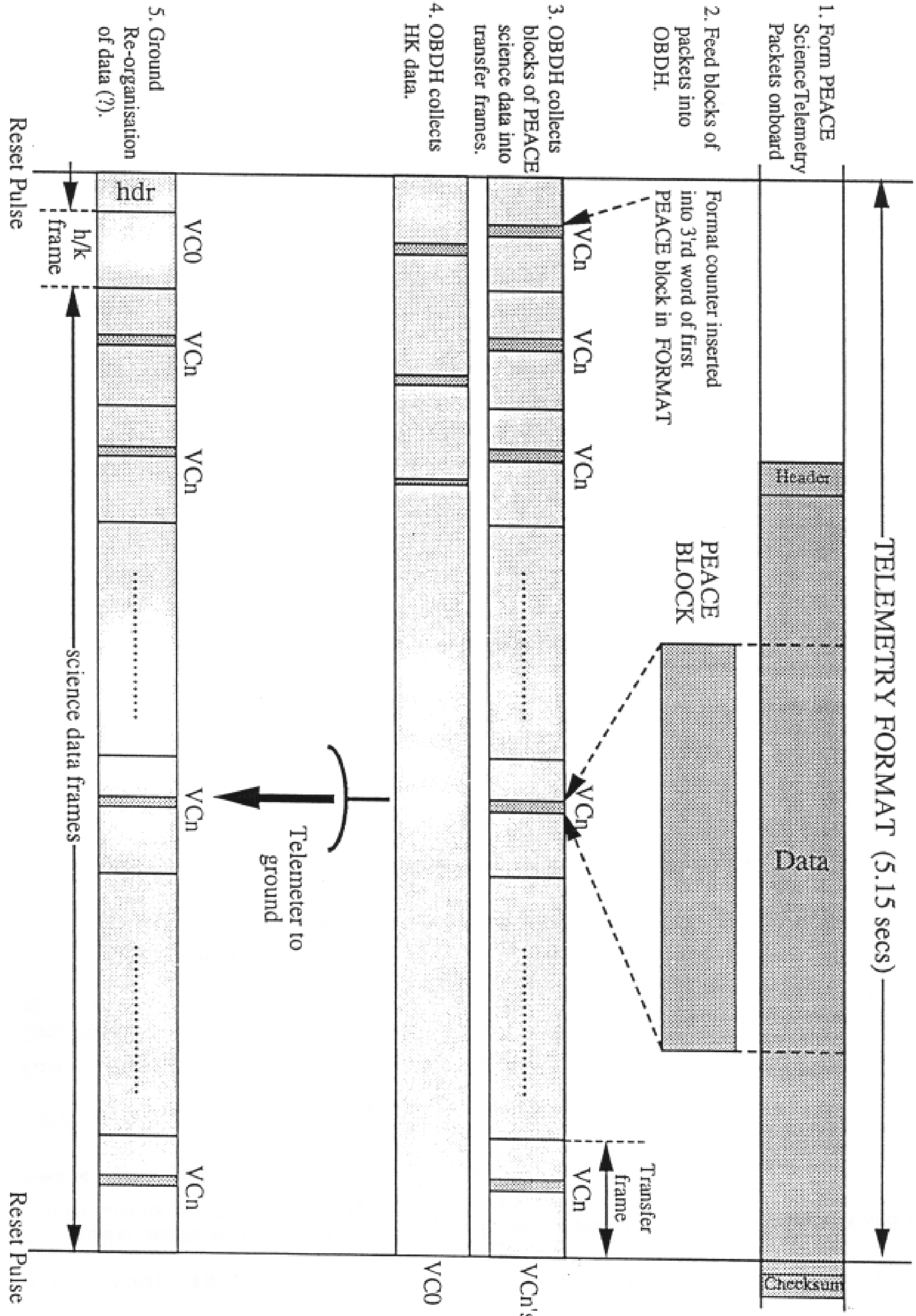

Figure 1: PEACE General Telemetry Structure

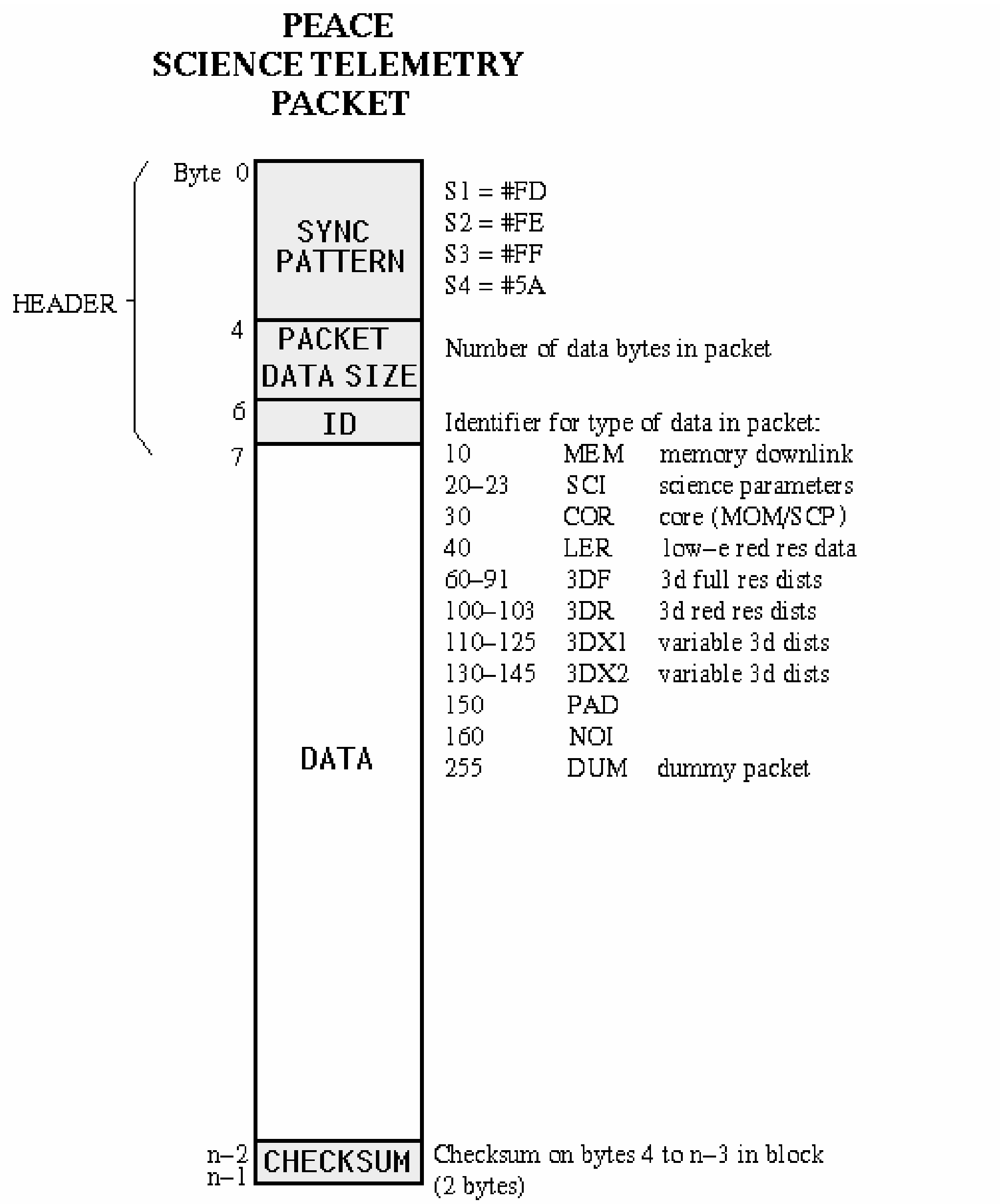

Figure 2: PEACE Science Telemetry Packet Structure

The priority system allows the high priority core data to be always transmitted, whilst the lower priority data is transmitted whenever sufficient telemetry becomes available. (Memory downlink and science parameters will only be telemetered infrequently.) It is possible to effectively omit data products by lowering their priority.

2.4.3 Timing the PEACE data (Format Counter)

In order to be able to assign times to the PEACE data, a system has been adopted which relates the start time of each spin as a time offset from the OBDH reset pulses which have UT time stamps assigned to them on the ground.

To do this, a format counter is entered into the OBDH system in a specific telemetry slot just after reception of a new reset pulse. This format counter allows the particular reset pulse, and hence the time of the reset pulse, to be identified on the ground.

This format counter cannot be entered simply within a PEACE packet because the PEACE packets are not fixed in relation to the reset pulses. Because of this, when decoding the data, this specific telemetry slot must NOT be considered to be part of a PEACE packet, but must be identified (it is the 3rd 16-bit telemetry word after the reset pulse), and extracted as the format counter.

Thus, the start times of the PEACE data can be determined on the ground by downlinking the spin number, the delay time of the spin pulse since the last reset pulse, and the format counter which identifies that reset pulse.

This timing chain is illustrated in Figure 3.

(Note: The format counter is inserted into the science telemetry stream by the main application program, the memory dump data product is produced by the executive code which runs before the main application and so will not have the format counter described above inserted in the science stream).

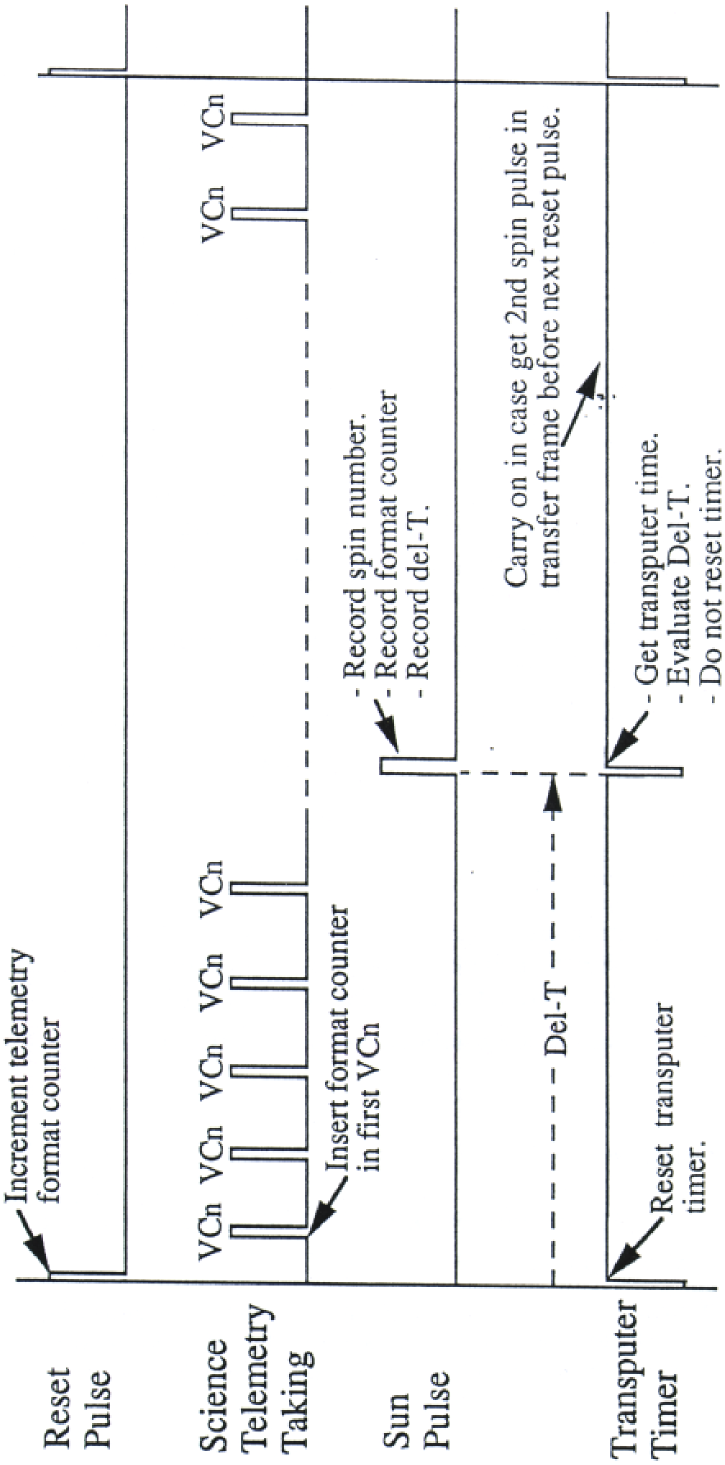

Figure 3: PEACE Spin Time Tagging

2.4.4 OBDH System

Once selected for downlinking, the PEACE packets will be gradually fed into the ESA OBDH system a block at a time.

