Sentinel GPSR

Command and Housekeeping Data Interface Specification

DRL: -
CI-No.: -
Applicable for: **S1** ☒ **S2** ☒ **S3** ☒ **EC** ☒

☒ **Sentinel A**
☒ **Sentinel B**
☐ **Sentinel B, Amendment to:**

	NAME:	FUNCTION:	SIGNATURE:	DATE:
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Document Change Log:

Issue	S1-IF-AAE-SC-0001Date	Modified Pages	Description
1	14 Jan 2009		Initial Issue; the change log here describes the **changes with respect to [SCHKDIS]**:
		§3.3	LOBT definition changed, also the use of LOBT in §3.3.2 and §3.3.3
		§4.1	New definitions for APID
		§4.2	New max. CCSDS packet length, new APID definitions; Code and Carrier Phase Science Data Packets will have a different PCAT than other Science Data Packets
		§4.4	New section for data field header
		§5.1	TC(6,130) replaced by TC(6,210), TC(6,2) replaced by TC(6,212), TC(6,5) replaced by TC(6,215), TC(6,9) replaced by TC(6,219), TM(6,10) replaced by TM(6,218), TM(6,6) replaced by TM(6,216), TC(6,131), Abort Memory Cmd deleted, new TM/TC (5,210) to (5,213) TC(8,128) replaced by TC(210,1), TC(8,131) replaced by TC (211,1), TC(8,132) replaced by TC(211,2), TM(8,133) replaced by TM(211,3), TM(20,1) replaced by TM(212,1)
		§5.2.x	Redefinition of FIDs. FID parameter length is now constant

		§5.3.5	TM(3,25): Adapted format of HK parameter report to Sentinel PUS definition and replaced UART status by MilBus status information. Mentioned two Science Packets being sent as TM(3,25) according to S3-MN-TAF-GN-00440.
		Several pages	Added filler bytes after the EID for all event format definitions
		§5.4.4.6	Removed Full Telecommand Buffer Event
		§5.4.1	Removed “Missing LOBT” and “LOBT returned” from event list. Redefinition of Event IDs acc. to suggestion by S-2.
		§5.4.3.1	Removed chapter 7 and added SW_VERSION to the Startup Success Event instead (to save memory).
		§5.4.7 to 5.4.10	New TC/TMs on event enabling/disabling
		§5.5.X	Removed Abort Memory Command. Redefined other memory services.
		§5.6, §5.7, §5.8	Replaced services (8,x) by services (210,x) and (211,x). New definitions for the Periodical Memory Diagnosis and the Periodical Memory Diagnosis report. FMT_LOBT replaced by FMT_GPST; further the new FMT_GPSR does not need to be supported in Startup SW. FMT_DiagnosticFilter is not supported in Startup SW.
		§5.8.2	New report split for many parameters.
		§5.8.3	Changed fields of Table 5-28, marked changed fields by grey shading.
		§5.8.3 + §5.3.5	Changed width of SN from 3 to 4 bits
		§5.8.4.6	Changed the time format of FMT_InitialStateVector
		§5.8.4.30	BEGIN_LOBT, END_LOBT is now BEGIN_GPST, END_GPST because the LOBT is obtained via low-level MilBus-protocol instead via a CCSDS packet.
2	20 Apr 2009	§3.3.2	Removed comment on the internal resolution of the LOBT. Since the resolution visible to the outside world is less than 32 bits, this was just misleading.
		Chapter 4	Update of Figure 4-2 and Figure 4-3 as closeout of DESIGN-PERF-IF-135: Sentinel-1 uses zero padding for the time field.
		§4.2	Added details to Table 4-2 to avoid misinterpretations.
		§4.3	Added a clarification that packet sequence counters are incremented at application level (and not at MilBus driver level) acc. to DESIGN-PERF-IF-79.
		§4.4	The GPSR has to omit processing of the PEC in case the CRC flag is zero, acc. to DESIGN-PERF-IF-59.

		§5.2.4	Added an FID for implausible Abort Memory Service Commands as part of the closeout of RID DESIGN-PERF-IF-129.
		§5.3.4	Corrected typo acc. to DESIGN-PERF-IF-128
		§5.3.5	Added a bit for MilBus I/F double bit errors
		§5.3.5 and 5.8.3	Removed the serial number. Is not needed in Sentinel acc. to early closeout of this sub-item of DESIGN-PERF-IF-135 via e-mail by Arnaud Breton.
		§5.4.1	Table 5-6: corrected event IDs 402Xh because one ID was erroneously issued for two different events.
		§5.4.3.1	Flipped one N/U field with the SW_VERSION field of the Startup Success Event to obtain the same header for all event types. Extended the SW_VERSION to 32 bits to comply to Sentinel-2's GPS-934/GDIR-10745/T,R.
		§5.4.5.2	Table 5-12: the RTOS error code is no longer constant zero.
		§5.4.7	Constrained event enabling/disabling to low severity events. Medium and high severity event handling makes no sense, since these events are associated with reboots.
		§5.5	Mentioned that long duration memory commands are aborted during any mode change. Now there is no longer a discrepancy to the claims of §5.7. Table 5-15 no longer distinguishes the nominal and redundant GPSR.
		§5.5.1	Corrected the maximum LEN.
		§5.6.1	Added a note about the constraint on the total LEN(x) fields. Any mode change can stop Long Duration Telecommands.
		§5.6.3	Added the Abort Memory Service Telecommand as enhanced closeout of PDR RID DESIGN-PERF-IF-129.
		§5.8	Table 5-24 now also contains FMT_SatelliteMask, which is supported in Navigate Mode.
		§5.8.1	Clarified wording to avoid an interpretation, that there is only one function parameter that can be uploaded in navigate mode.
		§5.8.4.34	New section on manoeuvre commands.
		Table 5-28, Table 5-43	Added columns to the table as closeout of PDR RID DESIGN-PERF-IF-135.
		Table 5-43	Default sample rate settings corrected.
		Table 5-42	INDEX field description for missing record types added.
		§5.4.5.2	Meaning of ERR_CODE field clarified.
		Figure 5-41	Not Used field renamed to ENABLED.
		Table 5-41	Interpretation of the field clarified.

		§5.8.4.25 §5.4.4.4 §5.3.5	Described the connection between quality thresholds and deterioration flag determination. Blacklisting time applied in case of a failed acquisition changed to 40 seconds. Description of situations leading to an Acquisition Failed event amended. Information regarding the fields SV_ACQ, SV_SF_TRK, SV_MF_TRK and SV_PVT added.
3	1 Jul 2009	§5.8.3 §5.3.5 §5.8.4.7	DESIGN-PERF-IF-83: Added a note that the GPSR automatically takes care that the packets do not exceed the maximum size of 256 bytes. Since the protocol is no longer selected using the ASF bit of the CC mode codes with data word, the description of the meaning of flag I had to be changed. Takeover of a note on ATT_UNC and ATT_LOBT from SWARM Sentinel CHKDIS revision 3.5.
4	13 Jul 2009	§5.6.3	Changed the Abort Memory Service Command to a format that is 16-bit aligned according to a request by TAS-I, via e-mail “R: TC(213,3)” from 9 Jul 2009 from Mario Masci.
5	7 Oct 2009	Table 4-2 §5.3.5 §5.8.4.9 Table 5-43 Table 5-60 Table 5-8 §5.8.4.8 Table 5-32 Table 5-28	Refined the PCAT definition according to e-mail “RE: Definition of SIDs for the PCAT 6 for Sentinel missions” from Patrizio Pavia on 30 Sep 2009 Added a trailing filler word to the HK parameter report to achieve 32-bit alignment set default value for ATT_UNC to 0 Harmonised the SIDs for Startup Mode and other modes acc. to RID DESIGN-PERF-IN-23. Defaults corrected, LEVEL should be 2 (Warning) and reporting for all tasks and modules should be enabled by default. Units of PSR_DEV field changed from cm to m to avoid saturation of typical values (ranges corresponding to several milliseconds) A note has been added that the GPSR will not accept a TC with 3D position 0. Correction of initial values. FMT_IonoCorrectionPar removed from the parameter types intended for in-flight diagnostic purposes. Added new record types to the end of the list. FMT_ReceiverAntField is no longer used for diagnostic purposes, only. In fact it is needed by Sentinel-3 for the Safe Mode.

		§5.8.4.9	Added a note to clarify that the FMT_AttitudeVector TC is not a time tagged command.
		§5.8.4.34 – §5.8.4.37	New parameter record formats defined for - manoeuvre support - COG to antenna phase center adaptation (acc. to S3-MN-TAF-GN-00780) - S3 safe mode support - earth orientation parameter adaptation
		§5.9.1	TC(17,1) now accepts variable length dummy data.
		§5.4.7 to 5.4.10	Added notes in which receiver modes the TCs are accepted according to e-mail “Enabling/Disabling Events in the Sentinel Missions” on 7 Oct 2009 by Stephan Grünfelder to the Sentinel consortium. Removed the TBCs for the format of the TCs and TMs handling enabling/disabling events. Added a definition on handling of TCs containing invalid EIDs for the enabling/disabling of events.
		Table 5-28	FMT_NavSolMethod is no longer “not part of the requirements baseline”
		§5.5	Refined the definition which situation lead to an abort of long duration memory management services.
		Table 5-18	Removed the note “TBC by S-2”
		§5.6.1	The different REQUEST_IDs are TBC at the time being.
		Table 5-21	Added a note on checking of physical existence of memory addresses.
		§5.5.1, 5.5.2	Clarified that the meaning of X_LENGTH fields is different when loading/dumping to/from the I/O area of the CPU.
		Table 5-15	The memory IDs are now TBD. There is still no agreement on IDs within the Sentinel consortium, see e-mail from 8 Oct 2009 from Patrizio Pavia.
		Table 5-4	Correction/refinement of the description of the reported number of SVs tracked wrt single and multi frequency tracking.
		§5.4.4.3	Removed “TBC”, i.e. RUAG confirmed the banning of a SV for three minutes.
		§5.4.4.4	Removed “TBC”, i.e. RUAG confirmed the definition of the Acquisition Failed Event.
		Table 5-24	Added new parameter formats, simplified the table structure.
		Table 5-29	Replaced a “TBD” by a reference to the updated MDIS document.