The blocks are defined by ESA and will be a fixed size for a given telemetry mode. They will generally not align to the packet boundaries. They may even contain the end of one packet and the beginning of another. However, by laying the blocks end to end, a continuous series of PEACE packets will be formed, and will therefore be decodable by searching for the synchronisation patterns. (Do not forget the 3rd word of the first block after the reset pulse will contain the format counter and not a word of a PEACE packet.)

The ESA OBDH system will form transfer frames, each frame containing a single block of PEACE science data, the blocks of PEACE data being taken consecutively from the PEACE packets.

A set of transfer frames collected between reset pulses which occur every 5.15 seconds will be here termed a format of data. These data formats will be telemetered to the ground.

A format will contain a housekeeping frame and a number of science data frames. The number of science frames will depend upon the particular telemetry mode.

2.4.5 ESA PEACE Blocks

The ESA defined telemetry blocks containing PEACE science data are contained within the transfer frames for virtual channels $n \geq 1$, *i.e.* VCn's, but not VC0's which contain only housekeeping data [4]. These science blocks will be called PEACE blocks.

It is in the first PEACE block only of the format, that a format counter will be placed in the 3rd 16-bit word. The format counter will cycle in the range [0-65535]. (At 5.15 seconds per format, this format counter will cycle round every 3.9 days approximately).

The rest of the first block, and all other blocks in the format, will be used to place bytes from the PEACE telemetry packets.

2.4.6 Ground Telemetry Structure

On the ground, the science data must be extracted and treated as a continuous stream of data. The packets may then be identified by the location of the synchronisation bytes in the science stream. The contents of the packets must then be decoded as explained in the following sections.

2.5 PEACE Telemetry Packets

This section defines the detailed sub-structure for the PEACE telemetry packets.

The basic structure shown in Figure 2.

Note that each telemetry packet will be composed of an even number of bytes, as this simplifies the entry of packets into the OBDH telemetry system which is organised on a 16-bit word basis. For this reason, some packets include a packing byte in order to make the total number of bytes even.

2.5.1 Header

Each packet will begin with a 7 byte header component, which will contain the following items in order:

1. Synchronisation Pattern
   The header will begin with a synchronisation pattern in order that the start of a packet can be identified (this is essential for interpreting the data). This will be composed of four bytes containing #FD, #FE, #FF, #5A in hexadecimal notation, in that order.

   (The probability of obtaining this combination by random accident is one part in 4.3×10^9. The frequency at which this search for synchronisation has to be made could be estimated as once at switch-on, and then once, say, every 10 minutes when a telemetry error means that synchronisation is lost. This works out at about 145 synchronisation searches a day. Then, assuming the average size of a telemetry block is about 1 kilobyte, about 145x1024=14848 bytes of telemetry will be searched per day for synchronisation. Thus, the frequency at which a random synchronisation pattern will be detected will be once every $4.3 \times 10^9/14848 = 28926$ days = 79 years. A 3 byte pattern would be detected by chance about once every 112 days.)

2. Packet data Size
   This will be a 2 byte value which records the total number of data bytes only in the packet. (The total packet size will be the packet data size plus 7 bytes for the header and 2 bytes for the checksum.)

3. Id
   This will be a single byte which indicates which type of dataset will be contained within the PEACE science telemetry packet, as shown in Figure 2.

2.5.2 Data

The type of dataset which occupies the data component of the PEACE science telemetry packet will depend upon the id byte contained in the header component. The details of each dataset component are discussed later in subsection 2.6.

2.5.3 Checksum

The checksum will be a 2 byte value at the end of the packet. It will be a 16-bit modulo summation of all the packet bytes excluding the synchronisation pattern and the checksum itself. Starting at byte 4 in the packet, the bytes will be ganged into 16-bit values which are then 16-bit modulo summed.

2.6 PEACE Packet Datasets

This section gives the structure for the PEACE packet datasets according to the id parameter set in the header component.

2.6.1 MEM: Memory Downlink

This is to enable downlink of the state of the onboard memory, and is identified by the packet header parameter id=10.

It can be used to check RAM/ROM code and data. The memory dump facility is only available before the main code, which produces all other science telemetry packets, is run. This facility should be used in conjunction with the instrument status variable in the house keeping which is described in document [9].

Note: As this packet is produced before the main code is run the format counter described above will not be inserted in the 3rd word after the reset pulse. This means that this word will contain two valid data bytes and so should not be removed from the telemetry stream when a memory dump is being performed.

To simplify the executive code which generates the memory dump packet the checksum is generated over all bytes, including the synchronisation pattern.

The format for this type of PEACE data will be as shown by Table 1.

ID=10: MEM - MEMORY DOWNLINK			
Byte	Bits	Parameter	Values
		DATA	
0		Packing byte	
1-64468		Memory bytes	64468 8-bit values

Table 1: PEACE Memory Downlink Telemetry Format.

2.6.2 SCI: Science Parameters

This will be used to downlink parameters which are used by the science processing but do not change between experiment turn on and off.

It is too large to be downlinked as a single packet, so is divided into 4 packets, which are identified by the packet header parameter id 20 to 23.

(This dataset would normally be downlinked just before starting science processing after experiment turn-on.)

This will include those parameters in keep alive memory.

The packets will be downlinked in order, starting with packet id=20 which contains the Interface processor general parameters as shown by Table 2.

Packet id=21 will contain the LEEA moment extraction parameters as shown by Table 3.

Packet id=22 will contain the HEEA moment extraction parameters as shown by Table 4.

Packet id=23 will contain general parameters and instrument correction parameters as shown by Table 5.

ID=20: SCI - IP GENERAL PARAMETERS			
Byte	Bits	Parameter	Values
0-199		macro commands	
200-201		spare	
202-265		macro info	
266-267		spare	
268-269		IP KAL array 2 checksum	[INT16]
270-273		IP KAL array 1 checksum	[INT16]
274-275		Spare	
276-277		KAL initialisation id patterns	
278-309		[32] HK monitors lower limits	[BYTE]
310-341		[32] HK monitors upper limits	[BYTE]
342-373		[8] FGM range minimum value	[INT32]
374-405		[8] FGM range step size	[INT32]
406-437		[8] FGM x axis calibration	[INT32]
438-469		[8] FGM y axis calibration	[INT32]
470-501		[8] FGM z axis calibration	[INT32]
502-721		[110] Interface processor code directory	[INT16]
722		Packing byte	

Table 2: Science Parameters: 1st packet - IP general Parameters

ID=21: SCI - LEEA MOMENT EXTRACT ION PARAMETERS			
Byte	Bits	Parameter	Values
0-23		[6] Geometric factors	[REAL32] Reduced resolution polar anodes [0-5] (m^2 sr eV/eV)
24-395		[93] Energy levels	[REAL32] [0-92] (eV)
396-767		[93] Energy efficiencies	[REAL32] [0-92] (eV)
768		Packing byte	

Table 3: Science Parameters: 2nd packet - LEEA Moment Extraction Parameters

ID=22: SCI - HEEA MOMENT EXTRACTION PARAMETERS			
Byte	Bits	Parameter	Values
0-23		[6] Geometric factors	[REAL32] Reduced resolution polar anodes [0-5] (m^2 sr eV/eV)
24-395		[93] Energy levels	[REAL32] [0-92] (eV)
396-767		[93] Energy efficiencies	[REAL32] [0-92] (eV)
768		Packing byte	

Table 4: Science Parameters: 3rd packet - HEEA Moment Extraction Parameters

ID=23: SP - GENERAL SCIENCE PARAMETERS			
Byte	Bits	Parameter	Values
0-3		Spin period	[REAL32] in seconds
4-131		[32] Dead-time factors	[REAL32] LEEA anode [0-15] [REAL32] HEEA anode [16-31]
132-133		SP KAL array checksum	
134-135		Spare	
136-137		Spare	
138-139		Calibration id	[0 - 65536] (def = 0)
140-141		Spacecraft potential start polar zone	[0 - 8] polar zone. (def = 4)
142-143		Spacecraft potential azimuth angle	[0 - 360] degress (def = 0)
144-145		Spacecraft potential variance limit	[0-65536] (def = 1000)
146-147		Spare	
148-149		Spare	
150-151		FGM polar offset angle	[0 - 180] (def = 0)
152-153		FGM azimuth offset angle	[0 - 360]
154-373		[110] Interface processor code directory	[INT16]
374		Packing byte	

Table 5: Science Parameters: 4th packet - General Science Parameters

Notes:

1. The dead-time factors, geometric factors, energy levels, and energy efficiencies will be downlinked as occam REAL32 values.

   These REAL32 values are stored in the ANSI/IEEE standard 754-1985 format representation. This has a single sign bit 's' at the most significant bit, followed by an 8 bit exponent 'exp', and further followed by a 23 bit mantissa 'frac'.

   The number is then given by:

$$\begin{aligned} \text{number} &= (-1)^s \text{ x } 1.frac \text{ x } 2^{exp-127} && \text{if } exp \neq 0 \\ &= (-1)^s \text{ x } 0.frac \text{ x } 2^{1-127} && \text{if } exp = 0 \end{aligned}$$

2. The calibration id would indicate the current set of calibration values being used by the software. It would start with value 0 at launch and be updated by one each time any new set of calibration data is uplinked.

3. The spacecraft potential parameters are used to generate the spacecraft potential onboard. They are stored in the science processor as keep alive variables and will be changed infrequently.

4. The FGM offset angles give the position of the magnetometer relative to the spacecraft coordinate system.

5. The code directory contains the information required to run up to 9 code modules. It consists of 110 INT16 words with the following contains:

Word	Contains
0	Directory checksum
1	Number of code modules
2 - 9	Spare
10	Directory version number
11	Module 1 checksum
12	Module 1 EEPROM storage page (1 or 2)
13	Module 1 code size in bytes
14	Module 1 run time start address
15	Module 1 storage address
16	Module 1 workspace size in words
17	Module 1 workspace start address
18	Module 1 vectorspace size in words
19	Module 1 vectorspace start address
20	Module 1 code entry offset
21	Module 1 version number
22 - 110	Words 11 to 21 repeated for code modules 2 to 9

   Any unused words in the directory are set to zero. The details of the modules should follow each other sequentially in the directory. The entries in the directory can be updated from ground by command.

2.6.3 COR: Core Science Data (General/Moments/Spacecraft Potential)

This would be used to telemeter the various components of the core science data.

It is identified by the packet header parameter id=30.

(The core data is a defined set of results from a single spin which can always be telemetered each spin even at the lowest PEACE telemetry rate.)

Table 6 shows the detailed layout of the core science data block, and Table 7 shows the layout for the core data within that block.

Further explanation for the components follows:

1. Time
   This will be the start time of the particular spin.

   It will be composed of the spin number, the time delay between the previous reset pulse and the spin pulse, and the format counter associated with the reset pulse.

   Since the time of the reset pulse will be known on the ground, the above should be sufficient in order to determine the start time for the spin. This timing relationship is illustrated by Figure 3.

   (a) Spin number
       This will be a 16-bit word which counts from 0 to 65535.

       It will refer to data collected between reception of consecutive sun reference pulses, and will be incremented on reception of each sun reference pulse.