6	10 Jan 2010	Table 4-2	Added SID 216 for PCAT 6 according to mail “Réf. : URGENT: Quick response required: Missing Definitions for the GPS Ancilliary Data” from 2 Nov 2009 from Stephane Pouzyreff. SID 213 and 214 now are of PCAT 6 according to S3-MN-TAF-GN-00998.
		§5.2.4	Removed “The table is TBC by the customer(s)” in the explanatory text to the FID table.
		§5.6.1, 5.6.2	REQUEST_ID is not used anymore.
		Table 5-25	Corrected and reordered FUNC_ID numbers
		Figure 5-61	Corrected size of FMT_FORCE command
		Table 5-24	Change to allow FMT_Antenna in Navigate mode.
		Table 5-62	Definition of PV_X/Y/Z clarified. Reference frame in “Interpretation” column corrected. Min/max values increased. Initial value updated (allowing to distinguish nom/red equipment).
		Table 5-15	The memory IDs are again that of version 4 of this document because the Sentinel consortium has not submitted a new definition by 26 Nov 2009 in reaction to e-mail “Quick response required: Missing Definitions for the Sentinel PUS” by Stephan Grünfelder from 28 Oct 2009.
		§5.8.4.9	Clarification regarding FMT_AttitudeVector used as TM added.
		§5.8.4.8	Clarification regarding FMT_InitialStateVector used as TM added.
		§5.9.1	Added a note on the nominal use of TC(17,1) & TM(17,2)
		§5.4.4.2	Added a note on the PVT validity in case of an Invalid Navigation Solution event.
		§2.2 and several pages with references	Added the user manual [UML] to the list of ref. documents and replaced references to [SUM] by references to [UML].
		§3.3.1	Resolved the “TBC by RUAG” about the uncertainty of the time stamp values.
		Table 5-33	Correction that the Euler angles are valid for a rotation from ORF to RRF (rotation matrix in [UML] remains valid). S-1 default roll angle added. Changed parameter definition to yaw/pitch/roll.
		§4.3	Corrected type “reset of power-up” → reset or power-up
		Table 5-14	Added the Abort Memory Service Command to the table.
		§5.5.6	Added missing descriptions of parameters.

		§5.8.4.5	Added a note on the use of FMT_GPST as telemetry.
		Table 5-18, Table 5-21	Corrected the number of maximum bytes to be patched and the number of blocks to be reported to fit into the 214 bytes maximum data length field of TCs.
		Table 5-43	Harmonised the PCAT value of this table with that of Table 4-2.
7	4 Mar 2010	Table 5-43	2nd attempt to harmonise the PCAT value of this table with that of Table 4-2: changed Satellite in View Status from PCAT 12 to PCAT 6, which was missing in issue 6.
		Table 5-4	Changed/refined the meaning of the bits M and I in the Housekeeping Parameter Report
		Table 3-1	Note on rounding updated.
		Figure 5-57 Table 5-60 Table 5-27	FMT_DiagnosticFilter definition extended from 64 to 96 module IDs.
		§5.8.4.7	Decription of FMT_GPST reworked, Table 5-31 added.
		§3.3	Clarification on LOBT added.
		Table 5-2	FID 5011 discarded, not used by the GPSR.
		Table 5-3	FID 5220 discarded, not used by the GPSR. FID 5225 is also applicable to TC(211,2). FIDs 500 and 502 have been changed to numbers 5500 and 5502 to have numbers higher than those of static checks.
		Table 5-14	Periodical Memory Diagnosis also supported in Startup mode.
		Table 5-4	Description of field SV_SF_TRK reworked.
		§5.5.3	Changed [bytes] to [SAU] to be inharmony with the telecommand according to DES-PERF-INT-86.
		Table 5-28	Size of FMT_SatelliteForce records corrected.
		Table 5-3	Removed FID 5264 from this table. Errors of this type are reported by FID 5225.
		§5.6.2	Added details on the abort of the Periodical Memory Diagnosis during mode transitions.
		Table 5-43 and Table 4-2	Changed the PCAT of TM(3,25) to 4 according to Fax S3-FX-TAF-017072/2010
		§5.4	For all TM(5,x) the LOBT time stamp in the event data field was replaced by an IMT time stamp acc. to a RUAG-internal request and acc. to mail “Redundant LOBT for TM(5,x) in GPS Receiver to be replaced by IMT” from 17 Feb 2010 sent by Stephan Grünfelder (RUAG) to the Sentinels.

		Table 5-4 – Housekeeping Parameter Report Definition	Update description of TC_DISC, TM_DISC, PRECNT fields.
8	10 Jun 2010	§5.8.4.38 §5.6.1 Table 0-1 Table 5-3, Table 5-18 Table 3-1 Figure 5-32 Table 5-33 Figure 5-31 Table 5-32 Figure 5-55 Table 5-58 §4.3 Table 5-62 Table 5-3 §5.5 §5.8.4.1 Table 5-28 §5.4 §5.7	Information on the Earth orientation parameters added. Provided details on the FIDs issued for various command rejections as part of the closeout of ticket #274. Minor changes in the Post Mortem Report: 'Not used' area renamed into 'Mission Params'. 'Checksums' area: SN and SW_Version field moved into 'Mission-Type' and new field MT (Mission Type) added. Length adjusted to 8 entries. Adjusted clarifications of usage the FID5211 and FID5214. Replaced the usage of FID5214 with FID 5211 in case of inconsistent length of requested blocks. Adjusted clarifications of usage the FID5225. Note corrected. GPST field split into XX_SEC and XX_SUBSEC part to achieve consistency with TC template field names. Added a clarification on the different maximum lengths for telemetry and telecommands. Initial values of PV_X/Y/Z are now defined in the user manual. FID5212: Added address misalignment as second reason for this FID to be used. Clarifications added, MID table extended with address information. FMT_ParamSave definition added. FMT_ParamSave and FMT_GPS_CNAV_GroupDelay entries added, FMT_SatelliteMask and FMT_AttitudeThreshold entries updated. FMT_WatchingPar discarded, not implemented in Sentinel. Added mode constraint table for Event services. Update of the mode constraint table and its explanatory text as closeout of http://trac/Sentinel1_GPS/ticket/517. Now the table contains the first 5 seconds of Startup Mode as separate transient mode.

		§5.1.1.2	Added details on the length of Long Duration Commands in harmony to the closeout of AI92.1 from CCB#92.
		§5.8.4.18.1, §5.8.4.18.2, §5.8.4.18.3	New subsections on default sample rate settings for the respective missions according to mail with subject “Réf. : GNSS CDR Board disposition for PCAT” on Thu, 22 Apr 2010 15:45:14 from Patrick.Nicol@thalesaleniaspace.com
		Various places	Replaced references to the “Minimum Navigation Solution” by references to the “S1 Navigation Solution” according to the mail cited above.
		§0 §5.4.4.4 §5.4.4.5	Clarifications added.
		Table 5-29	SIG field description adapted for Sentinel B.
		§5.8.4.11	FMT_SatelliteMask format definition extended for Sentinel B.
		Table 5-4	Clarifications wrt L2 CM tracking added.
		§5.3.5	Clarifications wrt mode transition Startup to Standby added.
		Table 5-60	Interpretation of fields clarified.
		Table5-3	Adjust clarification of usage Parameter1 FID5124 in case of TC(211,1) Adjust clarifications of usage the Parameter1 of FID5215, FID5216, FID5217 and FID5218.
		Table 5-64	TBDs for initial values resolved.
		Table 0-1	Mission Params: RES_04 field substituted by the OPTION_BITS field
		§5.8.4.11	Clarification wrt handling of FMT_SatelliteMask in warm and hot start situations added.
		Table 3-1 Table 5-29 Table 5-35 §5.8.4.31	Feedback from internal document review worked in.
9	30 Jun 2010	§5.8.4.18	Added note about HK parameter report is always sent with 1Hz in Startup mode.
		§5.8.4.18.2	Changed the S-2 default sample rates for the Noise Histogram, Channel Status, Tracking State and the event driven packets according to e-mail “AW: AW: S2B Requirements and PCAT Change 0045” from Wilhelm.Gockel@astrium.eads.net to heinrich.fragner@ruag.com from 22 Jun 2010 10:04h.
		Table 5-26	Activity IDs for FMT_StateRetention increased.
		Table 5-28	Entry for FMT_StateRetention corrected.

10	11 Aug 2010	Table 5-60 §5.8.4.33 §5.4.4.2 Table 5-45 Table 5-37 §5.8.4.31 §5.8.4.18	Default settings adapted to enable SW warnings by default which might be of interest and at least of LEVEL = 'Warning'. Clarification about other, not configurable filters for Software Warnings added. Event description improved. Clarified in the table title that the settings are for Operational Mode. Range corrected. Description of plausibility checks added. The default setting tables now indicate (in redundancy with MDIS and section 5.8.3) which data records are not subject to qualification testing
11	20 Nov 2010	§5.9.2 §5.6.1 and 5.6.2 §5.8.4.18 §5.5 Table 5-24 §5.8.3 Table 5-7, Table 0-1 Table 5-15 Table 4-2, Table 5-41, Table 5-42, Table 5-43 Table 5-26	Added a note that the TM(17,2) data field length varies with the command data field length. As requested in DESIGN/PERFOR-10 of the SW CDR the field REQUEST_ID no longer is an ignored value. Removed the greying in the tables of default sampling rate settings according to RID 1 and action DESIGN/PERFOR-23-2 of the SW CDR. Sampling rates are subject to qualification testing, the packet content is not always. Explained the greying of Table 5-14 according to RID DESIGN/PERFOR-8 of the SW CDR. Entries Pre-load Function Parameters for FMT_GPS_CNAV_GroupDelay and FMT_FORCE added because the customer wants to keep the Navigate mode when these TCs are sent. Added a note on verification of packets that are not required in response to SW CDR RID actions PA/MANAGEMENT-12 and DESIGN/PERFOR-5. Description of SW_VERSION field completed. Obsolete fields MT and SN deleted, SW_VERSION field description updated Ref: SW CDR RID action PA-13-2. DESIGN/PERFOR-9 requests RUAG to document what happens when a patch command tries to overwrite the NVM2 syndrome bits. This table gave and gives the answer: it is rejected with FID 5212. Changed the PCAT values according to S1-CN-AAE-SC-0049 Reduced the number of records in the FMT_SampleRate NoiseHistogram and ChannelStatus TC and TM to 1 record.

		Table 5-4	Update field descriptions of ITE, IDE, DTE, DDE due to SW modifications.
12	18 Jan 2011	§5.8.4.18 Table 5-43, Table 5-44, Table 5-45 §5.8.4.11 Table 5-4, Table 5-27 Figure 5-46, Table 5-49	Added a comment on the effect latency of sample rate settings. Removed the column PCAT from the default sample rate tables because the information is redundant to the Table 4-2. The Sentinel GPSR SW TR/R RID #1 revealed that the PCAT values were inconsistent. Table 4-2 is correct. Clarification added that settings with SEL = 1 are ignored during a cold start. Reference to [HWSWICD] added for field ‘FE_TEMP’ Cross-aiding configuration field added.
13	31 Mar 2011	§5.8.4.2 §5.8.4.4 §5.4.5.2 §0 §5.4.5.1 §5.4.4.5 Annex A §5.8.4.11	Clarified the ACQ_SV_ID usage for Pre-load function parameter TCs for Navigation Messages. In contrary to the definition of the action resulting of the RID DESIGN-PERF-I-5 of the Sentinel-A SW QR there is no change in this section of the document because the requested information is already there. Added addresses of the post mortem area as requested by RID DESIGN-PERF-I-1 of the Sentinel-A SW QR. To close action item DESIGN-PERF-I-8 from the SW QR, this document now defines error/warning event parameters in detail. Description of P(Y) force flags used to control the tracking scheme during normal operation improved.
14	27 Jul 2011	Annex A – codes for software warnings and software failures § 3.3.2 § 4.2 §5.8.4.18.1	Clarified the mapping between TM(5,2) SW Warnings and TM(5,3) SW Failures and the used ERR_CODEs. This should satisfy Sentinel-3 FM5&FM6 TRR RID #1 Document formatting corrected Removed the note that the APID indormation in the table is redundant to the APID information in later tables, because it is not true any more. Now the APId information is solely published in this chapter. Closeout for S2 ECGR Instrument TRR RID COM_S2_EC_TRR-2: Note added to clarify the missing sample rate setting entry for GPS CNAV Group Delay data records.
15	2 Feb 2012	Table 5-33	Changed initial setting of ATT_GPST_ SEC in FMT_AttitudeVector.

		§5.8.4.35 Table 5-6 §5.4.4.3 Table 5-4	Added a note regarding the vector plausibility check. Cross reference for 'Discarded Measurement' corrected. Note on field saturation added. Carification regarding SV_SF_TRK and SV_MF_TRK fields added. Clarification regarding fields PRECNT, D and L added.
16	15 May 2012	§ 5.7 Table 5-4 §5.10 §5.8.4.22 §5.8.4.31 § 3.3, 3.3.2, 5.4.2 Table 4-2, Table 5-45, Table 5-6, Table 5-7, Table 5-8, Table 5-9, Table 5-12, Figure 5-3 Table 5-57 § 5.8.4.36	Exchanged the term “warm start” to “reboot” in the context of reset the GPSR and restart in Startup mode. This resolves the ambiguity with GPS SV acquisition in “warm start” mode. Clarified the TC_DISC counter. Clarified that the generation of science TM with variable number of data records has certain preconditions. Note on plausibility check added. Clarified that BEGIN_GPST_SEC and END_GPST_SEC must be within certain limits. Clarified the LOBT synchronization process differentiated for Sentinel-1 & -2 and for Sentinel-3. Added the EID and SID values for S-3 SRDB. This closes RID DESIGN/PERFOR-6 from the GPSR QR. Resolved the TBD for maximum tracking state. This closes RID DESIGN/PERFOR-24 from the GPSR QR. Removed the S-3 safe mode ban time TBC.
17	15 Sep 2012	Table 5-28 § 3.4.1, Table 5-58 § 5.5.3	Corrected some TM byte lengths in the function parameter table. Clarified how the SRDB definition divides the parameters wider than 32 bits into a most significant and a least significant part. Added a note about the GPSR SW version SBGR-V2.3 and earlier memory dump report TM frequency when dumping from NVM1 or NVM2.
18	11 Oct 2012	Table 5-6, Table 5-45	Transformed SID and EID values to hexadecimal format on customer request (see S1-MN-AAE-SC-0118 AI-RSA)
		Table 5-43	Added a note about which TMs are sent in which operational mode and that the Housekeeping parameter report is sent hard coded with 1Hz in Startup mode. This note is referenced from the two following tables with S-2 and S-3 TM sample rates.
19	22 Oct 2012	§ 5.8.4.8	Clarified the InitialState Vector propagation.

		§ 5.8.4.37	Clarified the SRDB definition of the telecommands to set the FMT_KALMAN parameter table.
		Table 5-4	Increased readability of the housekeeping parameter report parameters for number of acquired and tracked SVs.
		§ 5.8.4.37	Clarified that the telecommand to set the FMT_KALMAN parameter table has three packet instances and the user is not supposed to change any individual parameter value.
20	1 Feb 2013	§ 5.4.1	Removed the erroneous sentence stating that the WD event is detected, generated and sent in Startup mode.
		Table 5-4	Clarified that the house-keeping report parameters TC_DISC and TM_DISC are reset on mode change Startup->Standby and Standby->Startup.
		§5.8.4.36	Ban time value corrected to be in-line with the value used in tests and also stated in the User Manual.
		§5.6.1, §5.6.2, Table 5-21	Constraints added to service 'Periodical Memory Diagnosis' to reflect the current implementation of the Flight-SW.
		Table 5-14	Service 'Periodical Memory Diagnosis' not supported in Startup-Mode
		Table Annex A-3	Parameter reporting for EVENT_CODE__SPI_QUEUE_OVERRUN updated to reflect current implementation of the Flight-SW
		§5.5	Updated description about aborting of memory commands across mode changes.
		§5.8.4.21	Ranges for some fields corrected.
		§5.3.5	NCR GS2-73: Note added to make clear that Navigation Solution and Time Correlation data records are only generated in Navigate mode.
		§ 5.1.1.2	Added the execution time for memory load TC into NVM2.
21	29 May 2013	Table 5-64	Corrected the physical unit of the FMT_KALMAN parameter table parameters.
		§ 5.8.3	Added the note that the parameter table formats used on-ground for verification purpose also could be useful for in-flight maintenance and error investigation purpose.
		Table 5-14	Added clarification for the TC memory copy command
		§ 5.6.1, 5.6.2	Corrected the periodic diagnostic functional description.
22	1 Sep 2013	§ 5.6.3	Abort memory TC parameters described.

		§0	Additional information about SW context added.
		§ 5.8.4.1	Added the information that the user has to send the signature to disable the NVM2 write protection, before he/she sends a FMT_ParamSave TC.

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1. INTRODUCTION

1.1 SCOPE OF THE PROJECT

The Sentinel GPS Receiver (GPSR) is used in missions Sentinel-1, Sentinel-2, and Sentinel-3. It is a dual-frequency navigation receiver designed to be used on spacecrafts in Low Earth Orbits.

1.2 PURPOSE OF THE DOCUMENT

The purpose of this document is to specify the formats and contents of the telecommands and housekeeping telemetry packets of the Sentinel GPSR.

The following is also included:

- Initial values for commands and telemetry parameters are defined.
- Command verification is defined.
- The Post Mortem report is defined.

1.3 DOCUMENT EVOLUTION

Issue 1.0 of this document is derived from [SCHKDIS] issue 3.4 (plus minor changes from issue 3.5 draft) and from [PUS] in preparation of the Preliminary Design Review.

Issue 2 closes most of the discrepancies found during the PDR, issue 3 closes the remaining ones and takes over all changes of [SCHKDIS] issue 3.5. Issue 4 fixes a discrepancy found by TAS-I in issue 2, related to DESIGN-PERF-IF-129 and reported after issuing revision 3 of this document. Issue 5 contains updates based on the results of the PDR for the advanced navigation solution and on takeovers of updates of [SCHKDIS] issue 3.6.

Document issues 6 and 7 are intermediate issues documenting changes of requirements.

Issue 8 contains the extensions introduced to support Sentinel B.

Issue 9 includes a few small corrections.

Issue 10 includes corrections due to Sentinel B PDR RIDs, clarifications of Default Sample Rate setting tables and extensions in preparation of the Sentinel A CDR data package.

Issue 11 primarily contains updates made for Sentinel A CDR action closeout.

Issue 12 contains minor updates made in preparation of the Sentinel A QR data package.

Issue 13 was driven by Sentinel A QR action closeout, but also contains clarifications relevant for the Sentinel B delta CDR.

Issue 14 contains minor updates made for the Sentinel A S2 ECGR Instrument TRR and S3 FM5 & FM6 TRR RID closeout.

Issue 15 and upwards introduce minor clarifications~~Issue 15~~. See document history for further information.

1.4 ACRONYMS

Ack .... Acknowledgement
AD .... Applicable Documents
AGGA .... Advanced GPS/GLONASS ASIC
APID .... Application Process Identifier
bps............ Bits per Second
C&DH .... Command and Data Handling
CCSDS..... Consultative Committee for Space Data Systems
CIDL .... Configuration Item Data List
CMD .... Command
COG .... Center Of Gravity
CS .... GPS Control Segment
deg .... Degrees
FID............ Failure Identification Number
FORCE..... Advanced Force model used for precise receiver orbit propagation
GNSS .... Global Navigation Satellite System
GPS.......... Global Positioning System
GPSR .... Global Positioning System Receiver
GPST........ Global Positioning System Time
HK .... Housekeeping (data)
IMT .... Instrument Measurement Time
ISR .... Interrupt Service Routine
LEO .... Low Earth Orbit
LOBT .... Local On-Board Time
LSB........... Least Significant Bit
LSW.......... Least Significant Word
MD............ Measurement Data
ME............ Measurement Epoch, 20ms intervals synchronous to the PPS interval
MFC.......... Multi Frequency Channel
MSB.......... Most Significant Bit
MSW......... Most Significant Word
N/A .... Not Applicable
N/U .... Not Used
NVM Non Volatile Memory – EEPROM or PROM
ORF.......... Orbit Reference Frame
PCAT........ Packet Category, part of the APID
PEC.......... (CCSDS) Packet Error Control
PID .... Process Identifier
PLEN .... (CCSDS) Packet length field value (located in the primary header)
PPS .... Pulse Per Second
PUS.......... (CCSDS) Packet Utilisation Standard
PVT .... Position Velocity Time, the so-called Navigation Solution
RSA.......... RUAG Space Austria GmbH, former Austrian Aerospace GmbH
RCPVT ..... ReCeiver Position Velocity Time determination
RD .... Reference Document
RMS .... Root-Mean-Square
RTOS .... Real Time Operating System
SAU.......... Smallest Addressable Unit
SFC .... Single Frequency Channel
SRF .... Satellite Reference Frame
SV............. GNSS Space Vehicle
SVMPR..... Space Vehicle Mode PRocessing

TBC .... To Be Confirmed
TBD .... To Be Defined
TC............. Telecommand
TM .... Telemetry
USNO .... U.S. Naval Observatory
UTC .... Universal Time Coordinated
WGS84..... World Geodetic System 1984

2. DOCUMENTS

The following documents form part of this document to the extent specified here-in.

In the event of a conflict between this document and the Applicable Documents (AD), the AD shall have the precedence. Any such conflict should however be brought to the attention of RSA for resolution.

This document has been established based on the ADs and RDs as given below. The valid revision numbers are reflected in the relevant Configuration Item Data List Issue. Changes of ADs and RDs will lead to an update of this document only in case of impacts on its content.

2.1 APPLICABLE DOCUMENTS

[MDIS]	S1-IF-AAE-SC-0002	Sentinel GPSR Measurement Data Interface Specification
[PUS]	GS2.STD.ASD.SY.00001	Sentinel-2 Packet Utilization Standard
[SRD]	S1-RS-AAE-SC-0001	Sentinel GPSR Software Requirements Specification

2.2 REFERENCE DOCUMENTS

[CCS301]	CCSDS 301.0-B-3	CCSDS Recommendations for Time Code Formats
[ECSS70]	ECSS-E-70-41A	Space Engineering – Ground Systems and Operations – Telemetry and Telecommand Packet Utilization
[UML]	S1-MA-AAE-SC-0002	Sentinel GPSR, Equipment User Manual
[ICD200]	IS-GPS-200	Navstar GPS Space Segment / Navigation User Interface
[MilBus]	S1-RS-TASI-SC-0143	GPS Mil-Std-1553b Bus Specification
[SCHKDIS]	SW-IF-RAA-GP-0001	SWARM GPSR, Command and Housekeeping Data Interface Specification
[WGS84]	NIMA TR 8350.2	Department of Defense World Geodetic System 1984, Its Definition and Relationships with Local Geodetic Systems
[HWSWICD]	S1-IF-AAE-SC-0005	Hardware / Software ICD

3. DEFINITIONS AND CONVENTIONS

3.1 DEFINITION OF TERMS

Antenna Zenith Direction

The antenna zenith direction is equivalent to the antenna boresight direction.