       (For the nominal spin rate of 4 seconds this will cycle round in about 72 hours.)

   (b) ΔT
       This will be a 2 byte value which represents the time difference between the start of the above spin and the latest telemetry frame reset pulse which preceded it.

       This will be counted in units of 256μs, by using the transputer low priority clock, and dividing the number of ticks by 4.

       (This will give it a range of 16.77 seconds, which is more than sufficient given that the time between reset pulses is 5.15 seconds.)

       However, the accuracy of this time will be dependent upon the scheduling of the low priority processes, and so is likely to be of the order of several tens of milliseconds. This may limit the accuracy of the start of the spin to about 0.05s (TBC). This can be assessed using the high time resolution monitor which is the number of low priority clock ticks (64μs per tick) before the sun-pulse clock runs.

       (The time of the start of the spin is then the time of the reset pulse plus the above delay time.)

   (c) Format Counter
       This is the number of reset pulses which have occurred since initialisation of the PEACE telemetry software.

       It will be a single 16-bit word, and cycle every 65536 formats.

       (It is to identify the reset pulse associated with the spin. Then, since the time of the reset pulse is given on the ground, the time of the spin can be determined by simply adding on ΔT.)

2. General Parameters

   (a) Telemetry mode
       Telemetry mode, together with the HEEA and LEEA datasets parameter, can be used to estimate which distributions are likely to be downlinked and the frequency with which they should be expected.

   (b) Coincidence/correlator channel
       This is the polar polar zone that the coincidence/correlator in the HEEA sensor has been set to for this spin.

ID=30: COR - CORE SCIENCE DATA			
Bytes	Bits	Parameter	Values
		TIME	
0-1	-	Spin Number	[0-65535]
2-3	-	ΔT	[0-32767] in units of 256μs
4-5	-	Format Counter	[0-65535]
		GENERAL PARAMETERS	
6	0-2	Telemetry Mode	0 = Normal.1
			1 = Normal.2 (CIS Priority)
			2 = Normal.3 (PEACE Priority)
			3 = Burst.1
			4 = Burst.2
			5 = Burst.3
	4-7	Coincidence/correlator zone	0 - 11 polar zone
7	0-2	LEEA Sweep Mode	0 = Non-sweeping
			1 = LAR
			2 = HAR
			3 = MAR
	3-4	LEEA Stim status	0 or 2 = Off
			1 = Variable amplitude & freq
			3 = Fixed freq, variable amplitude
	5	LEEA Grid status	0 = Off
			1 = On
8	0-6	LEEA Preset	LEEA start energy level [0-92]
9	0-4	LEEA MCP preset	LEEA MCP preset
10	0-2	HEEA Sweep Mode	(As for LEEA)
	3-4	HEEA Stim status	(As for LEEA)
	5	HEEA Grid status	(As for LEEA)
11	0-6	HEEA Preset	(As for LEEA)
12	0-4	HEEA MCP preset	(As for LEEA)
13-14		IEL - EDI blanking pulse	
	11-15	Number of events in spin	0-30 = No of events
			31 = Means $\geq$31 events
	0-9	Accumulation bin for last event	0-1023
	10	start/end of EDI pulse	
15		IEL - FGM	
	0-2	Magnetic Field select	0 = Magnetic field taken from FGM
			1 - 7 = Magnetic field taken from PEACE
	3	FGM event flag	0 = No FGM event flag
			1 = FGM event flag detected in spin
		IEL - WHISPER blanking pulse	
	4-6	Whisper mode	see Table 4.
	7	FGM/EDI high res switch state	0=FGM, 1=EDI
16-216		**CORE DATA**	
		(a) Moments Data	
		(b) Spacecraft Potential	
		(c) Data Monitor	
		(d) Magnetic field data	
		(e) LEEA and HEEA datasets	

Table 6: Detailed layout of the core general parameters

ID=30: COR (MOM/SPC) - (Moments/Spacecraft Potential/Data Monitor)			
Byte	Bits	Parameter	Values
		MOMENTS DATA	
16-43		Top Region Moments	[14] values, 16-bits each
44-71		Overlap Region-1 LEEA Moments	[14] values, 16-bits each
72-99		Overlap Region-1 HEEA Moments	[14] values, 16-bits each
100-127		Overlap Region-2 LEEA Moments	[14] values, 16-bits each
128-155		Overlap Region-2 HEEA Moments	[14] values, 16-bits each
156-183		Bottom Region Moments	[14] values, 16-bits each
		SPACECRAFT POTENTIAL	
184	0-2	Control	0 = LEEA data used 1 = HEEA data used 2 = Set to fixed value test pattern 3 = Set to incrementing test pattern 4 = No value produced
	3-6	Start Polar zone	[0-8] (Course zone)
185	0-7	Start Azimuth sector	[0-63]
186	0-7	No. of useable energy spectra found	[0-31]
187	0-7	Min Spacecraft potential value	[0-255] in 0.2 eV units
188	0-7	Max Spacecraft potential value	[0-255] in 0.2 eV units
189	0-7	Average Spacecraft potential value	[0-255] in 0.2 eV units
190	0-7	Variance	[0-255]
		DATA MONITOR	
191-192		Data bytes received monitor	
193-194		HEEA time monitor	[0-65536] in units of μs
195-196		LEEA time monitor	[0-65536] in units of μs
197-198	0-13	Sunpulse rephase offset	[0-16384]
		MAGNETIC FIELD DATA	
199-200		high res time monitor	
201-202	0-8	**B** field azimuthal angle	0 to 360 degrees
	9-12	LEEA polar zone containing **B** field in first half of spin	[0-11]
	14-15	Energy bin start offset	[0-3]
203-206		last FGM x	
207-210		last FGM y	
211-214		last FGM z	
		LEEA & HEEA DATASETS	
215-216		datasets bytes	

Table 7: Detailed layout of the core datasets (see also Table 6)

(c) Stim Status
This is used to show the mode of the stim generators on each sensor.
The data associated with the given spin is determined by the stim status parameter as follows:

stim status =	off	-	spin contains science data of observed electrons
	variable	-	spin contains engineering data for the determination of amplifier threshold levels
	fixed	-	spin contains engineering data for the verification of the onboard software.

(d) Grid status

grid status =	= on	-	means that the sensor grids have been biased to provide background measurements
	= off	-	means that the data is from normal science measurements

(e) LEEA and HEEA MCP presets
This is the step number that the sensor MCP HV generator is set to.

(f) IEL EDI Blanking Pulse
This will consist of the accumulation bin number when the last blanking pulse arrived.
(It is intended to indicate when the EDI beam is in the aperture of either the LEEA or HEEA sensor and could be interfering with our data.)

(g) IEL WHISPER Blanking Pulse
This will consist of mode information about the WHISPER experiment during the particular spin.
The mode information is contained in bits b6, b5, and b4, and is shown by Table 8 [6].

b6	b5	b4	Whisper Mode
0	0	0	No sounding
0	0	1	Synchronous (16 transmissions per spin)
0	1	0	Glide mode
0	1	1	Continuous mode
1	0	0	not used
1	0	1	Synchronous (32 transmissions per spin)
1	1	0	not used
1	1	1	not used

Table 8: Whisper Mode Format

(h) FGM/EDI high resolution switch state
A subset of FGM or EDI data is collected for commissioning purposes (t.b.c.).

(i) Magnetic Field Select
The source of the magnetic field direction can be set as follows in Table 9.
Note: for PEACE symmetry data selections, if the density in the moments regions selected is zero, the magnetic field theta and phi angles will be set to the previous spins values. The first spin will have the angles both set to zero.

3. Core Data

(a) Moments Data
Moments are computed onboard using data from the reduced 3d distributions which have resolution (6p*15e*16a).

Bit	Meaning	
0	FGM:	Use the FGM data from the IEL
1	PEACE:	Moments Top region
2		Moments Bottom region
3		LEEA overlap1 + LEEA overlap2
4		HEEA overlap1 + HEEA overlap2
5		LEEA overlap1 + HEEA overlap1
6		LEEA overlap2 + HEEA overlap2
7	Not used	

Table 9: Sources of magnetic field direction.

ID	Region	Sensor	Time resolution
0	Top	L or H	Spin
1	Overlap-1 L	L	1/2 Spin
2	Overlap-1 H	H	1/2 Spin
3	Overlap-2 L	L	1/2 Spin
4	Overlap-2 H	H	1/2 Spin
5	Bottom	L or H	Spin

Table 10: Moments Datasets Telemetered

6 sets of moments data will be telemetered in the order given by Table 10.

The 'top', 'overlap' and 'bottom' regions defined in Table 10 refer to moments results calculated from data originating in particular energy regions. Examples of these regions are given in Figure 4.

The overlap-1 and overlap-2 regions signify data from the 1st and 2nd half of the spin respectively. The 'H' and 'L' characters refer to data from the HEEA and LEEA sensors respectively.

The top, overlap and bottom regions, are energy regions defined according to the relative energy span covered by HEEA and LEEA. They are defined according to the alignment of the reduced energy bins for HEEA and LEEA. These are the reduced energy bins which apply to the reduced 3d distributions. The regions are defined more exactly as follows:

- TOP REGION
  Includes data from the reduced energy bin having the highest energy of HEEA or LEEA (Determined by examining which sensor has the highest start energy level) to the bin just above that common to both HEEA and LEEA.
- OVERLAP REGION
  Includes data from the highest reduced energy bin common to both HEEA and LEEA, to the lowest bin common to both HEEA and LEEA.
- BOTTOM REGION
  Includes data from the highest reduced energy bin which is just below the lowest bin common to both HEEA and LEEA, to the highest bin of either (a) lowest energy bin of sweep or (b) bin just above that which includes energy step 15 of energy table.

Which of the above regions are defined, and their reduced energy bin limits, can be determined on the ground from the sweep mode and preset level for each sensor.

If moments for a region do not exist, zeros will be telemetered.

TCOR (top core) is COR for the top region, which is the default case for the single sensor option. In this case overlap moments are not telemetred. Sending only top therefore saves telemetry. Details t.b.d.

It must be noted that sensible energy regions will only be determined onboard if the preset levels are set such that the reduced energy bins align exactly. This is illustrated by Figure 5.