CCSDS Packet

A CCSDS-formatted data block, see [ECSS70], [CCS301] and [PUS].

GPS Time

The GPS Time is based on the atomic clocks in the satellites and in the ground segment. GPS Time does not introduce any leap seconds. The GPS control segment keeps the GPS Time within 1 μs of the UTC_{USNO} time (modulo-1 s). The GPS UTC parameters are used to relate them more precisely, as defined in [ICD200].

Packet

The data unit useful at user level, above CCSDS, transferred in one or more CCSDS Packets, contained in the DATA areas, e.g. Memory Dump Packet.

Uncertainty

The uncertainty of a given parameter value V is specified either as 1 or 2 below depending on the characteristics of the parameter errors.

1. Uncertainty: (X,Y)
   where (V+X) is the minimum true value and (V+Y) is the maximum true value for a given parameter.

2. Uncertainty: Z RMS
   where Z is the root-mean-square (RMS) of the estimation errors for the given parameter.

See also section 3.3 for uncertainty in time values.

UTC

UTC (Universal Time Coordinated) is an atomic clock time scale coordinated by the Bureau International de Poids et Mésures in Paris. UTC differs from a pure atomic clock in that it occasionally introduces leap seconds. This is done to keep this atomic time scale in approximate step with the Earth’s rotation. The leap second adjustment can cause the particular minute to have 59 or 61 seconds instead of 60.

UTC_{USNO}

USNO forms its own version of the UTC, UTC_{USNO}, based on more than 20 caesium standards. UTC_{USNO} is kept within 1μs of UTC.

3.2 CONVENTIONS

The following conventions are used throughout the document, unless otherwise specified.

3.2.1 Service Types and Service Subtypes

[ECSS70] defines Service types and Service subtypes. One service represents a certain part of the entire telecommand and telemetry interface, e.g. the Memory Management Service, and is divided into service subtypes. Service subtypes may correspond to either telecommand or telemetry formats. Service types and service subtypes are 8-bit numbers according to [ECSS70]. The notation used in [PUS] and in this document is defined as TC(service type, service subtype) or TM(service type, service subtype), respectively.

3.2.2 Number Representation

- Hexadecimal numbers are subscripted by 'H', e.g. 15_H = 21 decimal, of prefixed with '0x'.
- Binary numbers are subscripted by 'B', e.g. 1011_B = 11 decimal.
- Any other number, i.e. not followed by the 'H' or 'B' subscripts, not prefixed, is decimal.

3.2.3 Bit, Byte and Word

The bit number of an N-bit field is defined according to Figure 3-1. Bit number 0 is the most significant bit (MSB) of the field and bit number N-1 is the least significant bit (LSB). The MSB is always on the left side and the LSB is always on the right side.

Bit number				
0	1	…	N-2	N-1
MSB				LSB

Figure 3-1 – Bit Numbering

A byte is an 8-bit field.

A word is a 16-bit field.

A word-32 is a 32-bit field.

An array of more than one word and an N-bit field consisting of more than one word is organised according to Figure 3-2. Word number 0 is the most significant word (MSW) of the array or field and word number N-1 is the least significant word (LSW).

	Word number
MSW	0
	1
	…
	N-2
LSW	N-1

Figure 3-2 – Word Numbering

3.2.4 Field Values

The value of an N-bit field can have one of the following representations:

- An **unsigned integer** value uses the whole N-bit field to represent any number in the range from 0 to 2^N-1.
- A **signed integer** is represented using two's complement with the most significant bit indicating a positive (0) or a negative (1) number. The range of an N-bit signed integer is from -2^{N-1} to 2^{N-1}-1.
- A **range** from N to M occupying less than the full range of a field is expressed as N .. M.
- An **enumeration** type, either if the full range of the field is used or not, is expressed as discrete values with comments describing the definition of each value.
- **N/U** (Not Used) indicates that the field is not used. All bits in the field shall have the value 0. On reception N/U fields are verified.

3.3 TIME BASES

The receiver maintains 3 time bases:

- The *GPS Time (GPST)* is the GPS System Time derived from the GPS signals processed; this second/subsecond counter starts at the reference date 06.01.1980, 0:00:00h.
- The *Local on-board time (LOBT)*, is in CUC-like format as defined in section 4.5. Instead of deriving this time from the GPS signals, it is commanded by the Mil-Std-1553b Bus Controller [MilBus].
- The *Instrument Measurement Time (IMT)*, which is used for internal purposes.

IMT is a strictly monotonous time scale, starting at zero after the reset of the receiver. It is maintained by means of the AGGA-2 baseband processing chip, regardless of the receiver mode and state. In the AGGA chip an IMT counter with core clock (28.333333MHz) resolution is latched every 20ms.

LOBT is updated based on the time information distributed on the Mil-Std-1553b interface, which is assigned to the upcoming Time Synchronization Cycle (Sentinel-1 and Sentinel-2) or the upcoming GPSR PPS (Sentinel-3).

GPST is propagated with delta IMT values before a first fix has been achieved. After a first fix, the time component of PVT is used to derive GPST.

LOBT is used for time stamping of housekeeping and science telemetry data. In addition, GPST, IMT and UTC are provided in certain science TM formats.

Correlation

The maintained time bases and the UTC representation of the GPST are regularly correlated at the PPS event. Only LOBT time stamps are provided in telemetry packets; in special cases the GPST or IMT is included as well. A specific Time Correlation Data Record has been defined, that allows to observe the time bases at comparatively low downlink bandwidth cost.

The LOBT is provided in the Data Field Header of every CCSDS packet used for telemetry data transfer, as defined in [PUS].

Uncertainty

Time value uncertainty can be divided into two steps:

- Uncertainty due to the process of representing or estimating the time inside the receiver, relative to the specified source, see sections 3.3.1 to 3.3.3.
- Uncertainty of the stamping process, relative to the event it is stamping.

3.3.1 Instrument Measurement Time (IMT)

The Instrument Measurement Time (IMT) is a monotonic time derived from the clock generated by the oscillator in the receiver.

IMT has the following characteristics:

- The time is available in all receiver modes.
- The time is derived from a hardware counter in the AGGA chip.
- The IMT resolution is therefore 1 AGGA core clock cycle (frequency = 28.333333MHz, the length of one clock cycle amounts thus to 35.294ns).
- The time is monotonic, but updates are done in a 20ms interval in the AGGA chip. This is not a problem for measurement datation, since measurement capturing and the timebase update is done synchronously, i.e. with the same hardware signal at 50Hz.
- Uncertainty is zero by definition for all 20ms intervals and the PPS intervals.
- Uncertainty for any discrete point in time between the 20ms events is [-50 µs … +200µs][1].
- After reset the IMT starts at zero.

The IMT is used for:

- Precise datation of GNSS-core related hardware events
- Internal time stamping of all science data

[1] RUAG internal note: the calculation of this uncertainty is found in P:\s1gr\eng\software\Documents\CHKDIS_(S1-IF-AAE-SC-0001)\UncertaintyOfTimeStamps CalculatedForCHKDIS.eml

3.3.2 Local On Board Time (LOBT)

The LOBT has the following characteristics:

- The time is available in all receiver modes.
- The LOBT is commanded via the Mil-Std 1553b interface and is zero at reset.
- The uncertainty for LOBT introduced by the GPSR is in the range of 100µs, because the LOBT commanding via the Mil-Std-1553b interface is affected by software interrupt latency.

LOBT is used for:

- Time stamping of all telemetry packets

Note that the LOBT received via the Mil-Std-1553b interface is *not* used for the initialisation of the GPS time during receiver startup (warm start).

3.3.3 GPS Time (GPST)

GPS time is calculated from a previously calculated estimate of the GPS time according to [ICD200].

GPS time has the following characteristics:

- The time is maintained in Standby and Navigate mode only.
- The GPST resolution is 2^{-32}s (0.233ns).
- In the Navigate mode, before the first fix has been achieved, the receiver estimates the GPST based on pre-load setting done via telecommanding. Therefore the GPST is monotonic during this period. In case no telecommand for time pre-loading has been received, the initial IMT/GPST pair (0, 861235200s (1024 + 400 weeks) relative to 6th Jan 1980 0:00 is used for estimation. However, in such a situation a cold start will be performed due to the missing time information.
- In the Navigate mode, after the first fix has been achieved, the GPST is the time component of the PVT.
- In the Standby mode the GPST is propagated either based on the assumption of a perfect receiver clock (before a first fix) or based on the receiver clock error determined from the last PVT in Navigate mode.

GPS time is used for:

- SV prediction, selection and navigation solution computations and is a product of the navigation solution computation at the same time.
- Generation of an event for time transfer out of the receiver (PPS output)

3.4 TIME REPRESENTATION

The times defined in section 3.3 are transmitted using the following formats.

3.4.1 IMT Format

The IMT format consists of a 64-bit value as specified in Figure 3-3. IMT is set to zero at the receiver reset. It will never wrap around during the lifetime of the receiver due to its 64-bit nature. The IMT is for internal and maintenance use, only. Since it precisely describes how the GPSR clock oscillator behaves, it is an important measurement to derive short and long term clock drift.

The type resolution can directly be derived from the AGGA core clock frequency and is thus (1/28.333333MHz) which is approximately 35.294ns.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16" rowspan="4">IMT</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
</table>

Figure 3-3 – IMT Format

In the SRDB definition, the IMT time stamp is divided in two 32 bits wide parameters. The parameters are named IMT_MSB (most significant bits) and IMT_LSB (least significant bits). The aggregate IMT is calculated as (C syntax): IMT = IMT_MSB<<32 | IMT_LSB

3.4.2 UTC Format

The UTC format uses the Universal Time Coordinated (UTC) time base.

The UTC format consists of a 64-bit value according to the CDS (CCSDS Day Segment) time code format, as defined in Figure 3-4 and Table 3-1.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16">DAYS</td></tr>
<tr><td>1</td><td colspan="16" rowspan="2">MSEC</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td colspan="16">USEC</td></tr>
</table>

Figure 3-4 – UTC Format

Name	Definition	Field width	Value	Interpretation
DAYS	Day number	16	Unsigned	Number of days since 1st of January 2000, 00:00:00 starting with 0.
MSEC	Milliseconds	32	Unsigned 0 .. X	Number of ms of day. X is 86399999 if no leap second adjustment is performed. X is 86400999 or 86398999 when leap second adjustment is performed.
USEC	Microseconds	16	Unsigned 0 .. 999	Number of μs of ms. Note: In case this format is used in telemetry, rounding is performed to avoid jitter between readings 0 and 999.

Table 3-1 – UTC Format Contents Definition

3.4.3 CUC Format

The CUC (CCSDS unsegmented time code) Format is defined according to Figure 3-5.

The type resolution is thus 2^{-24}s, which is approximately 59.6 ns.