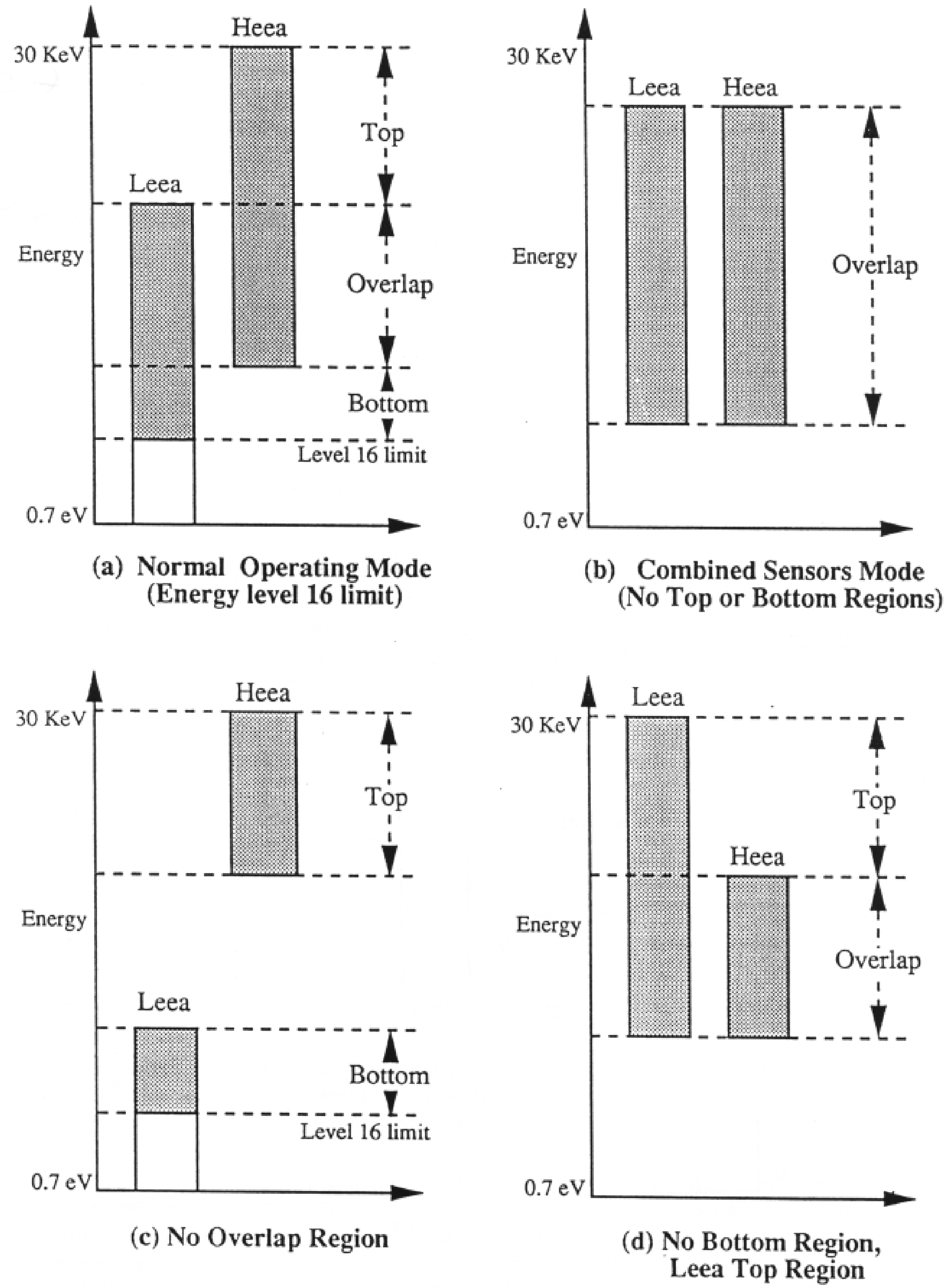

Figure 4: Moment Energy Regions - Examples

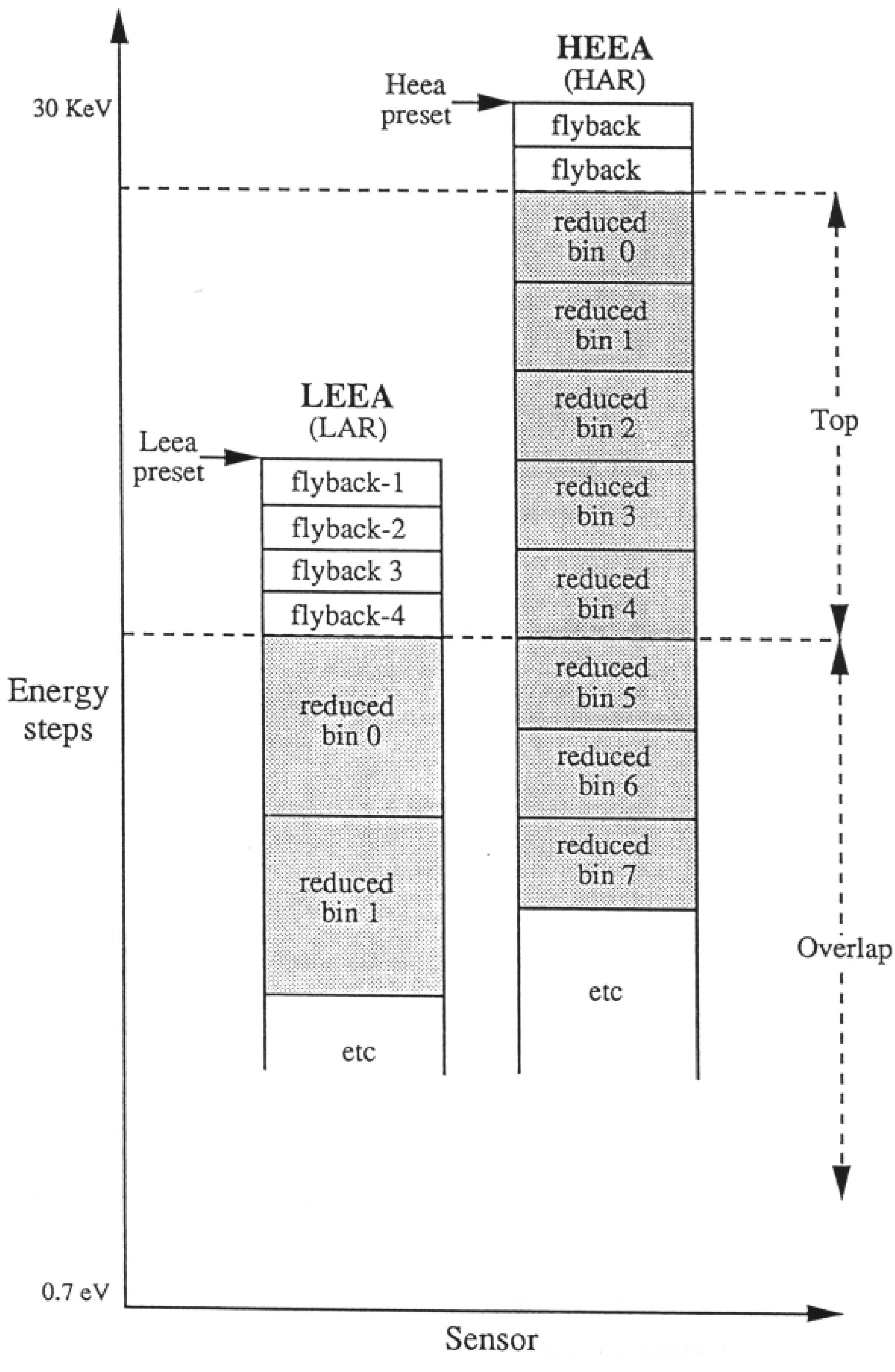

Figure 5: Presets Set To Achieve Correct Alignment Of Reduced Energy Bins.

Each moments set will consist, in order, of the following 14 parameters:

1. *total_counts*
2. *sum_n*
3. *sum_vx*
4. *sum_vy*
5. *sum_vz*
6. *sum_pxx*
7. *sum_pyy*
8. *sum_pzz*
9. *sum_pxy*
10. *sum_pxz*
11. *sum_pyz*
12. *sum_qx*
13. *sum_qy*
14. *sum_qz*

Each of the above values will be telemetered in compressed form, where each 16-bit value is arranged as shown by Figure 6. The relationship between the telemetered parameters and the standard velocity moments as defined in [5] is as follows:

$$n = sum\_n \tag{1}$$

$$u_i = sum\_u_i / sum\_n \tag{2}$$

$$P_{ij} = m_e * sum\_p_{ij} \tag{3}$$

$$Q_i = \frac{m_e}{2} * sum\_q_i \tag{4}$$

where i and $j = x$, y or z.

(b) Spacecraft Potential Data

Spacecraft potential results will be computed once per spin, according to the control parameter [8].

The control parameter may be set to produce either of the fixed or incrementing test patterns, which are designed for use in testing the IEL link to ASPOC [7].

The fixed value test pattern is designed to produce a known spacecraft potential which can be confirmed as being received correctly by ASPOC. This fixed value is downlinked here as the average spacecraft potential value. For this case all the other spacecraft potential parameters have no meaning.

The incrementing value test pattern is similar to the fixed one except that a known incrementing pattern of spacecraft potentials is sent to ASPOC, where the value is incremented to the next value in the pattern at every spin.

If the control parameter is set so that no spacecraft potential is produced at all, then all the other spacecraft potential parameters have no meaning.

If the control parameter is set to use either LEEA or HEEA data as indicated, the other spacecraft potential parameters have the following meanings:

A value for the spacecraft potential is computed, every spin, for each of up to 32 energy spectra, formed in the following way:

Each energy spectra is formed from the lowest 16 energy levels for a particular azimuth sector and polar zone. The 32 spectra are taken from 8 selected azimuth sectors for each of 4 selected polar zones. The selected polar zones are 4 consecutive zones starting at the 'start polar zone'. The selected azimuth sectors are, for each selected polar zone, the 8 consecutive azimuth sectors starting at the 'start azimuth sector'.

Each of the selected energy spectra are then analysed to determine a value for the spacecraft potential value. This analysis consists of first determining the energy bin containing the

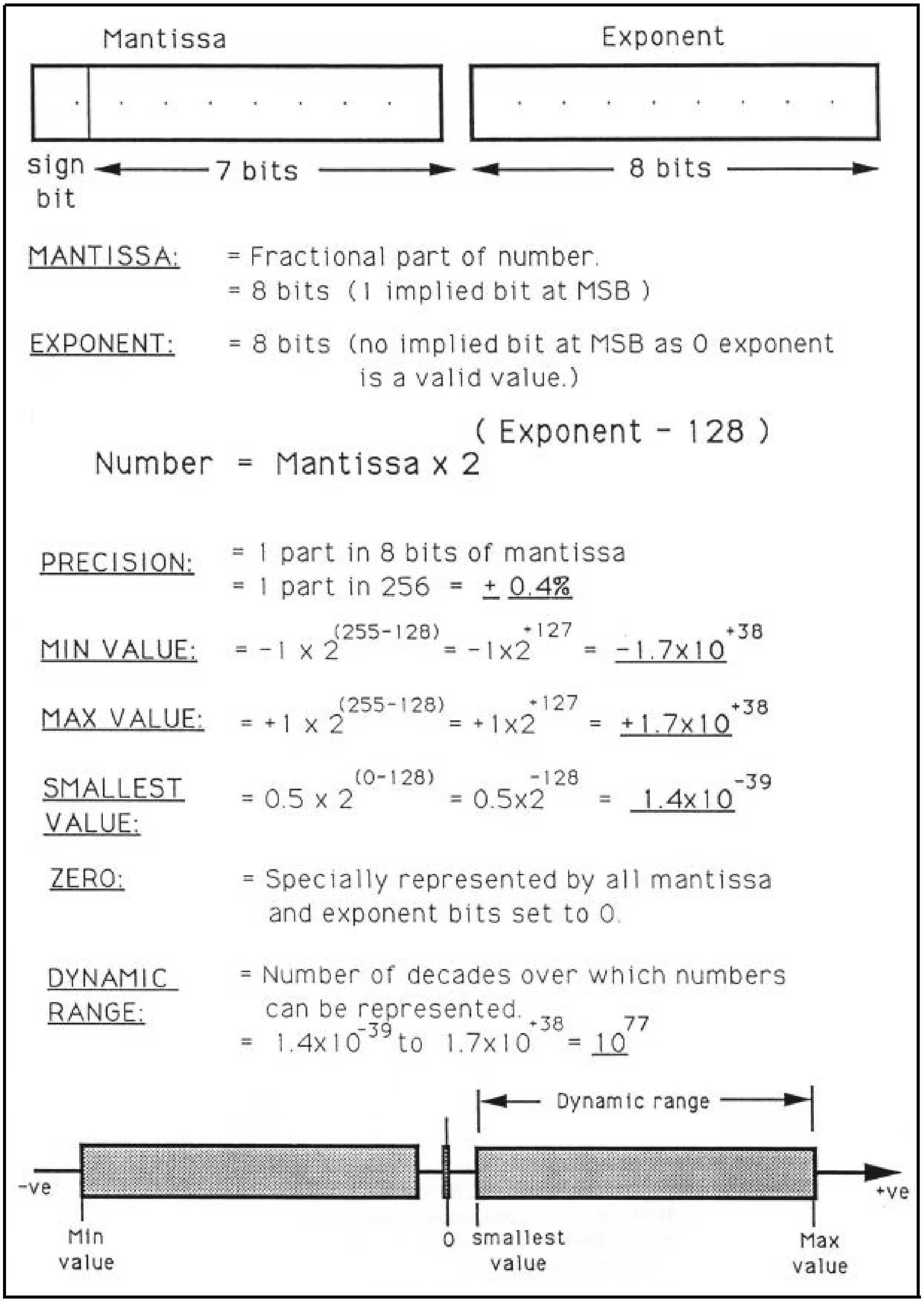

Figure 6: 16-bit Floating Point Compression Scheme

maximum count value, by starting at the counts value at the highest energy bin and seaching towards the lower energy bins for the gradient to go negative. Then, the bin containing the minimum counts which lies between the lowest energy bin and the above maximum bin, is found. The spacecraft potential will then be set to the energy value which represents the centre of that minimum counts energy bin.

Occasionally, some of the energy spectra formed will be deemed to be unusable when no maximum counts value can be found at a bin higher than the lowest energy bin. For these energy spectra no spacecraft potential value will be calculated. The 'number of useable energy spectra' parameter will be the total number of energy spectra for which spacecraft potential values could be calculated.

(Note: If no usable energy spectra are found, then no statistical calculations are performed and no value sent to ASPOC.)

From the total number of spacecraft potential values the average, minimum, maximum and variance are calculated, and telemetered as the final parameters shown, in units of 0.2 eV.

(Note: If the variance is equal to or greater than the variance reference value stored in keep alive memory no value is sent to ASPOC.)

(c) Data monitor

The purpose of the data monitor is to check the integrity of the data received from the LEEA and HEEA sensors for each spin.

The total bytes received is the number of bytes accumulated by the LEEA or HEEA sensor in the last 1/16 of a spin. If the number of LEEA bytes is less than, or equal to, the number of HEEA bytes then the number of LEEA bytes is telemetered, if not the number of HEEA bytes will be telemetered.

The LEEA and HEEA timers measure the time between the last data byte received from each sensor and the sun-pulse. The time is measured in μs.

The sun reference pulse offset is the number of spin segment clock pulses by which the sun reference pulse is delayed before being used by the DPU.

High resolution timing monitor:

This is a 16-bit integer giving a timing offset in units of 64μs which can be applied to the ΔT parameter to provide more accurate timing.

(d) Magnetic field data

FGM x, y, z are the components of the magnetic field vector as received from the fluxgate magnetometer just prior to the end of a PEACE spin. They are in units of 1/32 nT. This is always experimental field data, never values generated from the observed particle distribution.

Magnetic field azimuthal angle and LEEA polar zone give the polar coordinates of the magnetic field direction in the PEACE coordinate system for the previous spin. These could be from FGM or from onboard calculations of the the symmetry axis of the particle distribution. Note that if FGM angles are used for onboard calculations, error checking is advised on the ground.

Note that both the FGM and internally generated magnetic field data in a COR packet come from the previous spacecraft spin.

Energy bin start offset is used to indicate if odd or even energy bins have been stored for the PAD when the sensor is in LAR mode.

EDI data can be inserted into the core in place of FGM data (see 'DPU Commanding System Specification' document).

(e) LEEA and HEEA Datasets

These are bytes where each bit indicates whether the DPU has been commanded to produce the listed datasets from the indicated sensor. The meaning of each bit is shown in Tables 11 and 12 as follows:

If for a particular dataset the bit is set to 1 (on), this does not necessarily mean that this dataset will appear in the telemetry for this spin. That depends upon the priority of the dataset in the telemetry list, and the capacity of the particular telemetry mode (See section on evaluation of format).

Byte 0 (core 215)	
Bit	Meaning (0=off, 1=on)
0	full core
1	top core
2	PAD
3	NOI
4	LER
5	3DF
6	3DR
7	3DX1

Table 11: Dataset Command State, Byte 0

Byte 1 (core 216)	
Bit	Meaning (0=off, 1=on)
0	3DX2
1	Init packets
2	3DX1 SPAD
3	3DX2 SPAD
4	3DR LEEA only
5	3DR HEEA only
6	3DX2 sensor switch mode
7	0=use LEEA data in LER 1=use HEEA data in LER

Table 12: Dataset Command State, Byte 1

Note:

- Full core and top core cannot be on together (see section 3a)
- PAD and NOI cannot be on together
- 3DR LEEA only means only LEEA portion of 3DR sent; likewise for HEEA
- 3DX1 and 3DX2 are two alternative 3DX data products which were not available on the original Cluster mission. 3DX2 can use simultaneous LEEA and HEEA observations, 3DX1 cannot.
- It is not possible to have 3DX SPAD using LEEA and HEEA together; although 3DX data products can be produced from half LEEA and half HEEA (both collected on the first half of the spin) this is not possible for SPAD. See Section 2.6.7.
- The "init packets" (bit 1, Table 12) refers to the four science packets shown in Tables 2 to 5.
- Bit 6 (Table 12) is a switch for the SPAD to select LEEA or HEEA.

2.6.4 LER: Low Energy Reduced Resolution Distribution

This is to downlink low energy data at reduced resolution.

It is identified by the packet header parameter id=40.

The format for the downlink of this distribution is shown by Table 13. These will consist of either HEEA

ID=40: LER - Low Energy Reduced Resolution Distribution			
Byte	Bits	Parameter	Values
		HEADER	
0-1		Spin number	[0-65535]. (The time associated with the spin number can be obtained from the core data.)
		DATA SET	
2-193		Low-E data	(192, 8-bit values) (3p*ne*na) (4-bit mantissa, 4-bit exponent)
194		Packing byte	

Table 13: Detailed layout of Low-E distribution data.

or LEEA data as indicated by the LEEA and HEEA datasets bytes in the core general parameters.

This distribution is composed of only the lowest energy bins of the sweep. For LAR mode it is the lowest 16 energy bins, and for MAR and HAR modes the lowest 8 energy bins.

Not all azimuth bins are included.

For LAR mode, only 4 out of the total of 16 azimuth bins are included. The sectors selected depend on the spin number as follows:

1st selected sector = REM(spin number /4)
2nd selected sector = 1st sector + 4
3rd selected sector = 2nd sector + 4
etc ...
so subsequent sectors = previous sector + 4

For MAR mode, 8 sectors out of 32 are similarly selected, as follows:

1st selected sector = REM(spin number /4)
etc...
so subsequent sectors = previous sector + 4

For HAR mode, 8 sectors out of 64 are similarly selected, as follows:

1st selected sector = REM(spin number /8)
etc ...
so subsequent sectors = previous sector + 8

For the selected energy and azimuth bins, the polar resolution is reduced to 3 bins by summing the counts over the polar zone bins as follows:

$$low\_E\_cts(p_0, ie, ia) = \sum_{ip=0}^{3} cts(ip, ie, ia) \quad (5)$$

$$low\_E\_cts(p_1, ie, ia) = \sum_{ip=4}^{7} cts(ip, ie, ia) \quad (6)$$

$$low\_E\_cts(p_2, ie, ia) = \sum_{ip=8}^{11} cts(ip, ie, ia) \quad (7)$$

Thus, each low energy distribution will consist of 192 values composed of (3p*16e*4a) bins for LAR, and (3p*8e*8a) bins for HAR and MAR modes.

(Note: With the above method of effectively sub-commutating the azimuth bins, a low energy distribution covering all azimuth bins could be formed over a 4 spin period with LAR, or 8 spins for MAR and HAR modes. Such a distribution would of course be composed of slices of data from each of the included spin.)

These values will be telemetered as single byte values, using the same 8-bit, 3% compression scheme as shown by Figure 8.

2.6.5 3DF: 3D Full Resolution Distribution

This is to downlink both LEEA and HEEA polar zone data at full resolution.

It is too large a dataset to be downlinked in a single packet, so is divided into 32 equal size sections. Each section is placed in an individual packet. The packets are downlinked in order, and are identified by the packet header parameter id 60 to 91.

The format for the downlink of this distribution is shown by Table 14.

ID=60-91: 3DF - 3d Full Resolution Distribution			
Byte	Bits	Parameter	Values
		HEADER	
0-1		Spin number	[0-65535]. (The time associated with the spin number can be obtained from the core data for that spin number.)
		DATA SET	
2-721		Full 3d data	(720, 8-bit values) (np*ne*na) (5-bit mantissa, 3-bit exponent)
722		packing byte	

Table 14: Layout of full 3d distribution data.

These values will be telemetered as single byte values, using an 8-bit, 1.5% accuracy compression scheme as shown by Figure 7.

It will be composed of all the polar zone data bins from both LEEA and HEEA, which is 23040 data values.

(Since 60 data accumulation bins are collected per 22.5 degree azimuthal sector, and each consists of 12 polar zone bins per sensor, then a total of (60*16)*12*2 = 23040 data values will be telemetered.)

The data will be telemetered in multiple sections of 720 bytes of data.

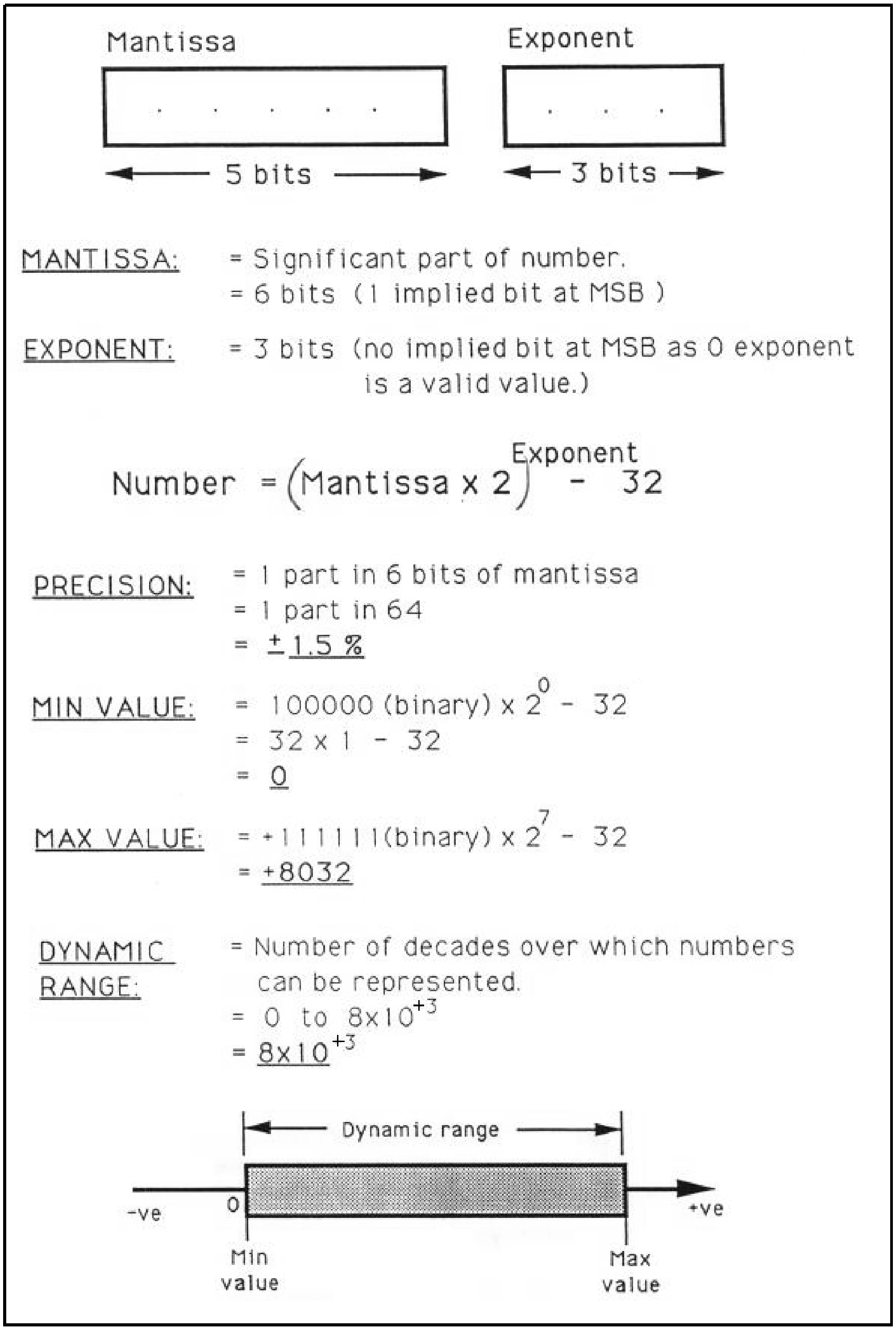

Figure 7: 8-bit, 1.5% Accuracy, Compression Scheme

The ordering of the telemetered data will be all the LEEA data before that from HEEA. The data within each sensor will be ordered as (np*ne*na).