Word	Bit number 0–7	Bit number 8–15
0	COARSE: Number of seconds since 6th of January 1980	
1		
2	FINE: Sub-seconds [2^{-24}s]	
3		0

Figure 3-5 – CUC Format

3.4.4 GPS Time Format

The GPS time format is defined by Figure 3-6.

The type resolution is 2^{-32}s, which is approximately 233 ps.

Word	Bit number 0–15
0	Number of seconds since 6th of January 1980, starting with 0 at 00:00:00 hours.
1	
2	Number of fractions of a second [2^{-32}s]
3	

Figure 3-6 – GPS Time Format

4. CCSDS PACKET SPECIFICATION

Figure 4-1 is an excerpt of [PUS] with slight amendments and shows all telecommand packet contents referred to in the document at hand. Figure 4-2 shows a general TM format.

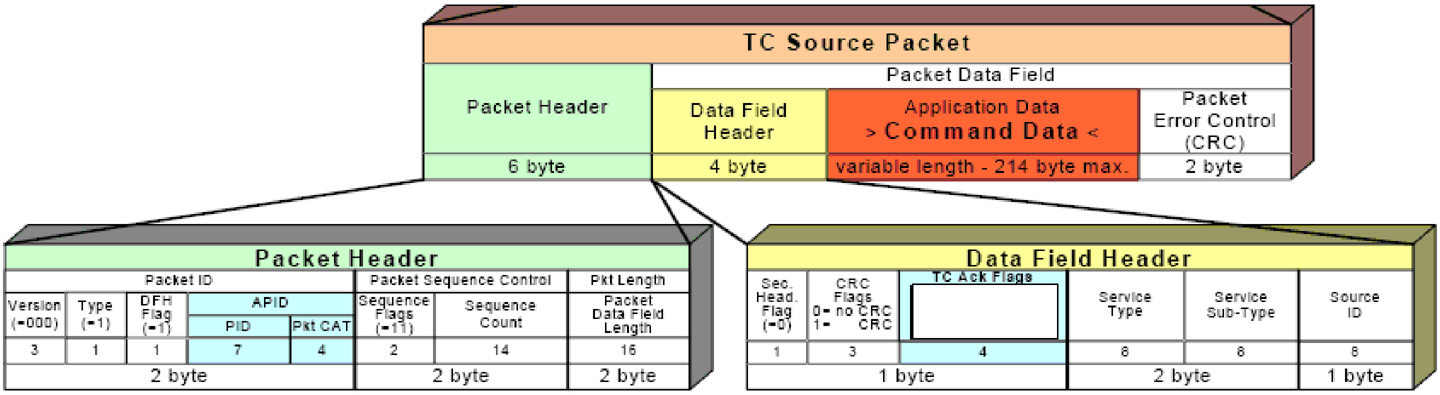

Figure 4-1 – TC Source Packet Format

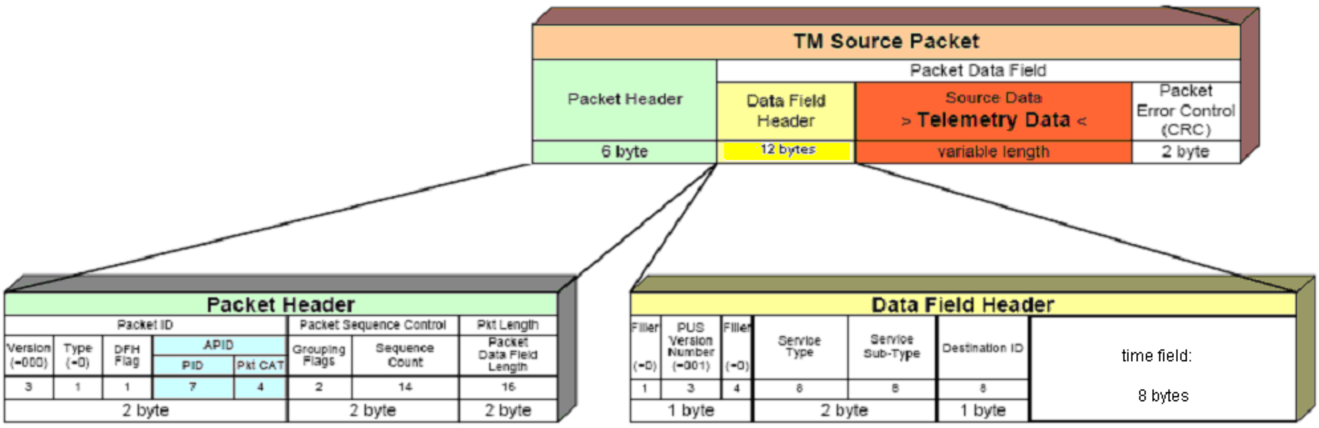

Figure 4-2 – TM Source Packet Format

As can be seen, the format of the Time Field in TM packets differs for Sentinel-1 from Sentinel-2 and Sentinel-3. Details are given in section 4.5

4.1 CCSDS PACKET DFH FLAG

The DFH Flag shown in the Packet Header of Figure 4-1 and Figure 4-2 is set to one for all TC and TM packets.

4.2 CCSDS PACKET APID

The Application Process Identifier (APID) found in the Packet Header is structured into two fields. The Process ID (PID, sometimes referred to as PRID in [PUS]) and the Packet Category field (PCAT, sometimes referred to as Packet CAT in [PUS]).

The value of the PID is different on the nominal and redundant GPSR:

Receiver	PID
GPS-A	30h
GPS-B	31h

Table 4-1 – CCSDS PID Values Definition

Table 4-2 shows the mapping of GPSR telecommands and telemetry packets to their corresponding PID and PCAT, as defined in [PUS, Volume B].

Packet type	Service Type	Services	Service Subtype	Category	APID	
					PID	PCAT
TC	All	All services	All	Telecommands	See Table 4-1	12
TM	1	Telecommand Verification	1,2,7,8	Acknowledge		1
	3	Housekeeping	25	Housekeeping Param. Rep.		4
				Time Correlation		4
				Navigation Solution		4
	5	Event Reporting	1,2,3,4	Generic Events		7
			213	Disabled Event Packets Report		3
	6	Memory Service	216	Memory Dump Report		9
			218	Memory Check Report		9
	17	Test Service	2	Link Connection Report		1
	211	GPS Parameter Report	3			3
	212	Science Data f. POD	1	Auxilary, SatelliteInView, CarrierPhase, CarrierAmplitude, CodePhase.		6
	212	Science Data f. Sentinel-1	1	MinimumNavigationSolution, IMT_GPST_Correlation		11
	212	Science Data f. Support of Signal Processing	1	ChannelStatus, TrackingState, NoiseHistogram		12
	212	Science Data Events	1	ConstellationStatus, GPS_NAV_Almanacs, GPS_NAV_Ephemeris, GPS_NAV_UTC_and_Ionosphere, AGC_Status		13
	213	Periodic Mem. Diagnosis	1	Diagnostic		9

Table 4-2 – CCSDS PCAT Values Definition

4.3 GROUPING FLAGS, SEQUENCE COUNT AND CCSDS PACKET LENGTH

For the Sentinel GPSR, each CCSDS packet is either one telecommand or one telemetry report. Thus, the Grouping Flags in the Packet Header (Figure 4-2) are set to 11_b, indicating stand alone packets.

The GPSR sets the Sequence Count in the TM Packet Header to 0 for the first packet per APID after a reset or power-up. The Sequence Count is incremented for each packet and wrapped back to zero when overflowing in the scope of the application software. As said, there is one such counter per APID. Ground can thus detect by discontinuous counters which packets had to be dismissed in case of buffer overflows.

The GPSR does *not* check, if the Sequence Counters of TCs are consecutive.

The maximum length of CCSDS packets transmitted via the Mil-Bus is 256 bytes. The field Packet Length, describing the number of bytes contained in the Packet Data Field minus one, thus ranges from 7 to 249 for telemetry. Telecommands never reach the maximum size supported by the Mil-Bus, see maximum size given in Figure 4-1. The type-specific packet length can be derived from the corresponding subsection where the TC/TM is defined.

4.4 TC DATA FIELD HEADER

If the CRC field in the TC Data Field header is 001_b, then the GPSR will check the PEC of that TC. If the CRC field in the TC Data Field header is 000_b, the GPSR will ignore the PEC of that TC. The GPSR rejects TCs with any other CRC field value.

Of the 4 TC Ack Flag bits, the MSB determines, if TM(1,1) is required for the TC at hand, and the LSB, if a TM(1,7) is required for the TC at hand. The two other bits are ignored by the GPSR. However, that does not mean that a defined reply message is not sent. That means for TC(17,1) in the error free case, for example, that, if both bits are set, the GPSR first sends TM(1,1), then TM(17,2), then TM(1,7).

In case of errors in the TC the GPSR sends TC Acknowledge Error Reports, i.e. TM(1,2) and TM(1,8), regardless of the TC Ack Flag settings.

4.5 TM DATA FIELD HEADER

The Destination ID in the Data Field Header of Figure 4-2 is a copy of the TC Source ID for reply packets and zero for packets not being directly linked to a TC, such as event packets and housekeeping packets.

The Time Field shown in the Data Field Header of Figure 4-2 differs in Sentinel-1 from the Time Field of the other Sentinels. The following figures give the details. In both cases it holds the LOBT. The LOBT is set via the Mil-Std-1553b interface, it counts the (sub)seconds since an initial time epoch, which is usually 00:00:00h on January 6th, 1980.

Byte	Bit number 0	1	2	3	4	5	6	7
0	00h							
1	LOBT Seconds (32 bits)							
2								
3								
4								
5	LOBT subseconds (LSB = 2^{-8} seconds)							
6	0							
7	0							

Figure 4-3 – TM Time Field for Sentinel-1

Byte	Bit number 0	1	2	3	4	5	6	7
0	LOBT Seconds (32 bits)							
1								
2								
3								

<table>
<tr><td>4</td><td colspan="8" rowspan="3">LOBT subseconds (LSB = 2^{-24} seconds)</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
</table>

Figure 4-4 – TM Time Field for Sentinel-2, Sentinel-3

The meaning of the bits in the last row of Figure 4-4 is as follows:

Bit 3: “Time Type”	1 = Local On Board Time, which is always the case for the GPSR
Bit 4: "Sync Source"	1 = external, which is always the case for the GPSR
Bit 5: "Sync Method"	0 = MIL-Bus Major Frame, always 0 for the GPSR
Bit 6: "Sync Status"	1 = synchronized with Central On Board Time, always the case
Bit 7: "Sync Ena/Dis"	1 = Enabled, which is always the case for the GPSR

To know which of the both formats needs to be used, the GPSR reads a configuration value from EEPROM.

5. SERVICES

This section specifies all commands and lists the corresponding responses – the telemetry data, used for operating the Sentinel GPSR.

5.1 SERVICE TYPE AND SERVICE SUBTYPE DEFINITIONS

Table 5-1 shows service types and service subtypes supported by the Sentinel GPSR and the corresponding TC and TM names used in this document. It further shows the GPSR reply/replies to the TCs.