2.6.6 3DR: 3D Reduced Resolution Distribution

This is to downlink both LEEA and HEEA polar zone data at reduced resolution.

It is too large a dataset to be downlinked in a single packet, so it is divided into 4 equal size sections. Each section is placed in an individual packet. The packets are downlinked in order, and are identified by the packet header parameter id 100 to 103.

The format for the downlink of this distribution is shown by Table 15.

ID=100-103: 3DR - 3d Reduced Resolution Distribution			
Byte	Bits	Parameter	Values
		HEADER	
0-1		Spin number	[0-65535]. (The time associated with the spin number can be obtained from the core data for that spin number.)
		DATA SET	
2-721		Reduced 3d data	(720, 8-bit values) (6p*15e*16a) (4-bit mantissa, 4-bit exponent)
722		packing byte	

Table 15: Layout of reduced 3d distribution data.

These values will be telemetered as single byte values using an 8-bit, 3% compression scheme as shown by Figure 8. For each sensor the data will consist of (6p*15e*16a) = 1440 values. The LEEA data will be transmitted first.

An option exists to telemeter only the LEEA or HEEA portion of the 3d distribution.

2.6.7 3DX: Variable Size 3d Distribution

It is too large a dataset to be downlinked in a single packet, so it is divided into 16 equal size sections. Each section is placed in an individual packet. The packets are downlinked in order, and are identified by the packet header parameter id 110 - 125 for 3DX1 and id 130 - 145 for 3DX2.

The format for the downlink of this distribution is shown by Table 16.

This will consist of data from either LEEA or HEEA as indicated by the LEEA and HEEA datasets parameters as given in the core data general parameters and repeated in the 3DX setup parameter contained in each 3DX packet.

The order of the data will be np*ne*na where the number of polar, energy and azimuth bins depends on how the 3DX has been constructed. This information can be extracted from the 3DX setup parameter shown in Table 17.

If the window in energy bit is set in the 3DX setup byte then data are taken from the energy bin defined by start energy (byte 2) to the energy bin just before the end energy (byte 3), *i.e.* end energy - 1.

The summation is performed over two consecutive bins, so if polar bins are summed the dataset will be (6p*ne*na), and if energy bins are summed the dataset will be (np*15e*na). Note that polar and energy bin pairs may be summed but **not** azimuthal bins.

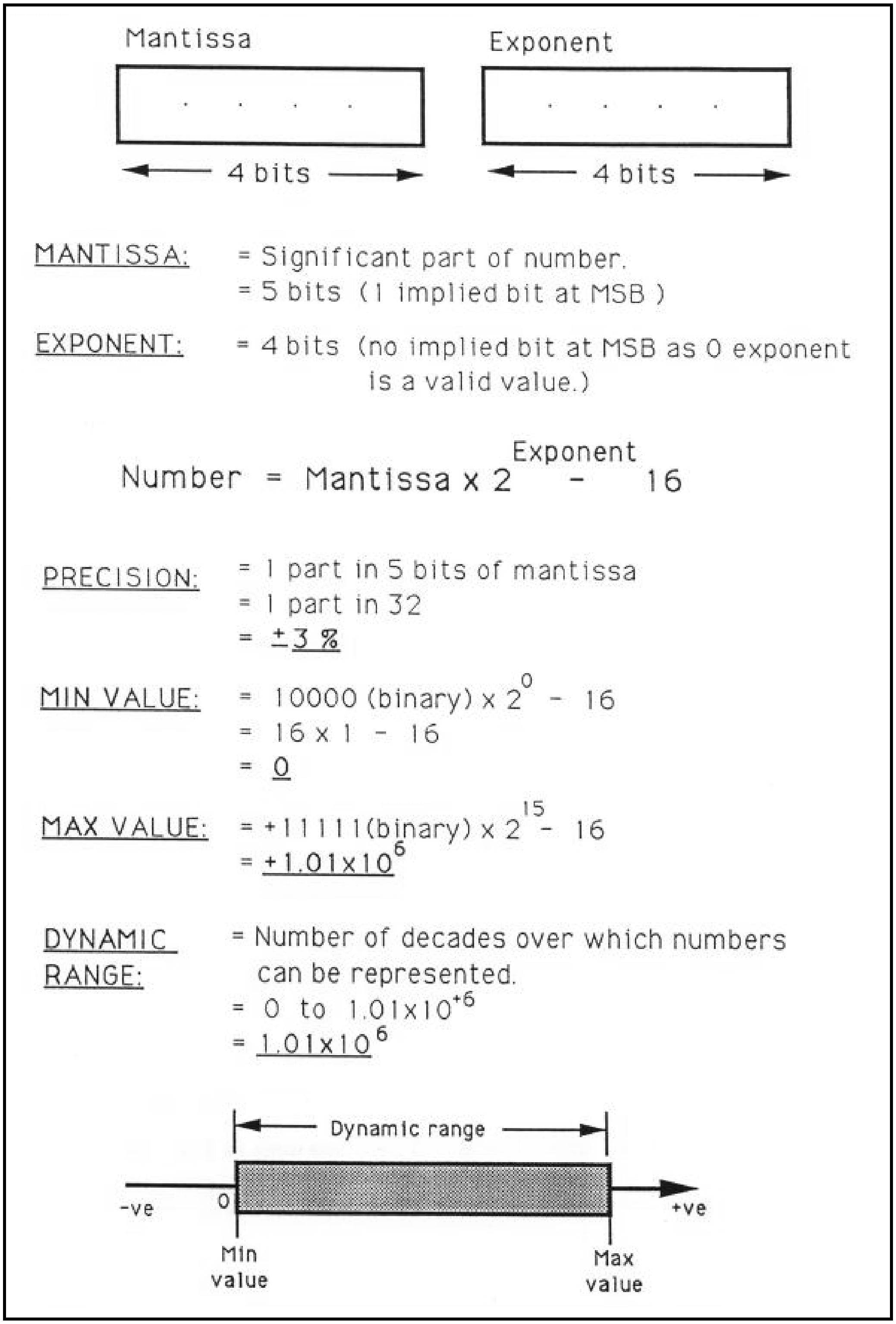

Figure 8: 8-bit, 3% Accuracy, Compression Scheme

ID=110-125: 3DX1, ID=130-145: 3DX2 - Variable Size 3d Distributions:			
Byte	Bits	Parameter	Values
		HEADER	
0-1		Spin number	[0-65535]. (The time associated with the spin number can be obtained from the core data for that spin number.)
		DATA SET	
2		Start energy	First energy bin of the distribution
3		End energy	Last energy bin is (end energy - 1)
4	0-5	3DX setup	Details the source and bins summed in the dataset
5-n		3DX data	(n - 4, 8-bit values) (np*ne*na) (n is always even)

Table 16: Layout of variable 3d distribution data.

Bit	Meaning (1 = On, 0 = Off).
0	Use fine zone data. Note: the fine zone data have been removed for Cluster II
1	Window in energy from start energy to (end energy - 1).
2	Sum polar or energy bins as defined by bit 3.
3	1 = sum polar bins. 0 = sum energy bins.
4	Use LEEA data.
5	Use HEEA data.

Table 17: 3DX datasets setup commanding

These values will be telemetered as single byte values using an 8-bit, 1.5% accuracy compression scheme unless bit 2 of the 3DX datasets setup byte is set, in which case the 8-bit, 3.0% accuracy compression scheme is used.

If a dataset contains less than 96 data bytes per 3DX packet, or 286 or 586 data bytes per 3DX packet, the distribution is not telemetered.

If both the LEEA and HEEA bits in the 3DX setup byte are set the dataset will consist of LEEA data from the first half of a spin in packets with an even packet id and HEEA data from the first half of a spin in packets with an odd packet id *i.e.* the simultaneous collection of LEEA and HEEA data from opposite azimuth bins (see notes accompanying Table 12).

In the special case of SPAD:

If the Super PAD bit (SPAD) defined in Table 12 “Dataset Command Stare, Byte 1” (which used to be called the HEEA datasets byte) of the core is set then only the 3DX packet aligned with the magnetic field direction for that spin and 3DX packet 180 degrees in azimuth away from the magnetic field direction are telemetered, *i.e.* LEEA **or** HEEA data are collected, two measurements half a spin apart.

If the switch sensor mode is selected the SPAD (for 3DX2 only) returns the 1 HEEA packet that contains the field direction and 1 LEEA packet that contains the field direction. This is the special case for which LEEA and HEEA data are collected simultaneously.

2.6.8 PAD Data

The PAD data packet is identified by the packet header parameter id 150. The format for the downlink of the PAD distribution is shown by Table 18.

ID=150: PAD - (Pitch Angle Distribution)			
Byte	Bits	Parameter	Values
0-1		spin number	
2-3	0-8	**B** field azimuthal angle	
	9-12	LEEA polar zone with **B** field	
	14-15	energy bin start offset	
4		LEEA azimuth sector	
5		HEEA azimuth sector	
6-785		780 bytes PAD data	

Table 18: Layout of pitch angle distribution data

PAD distributions will be collected and completely telemetered each spin as part of the core data only. The PAD is composed of data from the previous spin (*i.e.* spin number - 1).

The PAD data for each spin consists of selected full resolution data from consecutive half spins.

For each half spin, data from only the azimuthal sectors a_L and a_H which contain the onboard estimated magnetic field direction will form the PAD distribution (see Figure 9). The a_H and a_L indices refer to the selected azimuthal sector in the range [0-(na-1)], where ‘na’ is the total number of azimuthal sectors per spin corresponding to the sweep mode for the particular sensor. The telemetred bins depend on the sweep mode.

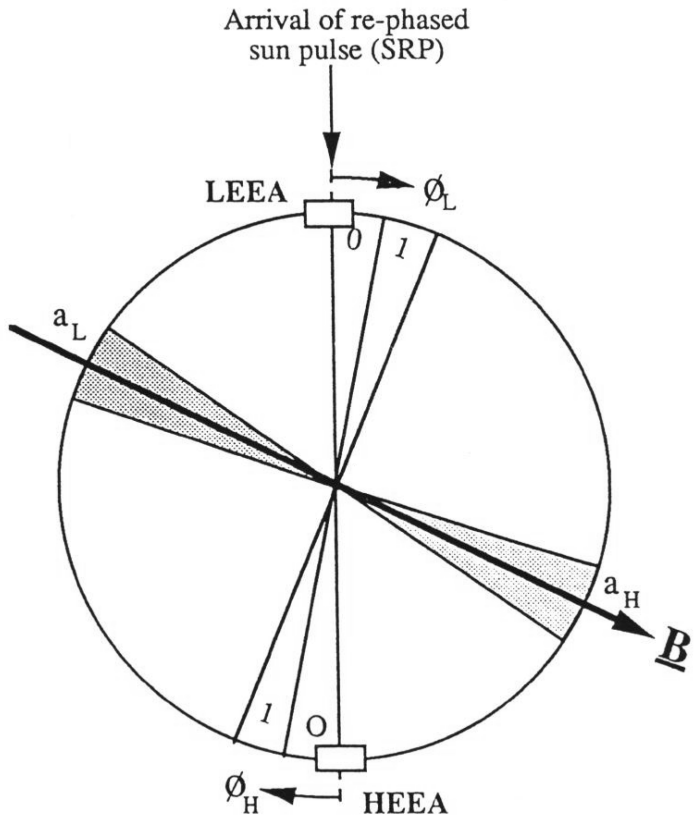

Figure 9: Selected Azimuth Sectors for PAD.

30 energy bins are telemetered as follows:

HAR sweep mode: All 15 energy bins telemetered from the magnetic field sector
and one other adjacent sector (1-15 telemetred; 0 is flyback).
MAR sweep mode: All 30 energy bins telemetered from the magnetic field sector
LAR sweep mode: Every 2nd energy bin telemetered from the magnetic field sector
(2-31 telemetered; 0 and 1 flyback).
One of sets (a) or (b) as follows:
(a) 4, 6, 8, ..., 62 (0,1,2,3 flyback)
(b) 5, 7, 9, ..., 63
set (a) is telemetered for even spin numbered data,
set (b) is telemetered for odd spin numbered data.
So 30 bins are sent, 4 are flybacks.

Note that consecutive bins are telemetred for HAR and MAR, whereas LAR sends every second bin.

For the selected azimuth and energy bins, only data from 13 polar bins will be telemetered as follows (Figure 10):

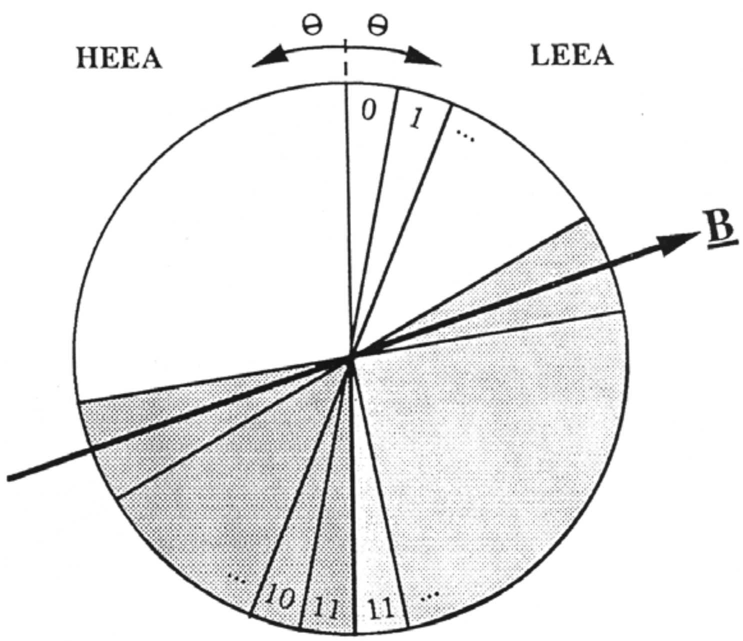

Figure 10: Selected Polar Zone data for PAD.

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For the first half of the spin, polar bins [n to 11] will be telemetered for LEEA, and polar bins [(11-n) to 11] for HEEA, where n is the polar polar zone which contains the magnetic field direction in the range [0-11].

For the second half of the spin, polar bins [(11-n) to 11] will be telemetered for LEEA and [n to 11] for HEEA.

The total number of values telemetered = (13p*30e*1a) or (13p*15e*2a)
= 390 values per half spin = 780 values per spin.

Each value will be telemetered in compressed form, where each value is represented in a single byte to 1.5% accuracy, as shown by Figure 7.

The order of the transmission will be LEEA data followed by HEEA data and [np=ip to 11]*ne*na where ip is as defined above for each half spin.

2.6.9 NOI

The NOI data packet is identified by the packet header parameter id 160.

The format for the downlink of the NOI distribution is shown by Table 19.

ID=160: NOI - Noise data			
Byte	Bits	Parameter	Values
0-1 2-513		spin number 512 bytes noise data	

Table 19: Layout of noise data

The format of the data will be (16p*1e*16a) = 256 bytes.

All energy bins and, when necessary, azimuth sectors will be summed together to achieve this resolution.

Polar bins 0-11 will contain polar zone data. Zones 12-15 are no longer connected due to the fines zones no longer being used: counts in these zones will indicate a higher level noise since these zones have a higher threshold.

LEEA data will be telemetered first, then HEEA data.

The total number of data bytes will be 2*256 = 512 bytes.

2.6.10 DUM: Dummy Packet

If no other data is available to be telemetered, a dummy packet consisting of 200 data bytes with values of zero will be telemetered. This ensures that the DPU can always respond to telemetry requests from the OBDH.

It is identified by the packet header parameter id=255.

The format for the downlink of this dummy packet is shown by Table 20.

ID=255: DUM - Dummy Packet			
Byte	Bits	Parameter	Values
0-199 200		Dummy data packing byte	200 8-bit values set to 0.

Table 20: Layout of Dummy Packet.

3 EVALUATION OF FORMAT

This section seeks to evaluate the format design with respect to flexibility, limitations and performance.

3.1 Performance

Here we consider the overhead used by header/descriptive information compared with the actual science data. This will be discussed in relation to the various telemetry objects, as follows:

1. ESA PEACE Science Telemetry Block
   Table 21 shows the science telemetry block sizes for the PEACE experiment. It also shows the number of bytes available for PEACE science data after the block header bytes used to store the format counter are subtracted.

Telemetry Mode	Telemetry Rate (bits/s)	Block Size (bytes)	Format			Block Overhead (%)
			No. of blocks	Header (bytes)	Data (bytes)	
1. Normal.1	2515.42	162	10	2	1618	0.12
2. Normal.2(CIS Priority)	1521.67	98	10	2	978	0.20
3. Normal.3(PEACE Priority)	3540.22	228	10	2	2278	0.09
4. Burst.1	15980.68	166	62	2	10290	0.02
5. Burst.2	3658.23	38	62	2	2354	0.08
6. Burst.3	1926	20	62	2	1238	0.16

Table 21: PEACE Science Telemetry Block Sizes

   From this table the worst case situation is for the CIS priority mode where 2 header bytes are required for every 978 data bytes. This is approximately a 0.2% overhead.

2. PEACE Core Science Telemetry Packet
   This is 226 bytes long, and the distribution between header and data bytes is shown in Table 22.

Item	Header (bytes)	Data (bytes)
1. Packet Header	9	-
2. Core Header	16	-
3. MOM	0	168
4. SCP	3	4
5. Other	26	-
Subtotals	54	172
Total	226 bytes	

Table 22: PEACE Core Science Packet Header/Data Bytes Usage

   This table shows that 54 header bytes are required for every 172 data bytes.

3.2 Flexibility

Since any of the PEACE data packets, whether core or one of the distribution types, are completely self contained, they can be telemetered in any order.

This allows telemetry prioritisation so that the core data can always be sent in preference to any other type of data.

Also, the 'datasets' commanding allows downlinking of only selected datasets, thereby avoiding wasting of telemetry for datasets not applicable to certain scientific study programs.

The breaking down the telemetering of 3d distributions into multiple smaller packets allows new core data to be inserted between the telemetry of adjacent 3d distribution packets, so that core data can always be telemetered every spin.

3.3 Limitations

The amount of telemetry required to continuously downlink all the currently defined core data is approximately (226+2) = 228 bytes = 1834 bits/spin (which represents a worst case since less than 2 format bytes are required per spin, since a telemetry format only occurs every 5.15 seconds).

At the nominal spin rate this requires a telemetry allocation of 456 bits/s which is within our minimum of 1521 bits/s nominal allocation for the CIS priority mode.

At the fastest spin rate of 3.6 seconds, a telemetry allocation of 507 bits/s, which is still well within our minimum telemetry allocation.

3.4 Possible Use of PEACE Telemetry Allocations

This section considers what formats of PEACE data could be telemetered within the PEACE telemetry allocations.

Table 23 shows the telemetry rates which would be required for continuous real-time downlink of the various PEACE datasets. The dataset size is the amount of telemetry required to downlink the complete distribution, including the packet overheads but not the block count overheads.

Item	Dataset Size (bytes)	Telemetry rate required	
		nominal spin (kbits/s)	3.6s spin (kbits/s)
0. COR	226	0.452	0.502
1. LER	204	0.408	0.453
2. NOI	514	1.028	1.142
3. 3DF	23424	46.848	52.053
4. 3DR †	2928	5.858	6.507
5. 3DX	N/A	N/A	N/A
6. PAD	796	1.592	1.769

Table 23: Telemetry Rates Required for PEACE Distributions

† If the 3DR distribution is made from either LEEA or HEEA data only, the dataset size is half that shown.

Table 24 shows which of the above distributions may be telemetered in a single spin for the different PEACE telemetry modes. The allocation to PEACE which is left after subtracting the block overheads

Telemetry Mode	ESA allocation (kbits/s)	Block over-head	Packet allocation (kbits/s)	Distributions downlinked completely (kbits/s)	Single spin use (kbits/s) †
1. Normal.1	2.515	0.12%	2.512	COR, LER, PAD	1.48/2.097
2. Normal.2(CIS Pri)	1.521	0.20%	1.518	COR, LER	0.86/0.955
3. Normal.3(PEACE Pri)	3.540	0.09%	3.537	COR, LER, PAD	1.48/2.097
4. Burst.1	15.980	0.02%	15.977	COR, LER, PAD 3DR, and for most spin rates a 3DX	0.7075/8.604
5. Burst.2	3.658	0.08%	3.655	COR, LER, PAD	1.48/2.097
6. Burst.3	1.926	0.16%	1.923	COR, LER	0.86/0.955

† The values in this section are given in the form 'a/b' where 'a' relates to the nominal spin and 'b' to the fastest spin rate of 3.6s. The values in this section includes the block overheads.

Table 24: Distributions Downlinked Completely Every Spin.

is called the packet allocation. The telemetry allocation which is available, after the downlinking of complete datasets at the high time resolution of a single spin, is used to downlink lower priority datasets.

Since this remaining telemetry allocation is not sufficient to completely telemeter the lower priority datasets every spin, the other datasets will be downlinked less frequently. This means that, perhaps only every 4th dataset collected will be downlinked (*i.e.* snapshot datasets collected occasionally).

Table 25 shows how long it would be expected to take to telemeter 3d distribution data of both full and reduced resolution at the nominal spin rate. This table gives the time to telemeter both LEEA and HEEA distributions, and assumes that a reduced resolution distribution has a factor 8 less bins (energy, polar, azimuth) than the full resolution distribution.

Telemetry Mode	3d-dists allocation (kbits/s)	Time to Telemeter			
		3DF (see note 1)		3DR	
		(Spins)	(Time)	(Spins)	(Time)
1. Normal.1	0.000	-	-	-	-
2. Normal.2(CIS Priority)	0.000	-	-	-	-
3. Normal.3(PEACE Priority)	0.937	50.00	3.33 mins	6.2 5	25.00 secs
3. Burst.1 †	13.377	3.50	14.01 secs	0.44	1.75 secs
4. Burst.2	1.055	44.41	2.96 mins	5.55	22.21 secs
5. Burst.3	0.000	-	-	-	-

† If reduced 3d distributions are telemetered in Burst.1 mode, the remaining telemetry allocation can be filled with a variable 3DX distribution.

Table 25: PEACE Additional Multiple Spin Telemetry Capability

From this distribution telemetering table, two things should be noted:

1. That the total cycle in collecting and downlinking full resolution 3d-distributions will be one more spin than quoted in Table 25, (*i.e.* a whole spin is required to accumulate 3DF before transmission) since there is insufficient memory to collect another spin of data whilst telemetering the old one.
2. That for Burst.1 mode, sufficient allocation exists to telemeter all distributions down in a single spin with 3DF reduced by factor 8 resolution to produce 3DR.