	Telecommand			**Telemetry**	
Service Type, Service Subtype	Request	Section	Service Type, Service Subtype	Report	Section
Service 1	**Telecommand Verification**				
	Any Telecommand		TM(1,1)	TC Acceptance Report – Success	5.2.1
			TM(1,2)	TC Acceptance Report – Failure	5.2.2
			TM(1,7)	TC Exec Completed Report – Success	5.2.3
			TM(1,8)	TC Exec Completed Report – Failure	5.2.4
Service 3	**Housekeeping Reporting**				
			TM(3,25)	Housekeeping Parameter Report	5.3.5
Service 5	**Event Reporting**				
			TM(5,1)	Normal/Progress Report	5.4.3
			TM(5,2)	Error Report Low Severity	5.4.4
			TM(5,3)	Error Report Medium Severity	5.4.5
			TM(5,4)	Error Report High Severity	5.4.6
TC(5,210)	Enable Event Packet Generation	5.4.7	-	no specific telemetry, just TM(1,x)	
TC(5,211)	Disable Event Packet Generation	5.4.8	-	no specific telemetry, just TM(1,x)	-
TC(5,212)	Report Disabled Event Packets	5.4.9	TM(5,213)	Disabled Event Packets Report	5.4.10
Service 6	**Memory Management**				
TC(6,212)	Load Memory	5.5.1	-	no specific telemetry, just TM(1,x)	
TC(6,215)	Dump Memory	5.5.2	(6,216)	Memory Dump Report	5.5.3
TC(6,219)	Check Memory	5.5.4	(6,218)	Check Memory Report	5.5.5
TC(6,210)	Copy Memory	5.5.6	-	no specific telemetry, just TM(1,x)	
Service 17	**Test**				
TC(17,1)	Perform Connection Test	5.9.1	(17,2)	Link Connection Report	5.9.2
Service 210	**Mode Service**				
TC(210,1)	Change GPSR Mode	~~5.6.3~~5.7	-	no specific telemetry, just TM(1,x)	
Service 211	**Parameter Service**				
TC(211,1)	Load GPSR Parameter	5.8	-	no specific telemetry, just TM(1,x)	
TC(211,2)	Report GPSR Parameter	5.8.2	(211,3)	GPSR Parameter Report	5.8.3
Service 212	**Science Data Service**				
			TM(212,1)	GPSR Science Data	5.10
Service 213	**Periodical Memory Service**				
TC(213,1)	Periodical Memory Diagnosis	5.6.1	TM(213,2)	Periodical Memory Diagnosis Report	5.6.2
TC(213,3)	Abort Memory Service	5.6.3	-	no specific telemetry, just TM(1,x)	

Table 5-1 – Supported Services

5.1.1 Telecommand categories

Telecommands are of either short duration or long duration type, or may have some special usage constraints. The following different categories have been identified:

5.1.1.1 Short duration telecommands

The execution of short duration telecommands is performed immediately, i.e. there is no systematic delay between reception and execution, except the delays resulting from execution of higher priority tasks in the software system or delays caused by execution of earlier received telecommands.

Telecommands of this category are:

- Load GPSR Parameter
- Report GPSR Parameter
- Perform Connection Test
- TC(5,x)

5.1.1.2 Long duration telecommands

The execution of long duration telecommands cannot always be performed immediately because of

- Excessive telemetry generation and the related data load restrictions
- Significant CPU load contribution to be distributed over a certain period of time
- Timing constraints when writing non-volatile memories

Telecommands of this category are:

- Load Memory
- Dump Memory
- Periodical Memory Diagnosis
- Check Memory
- Copy Memory

All of these are Memory Management telecommands. Their execution is mutually exclusive and can be aborted by means of a Receiver Mode Change, see chapter 5.5 for details, and by the Abort Memory Service Command.

The duration of such “long duration commands” can be quite short sometimes. Let’s think of a dump command with a very small dump size, for example. Commands that can have an execution time greater than 10 seconds are the Periodical Memory Diagnosis (the execution time of this command is infinite) and Copy Memory for writes to NVM2 which are longer than 1600 bytes. The Load Memory TC into NVM2 executes in less than 300 ms.

5.1.1.3 Telecommands with special usage constraints

- During execution of certain commands further commanding shall be suspended to avoid ambiguities at command interpretation. The only telecommand with this special constraint is:
- Change GPSR Mode

This telecommand is used in the Sentinel GPSR to initiate receiver mode changes. The execution is on one hand synchronized to the internal timebase and on the other hand it takes some time to finish all activities in the mode to be left. The mode changes are:

- Startup to Standby: A software context change is performed, i.e. the pre-emptive scheduler has to be initialised and started. The application software is initialised and certain status variables (LOBT, sequence counters) have to be ported from the Startup context to the operational context. This mode transition is synchronized to the Measurement Epoch (ME), which has a period of 20ms.
  Constraint: During a mode transition from Startup to Standby, further commanding must be suspended until the mode change has completed.
- Standby to Startup: This mode transition includes a processor reset and a number of boot activities to be executed (e.g. memory tests, RAM initialisation).
  Constraint: After a mode transition from Standby to Startup has been commanded, further commanding must be suspended until the transition has completed.
- Standby to Navigate: This mode transition is synchronized to the internal PPS.
  Constraint: After a mode transition from Standby to Navigate has been commanded, further commanding must be suspended for 2 seconds.
- Navigate to Standby: This mode transition is synchronized to the internal PPS. In the frame of this transition the Acquisition and Tracking of GPS signals are stopped, and measurement processing is finished decently. These activities are expected to take up to one second.
  Constraint: After a mode transition from Navigate to Standby has been commanded, further commanding must be suspended for 2 seconds.

Notes: Transitions between operational modes (Standby and Navigate) are safely handled by the receiver, i.e. a violation of one of the aforementioned constraints does not lead to incorrect behaviour. However, as long as the receiver has not finished the mode transition, it will not execute other telecommands. For transitions between Startup and Standby mode and vice versa, the situation is different: If a telecommand is sent after the issued mode command, i.e. during the ongoing software context change between the two modes, this telecommand may either be executed or discarded, dependent on the point in time of its reception.

5.2 SERVICE 1: TELECOMMAND VERIFICATION

5.2.1 Telecommand Acceptance Report – Success TM(1,1)

If a TC check does not reveal any of the errors defined in Table 5-2 on page 44, then the GPSR acknowledges the receipt of the TC with TM(1,1), if, and only if, the most significant Ack Flag of the TC Data Field Header is set. The format of the Telemetry Data field for this TM is defined underneath.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	TC_PACKET_ID															
1	TC_PACKET_SEQ_CTL															

Figure 5-1 – TM(1,1) Format

Where TC_PACKET_ID is the Packet ID from the header of the respective TC, TC_PACKET_SEQ_CTL is a copy of the 16 bits of the TC Packet Sequence Control contained in the TC Packet Header.

5.2.2 Telecommand Acceptance Report – Failure TM(1,2)

IF a TC check does reveal any error defined in Table 5-2 on page 44, then the GPSR always sends TM(1,2) as response. The format thereof is given in Figure 5-2. The FID is the Fault ID taken from Table 5-2, which identifies the cause of the command rejection.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	TC_PACKET_ID															
1	TC_PACKET_SEQ_CTL															
2	FID															
3	N/U															
…	Parameter(s)															

Figure 5-2 – TM(1,2) Format

Where TC_PACKET_ID is the Packet ID from the header of the respective TC, TC_PACKET_SEQ_CTL is a copy of the 16 bits of the TC Packet Sequence Control contained in the TC Packet Header.

TM(1,2) has variable length. Table 5-2 defines the length by the number of parameters used, i.e. if a parameter is not used, TM(1,2) gets shorter. The FIDs 5000 to 5999 are GPSR-specific error codes. The third column of this table helps to find correspondences in [PUS], it is grayed to avoid the impression that the GPSR uses the FID definitions of [PUS].

FID	Meaning	Covered. FIDs from [PUS]	Parameter 1 [32 bits]	Parameter 2 [32 bits]
5000	Illegal application process ID (process ID and/or packet category)	259, 260	Received APID	-
5001	Received Incomplete packet or packet length is out of range	263, 265	Length in the header of the received TC	Number of received bytes
5002	Incorrect CRC	271	Received CRC	Computed CRC
5003	Illegal service number[1]	268	Illegal service type value	-
5004	Illegal subservice number	269	Illegal service sub-type value	-
5007	Illegal function ID and/or activity/format ID in TC(211,x)	-	Received FUNCT_ID	Received ACT_ID or FORMAT_ID
5009	Illegal memory ID in TC(6,x)	1536	first memory ID found to be illegal	-
5012	Wrong constant packet header data	257, 258, 261, 266, 267	Packet header, bytes 1 to 4	Packet header, bytes 5, 6, filler, filler
272	TC input buffer full, TC discarded	272	-	-

Table 5-2 – FIDs for 'Static' Verification Checks, reported by TM(1,2)

5.2.3 Telecommand Execution Completed Report – Success TM(1,7)

The GPSR sends TM(1,7), if, and only if, the execution of a telecommand has finished, and the least significant ACK flag in the corresponding TC Data Field Header was set. The format of this telemetry is identical to TM(1,1).

5.2.4 Telecommand Execution Completed Report – Failure TM(1,8)

The report of a failure in a TC with long duration is reported via TM(1,8). The format of this telemetry is identical to TM(1,2).

Table 5-3 shows the FIDs defined for the GPSR. Other FIDs defined in [PUS] are not used by the GPSR.

[1] Please note that the Startup software (implements Startup mode) and the Operational software (implements Standby and Navigate mode) do not know about which services are supported by the other software image. I.e a service supported by Operational software but not supported by the Startup software will be rejected by the Startup software with FID=5003 and not with FID=5219.

FID	Meaning	Parameter 1 [32 bits]	Parameter 2 [32 bits]
5211	Requested block length is 0 in case of TC(6,X), TC(213,1) or greater than max allowed by CCSDS TM(213,2) in case of TC(213,1)	Inconsistent block length value	-
5212	Addressed memory not in line with accessible address range of the memory ID or address not properly aligned in case of I/O access	Start address	Length in Smallest Addressable Units
5213	Illegal parameter in TC(210,1)	Received activity ID	Received mode parameter
5214	Illegal parameter in TC(211,1) or TC(213,1) – Field content not in expected range	Value 0 in case of TC(211,1) with Illegal parameter corresponding to FuncID. Index of first illegal recod record in case of TC(211,1). Illegal number of dumped areas in case of TC(213,1)	-
5215	Illegal parameter in TC(211,1) – Index in record word invalid	Index of the data record for which the check failed	-
5216	Illegal parameter in TC(211,1) – Signal type in record word invalid	Index of the data record for which the check failed	-
5217	Illegal parameter in TC(211,1) – Instance in record word invalid	Index of the data record for which the check failed	-
5218	Illegal parameter in TC(211,1) – Plausibility check of record data failed	Index of the data record for which the check failed	-
5219	TC not supported in the current mode (mode constraint violation)	Current mode	-
5221	Long duration memory TC received during execution of another long duration memory TC.	Service type of TC being executed	Service subtype of TC being executed
5222	Long duration memory TC aborted because of a mode change or the receipt of an Abort Memory Service Command.	New receiver mode	-
5223	Write access to NVM1 or NVM2 failed	Address for which the write access failed	Number of all errors occurred
5224	Abort Memory Service Command received with no corresponding long duration memory service active.	-	-
5225	The expected TC length, according to (ST,SST), is greater than the received TC length or the expected length of all records does not match with the actual length of all records in the received TC packet. This FID applies to TCs with ST=5, 6, 211 and 213.	Expected TC length in octets	Actual TC length in octets
5500	Number of EIDs, is not the one expected in TC(5,x)	Received number of EIDs	
5502	EID selected by TC(5,x) does not exist	Constant 1	Received EID

Table 5-3 – FIDs for 'Dynamic' Verification Checks

If a TC is received and there are no TM buffers available to reply to the TC, the GPSR discards the TC and increments the DiscardedTC count in the Housekeeping Parameter Report.