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COMMAND VERIFICATION

Version 1.1
23-Nov-1999

VERSION 1.0 OF 16 NOV HAS BEEN MODIFIED SLIGHTLY

1. INTRODUCTION

This document explains how to verify that a PEACE command has been succesfully received and executed, by means other than the command echo. Some commands may be verified using data in the HK data stream, others using data in the Science data stream.

This Appendix should be read together with PEACE User Manual Chapter 3.

2. VERIFICATION TABLES

The following table (spread over several pages) shows:

- the ESOC name for a command (note that the first character in an ESOC name, such as nXPEA3001, which is n, stands for a spacecraft number 1,2,3 or 4; also the 3 following PEA implies prime interface, and will be a 6 for the case of the redundant interface)
- the PEACE User Manual name for a command
- the fixed bit pattern for the command
- "parameter" is occasionally given. Parameters are of the form pppp and can be added to te fixed bit pattern to give the desired command. Many parameters have been defined which are not discussed here. This document discusses only a limited set of specific, commonly used examples. As an example, the fixed bit pattern 5200 with parameter 0091 describes the case of the command 5291)
- verification in Science data (SCI), where COR means that verification of this command is available in the PEACE COR packet and INIT means that verification of this command is available in one of the PEACE Initialisation packets. ESOC cannot open Science packets. The four INIT packets are produced whenever science processing is started, i.e. after the command 4700, but are not produced thereafter while science processing is running. COR is produced once per spin, all the time that science processing is running.
- Verification in Housekeeping data (HK)
- Description of the command

Note that there may often be a set of parameters which could be added to fixed bit patterns, but which are not included. The following tables deal only with the most commonly used commands.

Note that some commands are not verifiable in either the Housekeeping or the Science telemetry.

ESOC name	**User manual name**	**Fixed Bit Pattern**	**Para meter**	**Verification in**		**Description**
				SCI	**HK**	
nXPEA3001	ZEPDLOWL	8000			EPD_DPST	Low level command (perform only at hardware turn on)
nXPEA3002	ZEPDCONF	4f55				Confirmer command
nXPEA3003	ZEPDDATS	0000		COR		Dataset select
nXPEA3004	ZEPDHDTC	7700		INIT		HEEA Dead Time Correction factor (control word)
nXPEA3005	ZEPDDTCF	0000		INIT		Dead Time Correction factor (parameter word)
nXPEA3006	ZEPDLDTC	5700		INIT		LEEA Dead Time Correction factor (control word)
nXPEA3007	ZEPDHEVE	7900		INIT		Uplink basic energy step table value (HEEA control word)
nXPEA3008	ZEPDE0PS	0000		INIT		Uplink basic energy step table value (first parameter word)
nXPEA3009	ZEPDE1PS	0000		INIT		Uplink basic energy step table value (second parameter word)
nXPEA3010	ZEPDLEVE	5900		INIT		Uplink basic energy step table value (LEEA control word)
nXPEA3011	ZEPDEAPP	5200				Run application code
			0091		EPD_STAT =100	
nXPEA3012	ZEPDEDR1	5300			EPD_STAT =10	Update directory (control word)
nXPEA3013	ZEPDEDR2	0000			EPD_STAT =11	Update directory (argument word)
nXPEA3014	ZEPDEMEM	5100			EPD_STAT = 12 (underway) EPD_STAT = 14 (complete)	Perform memory dump
nXPEA3015	ZEPDENGS	4e00				Engineering mode select
nXPEA3016	ZEPDHFVE	7a00		INIT		Uplink energy efficiency factor (HEEA control word)
nXPEA3017	ZEPDF0PS	0000		INIT		Uplink energy efficiency factor (first parameter word)
nXPEA3018	ZEPDF1PS	0000		INIT		Uplink energy efficiency factor (second parameter word)
nXPEA3019	ZEPDLFVE	5a00		INIT		Uplink energy efficiency factor (LEEA control word)
nXPEA3020	ZEPDFGM1	5b00		INIT		FGM calibration factor 1
nXPEA3021	ZEPDFGM2	0000		INIT		FGM calibration factor 2
nXPEA3022	ZEPDFGM3	0000		INIT		FGM calibration factor 3
nXPEA3023	ZEPDHGUE	7800		INIT		Uplink reduced polar geometric factor (HEEA control word)
nXPEA3024	ZEPDG0PS	0000		INIT		Uplink reduced polar geometric factor (first parameter word)
nXPEA3025	ZEPDG1PS	0000		INIT		Uplink reduced polar geometric factor (second parameter word)
nXPEA3026	ZEPDLGUE	5800		INIT		Uplink reduced polar geometric factor (LEEA control word)

ESOC name	**User manual name**	**Fixed Bit Pattern**	**Para meter**	**Verification in**		**Description**
				SCI	**HK**	
nXPEA3027	ZEPDHC1S	5400			EPD_MVAL	Change monitor control parameters (control word)
nXPEA3028	ZEPDHC2S	0000		INIT		Change monitor control parameters (argument word)
nXPEA3029	ZEPDHIPS	4200		COR		Correlator selection
nXPEA3030	ZEPDHPCN	6b00				HEEA power control
			0002 or 0003		EPH_P5VV=table 1 EPH_P8VV=table 1 EPH_M8VV=table 1	Turn on HEEA 5 V and +/-8V power
nXPEA3031	ZEPDLPCN	4b00				LEEA power control
			0002 or 0003		EPL_P5VV=table 1 EPL_P8VV=table 1 EPL_M8VV=table 1	Turn on LEEA 5V and +/-8V power
nXPEA3032	ZEPDHPUE	7600		INIT COR		HEEA uplink parameter (control word)
nXPEA3033	ZEPDPUPS	0000		INIT COR		Uplink parameter (parameter word)
nXPEA3034	ZEPDLPUE	5600		INIT COR		LEEA uplink parameter (control word)
nXPEA3035	ZEPDHWCE	4c00			EPD_DPST	DPU Hardware control
nXPEA3036	ZEPDKALE	4000				Initialise KAL
nXPEA3037	ZEPDBOOS	4d00				Execute executive code
			0001		EPD_STAT =3	
nXPEA3038	ZEPDMAGS	4400		COR		Magnetic field selection
nXPEA3039	ZEPDPDAT	4100			Confirm by poking location	Poke data byte
nXPEA3040	ZEPDPEEK	5000			EPD_STAT=data byte	Peek data byte
nXPEA3041	ZEPDPLSB	4900				Load peek/poke address least significant byte command
nXPEA3042	ZEPDPMSB	4a00				Load peek/poke address most significant byte command
nXPEA3043	ZEPDPRCN	4700			EPD_SPCT increments from 0	Start science processing
nXPEA3044	ZEPDRSET	48a5			EPD_STAT =201 (if watchdog is on, depends on zepdhwce)	Reset instrument
nXPEA3045	ZEPDSN1S	5500				Sunpulse rephase (control word)
nXPEA3046	ZEPDSN2S	0000			EPD_SPOS = argument word	Sunpulse rephase (argument word)
nXPEA3047	ZEPDSPOT	4500		COR		Spacecraft potential control

ESOC	**User manual**	**Fixed**	**Para**	**Verification in**	**Description**

name	name	Bit Pattern	meter	SCI	HK	
nXPEA3048	ZEPDSPWF	4800			EPL_P5VV=table 2 EPL_P8VV=table 2 EPL_M8VV=table 2 EPH_36VV=table 2 EPH_P5VV=table 2 EPH_P8VV=table 2 EPH_M8VV=table 2 EPH_36VV=table 2	Sensor power off
nXPEA3051	ZEPDTELS	4600		COR		Telemetry mode select
nXPEA3052	ZEPHCISG	2000		COR		HEEA grid voltage and coincidence channel command
nXPEA3053	ZEPLCISG	0000		COR		LEEA grid voltage and coincidence channel command
nXPEA3054	ZEPHCRDI	202f		COR		Disable correlator
nXPEA3055	ZEPHCRE0	2020		COR		Enable correlator
nXPEA3056	ZEPHCRES	2020		COR		Enable correlator and select channel
nXPEA3057	ZEPHHVGD	20c0				Disable HEEA sweep and MCP high voltages
nXPEA3058	ZEPHHVGE	20c0	0003		HV monitors show high levels	Enable HEEA sweep and MCP high voltages
nXPEA3059	ZEPLHVGD	00c0				Disable LEEA sweep and MCP high voltages
nXPEA3060	ZEPLHVGE	00c0	0003		HV monitors show high levels	Enable LEEA sweep and MCP high voltages
nXPEA3061	ZEPHMCPE	20c1			HV monitors show high levels	Enable HEEA MCP high voltage
nXPEA3062	ZEPLMCPE	00c1			HV monitors show high levels	Enable LEEA MCP high voltage
nXPEA3063	ZEPHMCPS	2040		COR	See table 3	Select HEEA MCP voltage level
nXPEA3064	ZEPLMCPS	0040		COR	See table 3	Select LEEA MCP voltage level
nXPEA3065	ZEPHSMPS	2060		COR		HEEA HV preset mode select (goes before ZEPHSMSS)
nXPEA3066	ZEPLSMPS	0060		COR		LEEA HV preset mode select (goes before ZEPLSMSS)
nXPEA3067	ZEPHSMSO	2060		COR		Select HEEA sweep mode only
nXPEA3068	ZEPLSMSO	0060		COR		Select LEEA sweep mode only
nXPEA3069	ZEPHSPSS	2080		COR		HEEA sweep preset (comes after ZEPHSMPS)
nXPEA3070	ZEPLSPSS	0080		COR		LEEA sweep preset (comes after ZEPLSMPS)
nXPEA3071	ZEPHSTMF	20e0		COR		HEEA stim off
nXPEA3072	ZEPLSTMF	00e0		COR		LEEA stim off
nXPEA3073	ZEPHSTMN	20e1		COR		HEEA stim on
nXPEA3074	ZEPLSTMN	00e1		COR		LEEA stim on

ESOC	User manual	Fixed	Para	Verification in	Description

name	**name**	**Bit Pattern**	**meter**	**SCI**	**HK**	
nXPEA3075	ZEPHSWEE	20c2			HV monitors show high levels	Enable HEEA sweep high voltage
nXPEA3076	ZEPLSWEE	00c2			HV monitors show high levels	Enable LEEA sweep high voltage
tbc	ZEPDDATP	4300		COR		Select dataset parameter
tbc	ZEPDMAC1	5e00		INIT		Uplink or launch PEACE macro (control word)
tbc	ZEPDMAC2	0000		INIT		Uplink or launch PEACE macro (multiple parameter words)

3. ACCOMPANYING REFERENCE TABLES

Table 1 Expected sensor voltages (LEEA values shown, HEEA identical)

	Upper limit	**Lower Limit**
EPL_P5VV	5.4 Volts	5.0 Volts
EPL_P8VV	8.4 Volts	7.6 Volts
EPL_M8VV	-8.4 Volts	-7.60 Volts
EPL_36VV	34.0 Volts	38.0 Volts

Table 2 Expected sensor voltages (LEEA values shown, HEEA identical)

	Upper limit	**Lower Limit**
EPL_P5VV	0.1 Volts	0.0 Volts
EPL_P8VV	0.1 Volts	0.0 Volts
EPL_M8VV	-0.2 Volts	0.0 Volts
EPL_36VV	0.5 Volts	0.0 Volts

Table 3 MCP generator output

MCP Level	EPL_MCP and EPH_MCP in Volts all values are +/- 5%
0	0
1	57.82
2	2023.0
3	2080.8
4	2138.6
5	2196.5
6	2254.3
7	2312.1
8	2369.9
9	2427.8
10	2485.6
11	2543.4
12	2601.2
13	2659.1
14	2716.9
15	2774.7
16	2832.6
17	2890.4
18	2948.2
19	3006.0
20	3063.9
21	3121.7
22	3179.5
23	3237.3
24	3295.2
25	3353.0
26	3410.8
27	3468.6
28	3526.5
29	3584.3
30	3642.1
31	3700.0

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