Please note that the FID=5219 “TC not supported in the current mode” is used when a valid telecommand supported in one operational mode is received in an operational mode in which it is not supported. This applies also to memory service telecommands TC(6,210) with destination NVM2,~~ and~~ TC(6,210) with destination NVM1 or NVM2 and TC(211,1) FMT_ParamSave when the NVM is write~~-enable~~ protected because the signature to disable the NVM write protection has not been written properly. See [UML] for further information.

5.3 SERVICE 3: HOUSEKEEPING AND DIAGNOSTIC DATA REPORTING

5.3.1 Enable housekeeping parameter report generation TC(3,5)

This service is not supported. The corresponding functionality is implemented via TC(211,1) based on the FMT_SampleRate format.

5.3.2 Disable housekeeping parameter report generation TC(3,6)

This service is not supported. The corresponding functionality is implemented via TC(211,1) based on the FMT_SampleRate format.

5.3.3 Define housekeeping packet sampling TC(3,132)

This service is not supported. The corresponding functionality is implemented via TC(211,1) based on the FMT_SampleRate format.

5.3.4 Housekeeping parameter status report TM(3,131)

This service is not supported. The corresponding functionality is implemented via TM(211,3) based on the FMT_SampleRate format.

5.3.5 Housekeeping Parameter Report TM(3,25)

The content of the Telemetry Data field of the Sentinel HK Parameter Report is shown in Figure 5-3, it follows the structure of a Science Data Packet with a single Record, see [MDIS]. In terms of a Science Data Packet the figure shows the Measurement Data Header plus the Data Record. The definition of the Telemetry Data field in a CCSDS packet is found in Figure 4-2.

HK Parameter Report packets are generated in all receiver modes. Generation of this report is not affected by mode transitions, except from Standby to Startup, which includes a processor reset and boot.

Note: Only the Housekeeping Parameter Report (SID 219) is generated in all modes. The other TM(3,25) data records Navigation Solution and Time Correlation are basically science data records and therefore generated exclusively in Navigate mode.

Word	Bit number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	Structure Identifier (SID) = 219[1]								FILLER							
1	FILLER								FILLER							
2	FE_TEMP								NU							
3	SN				V	R_MODE			Number of Records (NOF_REC) = 01h							
4	SV_ACQ				SV_SF_TRK				SV_MF_TRK				SV_PVT			
5	P	NSM			E	CNT			ITE		IDE		DTE		DDE	
6	TC_DISC								TM_DISC							
7	TXBUF_OCC															
8	DUMP_STAT															
9	CPU_LOAD															
10	CK	NU			D	M	I	L	PRECNT							
11	NU															

Figure 5-3 – Housekeeping Parameter Report Format

[1] Please note that the S-3 SRDB interprets the SID together with the adjacent FILLER fields, therefore the SID values are 2^24 bigger for S-3 than for S-1 and S-2. For example the HouseKeeping parameter report has for S-3 the SID = 219*2^24 = 0xDB000000

Name	Definition	Value& Interpretation	
FILLER	Filler	Zero, must not be used for compatibility between Sentinels	
FE_TEMP	R/F front-end temperature	Zero in Startup Mode. Modes Standby & Navigate: Raw value, scaling and calibration on ground. See [HWSWICD], section Temperature Measurment, Table – DAC code temperature relation for conversion table to degree Celsius.	
SN	Serial Number	This field is not used, set to zero	
V	Constant	1, no meaning in Sentinel	
R_MODE	Receiver Mode	1	Startup Mode
		2	Standby Mode
		3	Navigate Mode
		Other	Invalid
SV_ACQ	Number of SVs being acquired	Number of GNSS satellites being acquired at the most recent PPS[1]. Valid value range is [0...NOF_MFCS].	
SV_SF_TRK	Number of single frequency steady state tracked SVs with not yet all signal components in final tracking state	Number of single frequency steady state tracked GNSS satellites still in a transitional tracking state at the most recent PPS. The GPSR tries to achieve additional code and carrier loop locks for all available signals of the commanded tracking scheme[2].	
SV_MF_TRK	Number of tracked SVs in steady state tracking mode	GNSS satellites being tracked at the most recent PPS with all signal components in their final tracking state for their tracking scheme[3].	
SV_PVT	Number of SVs used for PVT	GNSS satellites being used for PVT at the PPS before the most recent PPS.	
P	PROM EDAC Single bit or uncorrectable error	0	No single bit or uncorrectable error since last report
		1	At least one single bit or uncorrectable error since last report
NSM	Navigation Solution Method	see [MDIS]	
E	SRAM EDAC Single bit error	0	No single bit error since last report
		1	At least one single bit error since last report
CNT	Corrected Register File errors	Captured LEON register value	
ITE	Instr cache tag error counter	Captured LEON register value. The counter is cleared after read.	
IDE	Instr cache data error counter	Captured LEON register value. The counter is cleared after read.	
DTE	Data cache tag error counter	Captured LEON register value. The counter is cleared after read.	
DDE	Data cache data error counter	Captured LEON register value. The counter is cleared after read.	
TC_DISC	Discarded TC packet counter	Number of TC packets discarded (wrapping counter). It is reset at power on and upon mode changes to and from Startup mode. This counter is incremented when the TC is discarded due to a full telecommand buffer or Milbuserrors	

[1] SV_ACQ basically refers to C/A code acquisition. Commanded C/A code acquisition is always done in a sequential mode - no parallel C/A acquisitions foreseen. Therefore the SV_ACQ counter contains in the normal case zero or one SV. Only in case of C/A fallbacks more than one SV might be reported in the SV_ACQ counter. After C/A code acquisition success, the corresponding SV is listed in the field SV_SF_TRK or SV_MF_TRK, because it is already being tracked. Parallel P(Y) or CM (re-) acquisitions are allowed, so several SVs may be listed in the field SV_SF_TRK.
The GPSR calculates the SV_ACQ as the number of Multi-Frequency Channels in Tracking State 2...4

[2] SV_SF_TRK counts the number of GNSS satellites being tracked with not all signal components in a final tracking state at the most recent PPS, i.e. channels with Multi-Frequency Tracking state 5...10 (L1 C/A & P(Y)) or Multi-Frequency Tracking state 5...7 (L1 C/A & L2 CM). GNSS satellites in Single-Frequency Tracking mode are never included in SV_SF_TRK, because they reach final tracking state directly after acquisition and get included in the SV_MF_TRK counter.

[3] SVs tracked with a Multi frequency tracking state of
11 for tracking scheme L1 C/A & L2 P(Y)
8 for tracking scheme L1 C/A & L2CM
5 for tracking scheme L1 C/A & L1 C/A
will be included here.

Name	Definition	Value& Interpretation	
		like DTD format error, DTD.DBC not updated, DTD.TS does not match with the transferred data size, double-bit errors in data or corrupted data (manchester, parity, etc.).[1]	
TM_DISC	Discarded TM packet counter	Number of TM packets discarded. It is reset at power on and upon mode changes to and from Startup mode. When the counter reaches its maximum of 255 it is wrapping to zero.	
CK	Clock Source	0	External Clock for the GPSR (*IntClkSel*) to be re-sampled for each new report
		1	Internal Clock for the GPSR (*IntClkSel*) to be re-sampled for each new report
D	MilBus I/F EDAC Double Bit Error	0	Always zero due to NCR 67 workaround implementation.
M	MilBus Protocol Selection Flag	0	Sentinel 1 Mil-Std-1553b protocol variant, acc. to the EEPROM settings
		1	Sentinel 2/3 Mil-Std-1553b protocol variant
L	MilBus I/F EDAC Single Bit Error	0	Always zero due to NCR 67 workaround implementation.
PRECNT	MilBus transient protocol error count	This counter is cleared at the start of the instrument and increases for each MilBus anomaly detected. Such anomalies are defined in S1-GPS-1553b-REQ-040050 of [MilBus]. The counter is preserved across mode transitions and is wrapping to zero when it reaches the maximum of 255.	
I	not used	This bit is not used	
TXBUF_OCC	Transmit buffer occupancy	Number of bytes buffered for transmission	
DUMP_STAT	Memory Dump status	Number of TM packets to be generated until the current Memory Dump is finished. The counter is reset to zero on the transition from Startup to Standby Mode.	
CPU_LOAD	Processor load	0 … 10000	CPU Load of most recent PPS interval in [0.01%] Note: In the very first Housekeeping Parameter Report after the mode transition from Startup to Standby this field will hold a value of zero.

Table 5-4 – Housekeeping Parameter Report Definition

In addition to this report two Science Data Packets are sent as TM(3,25), with different Structure Identifiers. These are described in [MDIS].

[1] Please note that the TC_DISC counter is cleared after a mode change between the Startup and Operational SW.

5.4 SERVICE 5: EVENT REPORTING

The GPSR supports the standard services TM(5,1), TM(5,2), TM(5,3) and TM(5,4). Continued or periodic reporting of the same event is suppressed by implementation of filtering measures.

In addition to that it is possible to switch on/off the generation of certain event types by means of TC(5,210), TC(5,211). The current state of enabled/disabled event types can be queried with TC(5,212), where the GPSR replies with TM(5,213).

Service Type	Service Subtype	Direction	Service Subtype Name	Receiver Modes		
				Startup	Standby	Navigate
5	210	TC	Enable Event Packet Generation	-	✓	✓
	211	TC	Disable Event Packet Generation	-	✓	✓
	212	TC	Report Disabled Event Packets	-	✓	✓
	213	TM	Disabled Event Packets Report	-	✓	✓

Table 5-5 – Event Service Mode Constraints

5.4.1 Event Types

Table 5-6 defines the event types and their respective ‘Event IDs’ – EID. The table further defines the generated telemetry report and in which receiver mode an event type may be generated.

Error/Anomaly reports of medium severity are typically generated in the mode the error occurred in, and stored in the Post Mortem Report area. Due to the severity of the error and the resulting risk for software context inconsistency, these events are not sent immediately. A processor reset is forced to enter Startup mode. After reporting of the Startup Test Success event, the Post Mortem Report area is analysed and if an error event is stored, it will be reported.

Event name	EID (for S-1&2 all TCs and TMs and for S-3 SRDB for TC(5,210/211) and TM(5,213)	EID (for S-3 SRDB TM(5,1/2/3/4) the EID is interpreted as a 32bit field)[8]	Section	Telemetry Type	Severity	Service Type	Service Subtype	Receiver Modes		
								Startup	Standby	Navigate
Startup Test Success	0010h	00100000h	5.4.3.1	Normal/Progress Report	-	5	1	✓	-	-
Entered Receiver Mode	0011h	00110000h	5.4.3.2	Normal/Progress Report	-	5	1	✓	✓	✓
First Navigation Fix Timeout	4021h	40210000h	5.4.4.1	Error/Anomaly Report	Low	5	2	-	-	✓
Invalid Navigation Solution	4022h	40220000h	5.4.4.2	Error/Anomaly Report	Low	5	2	-	-	✓
Discarded Measurement	4023h	40230000h	5.4.4.3	Error/Anomaly Report	Low	5	2	-	-	✓
Acquisition Failed	4024h	40240000h	5.4.4.4	Error/Anomaly Report	Low	5	2	-	-	✓
Software Warning	4010h	40100000h	5.4.4.5	Error/Anomaly Report	Low	5	2	✓	✓	✓
Software Failure	8010h	80100000h	5.4.5.1	Error/Anomaly Report	Medium	5	3	✓	✓	✓
RTOS Resource Failure	8011h	80110000h	5.4.5.2	Error/Anomaly Report	Medium	5	3	✓	✓	✓
Processor Exception	8100h	81000000h	5.4.5.3	Error/Anomaly Report	Medium	5	3	✓	✓	✓
Watchdog Expiration	8101h	81010000h	5.4.5.4	Error/Anomaly Report	Medium	5	3	✓	✓	✓
Startup Test Failure	C080h	C0800000h	5.4.6.1	Error/Anomaly Report	High	5	4	✓	-	-

Table 5-6 – Event Types, EID and Associated Telemetry Reports

Note: If a processor reset does not solve a problem, this problem is very likely related to a hardware failure. In such a case the hardware self-check (Startup Test) following the processor reset may detect the failure.

5.4.2 Event Time stamping

All events defined in the following subsections are time stamped with IMT. An event is time stamped when it has been detected, not necessarily when the cause of it occurred. Event detection may be delayed due to the runtime behaviour of the software, e.g. due to interrupts, task pre-emption etc.

Please note that the LOBT time stamp in the TM CCSDS secondary header and the IMT time stamp in the event payload data do not origin from the same point of time. The LOBT time stamp in the TM CCSDS secondary header is the time stamp for the TM *packet* creation, not the time stamp of the event detection.

[8] The EID values are for the S-3 SRDB TM(5,1/2/3/4) 2^16=65526 times bigger than for S-1 and S-2.

5.4.3 Normal / Progress Report TM(5,1)

5.4.3.1 Startup Test Success Event

This event is generated when the GPSR has completed its startup tests successfully. The content of the Telemetry Data field for this CCSDS packet is defined below.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16">EID</td></tr>
<tr><td>1</td><td colspan="16">FILLER</td></tr>
<tr><td>2</td><td colspan="16">N/U</td></tr>
<tr><td>3</td><td colspan="16">LEN</td></tr>
<tr><td>4</td><td colspan="16" rowspan="4">IMT</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td colspan="16" rowspan="2">SIGNATURE</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td colspan="16" rowspan="2">BOOT_STAT</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td colspan="16" rowspan="2">COREDMP_STAT</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td><td colspan="16" rowspan="2">SW_VERSION</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td><td colspan="16">N/U</td></tr>
<tr><td>17</td><td colspan="13">N/U</td><td colspan="3">R_MODE = 1</td></tr>
</table>

Figure 5-4 – Startup Test Success Event

<table>
<tr><th>Short Name</th><th>Long Name</th><th colspan="2">Values and Interpretation</th></tr>
<tr><td>EID</td><td>Event ID</td><td colspan="2">See Table 5-6 on page 51</td></tr>
<tr><td>FILLER</td><td>Filler</td><td colspan="2">0, this filler is needed to be compatible to all Sentinels. Note: the Sentinel-3 SRDB interprets the EID and this FILLER field together as the EID parameter. Therefore the EID values are bigger as in the Sentinel-1&2 case. See Table 5-6 above for more details. This applies to all TM(5,1/2/3/4) packets.</td></tr>
<tr><td>IMT</td><td>Instrument Measurement Time</td><td colspan="2">Instrument Measurement Time of the occurrence of the event</td></tr>
<tr><td>SW_VERSION</td><td>Software Version Identifier</td><td colspan="2">This number is the SVN revision eg. 3890. The SW revision is captured of the complete Flight-SW including Boot-, Startup- and Operational-SW. Later on, when patches are applied during flight it represents the Operational-SW revision. (Boot- and Startup-SW cannot be patched in flight).</td></tr>
<tr><td>SIGNATURE</td><td>Signature</td><td>‘PMRP’</td><td>Fixed pattern, a copy from the begin of the Post Mortem area</td></tr>
<tr><td rowspan="6">BOOT_STAT</td><td rowspan="6">Boot status - Reflects the reason for entering the Startup mode</td><td>0x4E4F4F50</td><td>‘NOOP’ - Normal operation after power-up</td></tr>
<tr><td>0x434D4E44</td><td>‘CMND’ - Commanded transition</td></tr>
<tr><td>0x4550524F</td><td>‘EPRO’ - Event Processor exception</td></tr>
<tr><td>0x45574447</td><td>‘EWDG’ - Event Watchdog expired</td></tr>
<tr><td>0x454F5448</td><td>‘EOTH’ – Other medium severity event</td></tr>
<tr><td>Other</td><td>Any other value is invalid</td></tr>
<tr><td rowspan="3">COREDMP_STAT</td><td rowspan="3">Core Dump status</td><td>0x2D2D2D2D</td><td>‘----‘ - No dump stored</td></tr>
<tr><td>0x444F4E45</td><td>‘DONE’ - Dump data stored</td></tr>
<tr><td>Other</td><td>Any other value is invalid</td></tr>
<tr><td>N/U</td><td>Not Used</td><td colspan="2">0</td></tr>
<tr><td rowspan="4">R_MODE</td><td rowspan="4">Receiver Mode</td><td>1</td><td>Startup mode</td></tr>
<tr><td>2</td><td>Standby mode</td></tr>
<tr><td>3</td><td>Navigate mode</td></tr>
<tr><td>Other</td><td>Any other value is invalid</td></tr>
</table>

Table 5-7 – TM(5,1) Definitions

5.4.3.2 Entered Receiver Mode Event

The purpose of this event is to report that the receiver has successfully completed a mode transition, and to capture the point in time when the mode has been finally reached. The content of the Telemetry Data field for this CCSDS packet is defined in Figure 5-5.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EID															
1	FILLER															
2	N/U															
3	LEN															
4	IMT															
5																
6																
7																
8	N/U													R_MODE		
9	N/U															

Figure 5-5 – Entered Receiver Mode Event Format

For an interpretation of the field values, please refer to Table 5-7 on page 52.

5.4.4 Error / Anomaly Report – Low Severity TM(5,2)

5.4.4.1 First Navigation Fix Timeout Event

This event is generated when the GPSR fails to achieve a first navigation fix within a predefined period of time. The timeout limit depends on the start mode of the receiver, i.e. on the amount of information available to the receiver to speed up its first fix. For details on the different start modes and the corresponding timeout periods refer to [UML].

The content of the Telemetry Data field for this CCSDS packet is defined hereafter.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EID															
1	FILLER															
2	N/U															
3	LEN															
4	IMT															
5																
6																
7																

Figure 5-6 – First Navigation Fix Timeout Event Format

For an interpretation of the field values, please refer to Table 5-7 on page 52.

5.4.4.2 Invalid Navigation Solution Event

This event is generated when the GPSR fails to build up a navigation solution because:

- The GPSR attempts to build up a first fix, but the GDOP is too high to rely on the computed PVT solution
- The GPSR attempts to build up a first fix, but the residual error is too high to rely on the computed PVT solution
- The GPSR was able to build up a first fix in the frame of a cold start, but due to tracking fallbacks the number of SVs available for PVT computation drops below 3
- The GPSR was able to build up a first fix, but the Kalman filter diverges during long phases with less than 4 SV. In this case the receiver attempts to pull in the Kalman filter by means of a least-square computation, but with less than 4 SV being tracked this is not possible.
- The GPSR attempts to compute a least-square based navigation solution, but the GDOP is too high to rely on the computed PVT solution
- The GPSR attempts to compute a least-square based navigation solution with a singular SV constellation

Note: This event is an indication for a failed PVT computation attempt (either based on the Least Squares or the Kalman Filtering algorithm). This does not necessarily mean that the reported navigation solution is invalid or has bad performance. The implemented PVT determination sequence is:

- Propagate the receiver state vector of the previous PPS
- Use the propagated receiver state vector as an estimate for a new PVT computation
- If the PVT computation succeeds, update the estimate with the computation result
- If the PVT computation fails, report the uncorrected estimate, i.e. the propagation result.

Therefore the validity of the reported navigation solution depends on the history. The user should use the Position Quality Index (QUAL_INDEX field) and the Data Valid Flag (V field) in the navigation solution telemetry packet to actually assess the usability of the reported PVT values, because both of these indicators consider the history, as well.

In order to avoid continued reporting of this event for the same reason, a filtering mechanism is implemented. Reporting is suppressed after the first occurrence, until a valid navigation solution has been computed again.

The Telemetry Data field for this CCSDS packet is defined as follows.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EID															
1	FILLER															
2	N/U															
3	LEN															
4	IMT															
5																
6																
7																

Figure 5-7 – Invalid Solution Event Format

For an interpretation of the field values, please refer to Table 5-7 on page 52.

5.4.4.3 Discarded Measurement Event

This event is generated either when the GPSR detects a large deviation between position or velocity estimates of a GNSS SV and the corresponding measurements, or when the calculated ionospheric correction exceeds a limit of 200m. In this case the measurements of the respective SV are not considered for the navigation solution computation. The thresholds for position and velocity deviations are 1000m and 7.5m/s, respectively.

In order to avoid continued reporting of this event for the same reason, a filtering mechanism is implemented. In case a satellite's measurements have been discarded once, it is deselected and banned for 3 minutes. After that time it will be considered for re-selection as any other SV.

Note: In case neither the PSR_DEV nor the DTR_DEV fields hold a value that exceeds the corresponding threshold, the third (i.e. ionospheric correction) limit is the cause for this event.

The Telemetry Data field for this CCSDS packet is defined as follows.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16">EID</td></tr>
<tr><td>1</td><td colspan="16">FILLER</td></tr>
<tr><td>2</td><td colspan="16">N/U</td></tr>
<tr><td>3</td><td colspan="16">LEN</td></tr>
<tr><td>4</td><td colspan="16" rowspan="4">IMT</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td colspan="3">CONS</td><td colspan="8">SV_ID</td><td colspan="5">N/U</td></tr>
<tr><td>9</td><td colspan="4">ANT</td><td colspan="4">N/U</td><td colspan="8">MF_CHN</td></tr>
<tr><td>10</td><td colspan="16" rowspan="2">PSR_DEV</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td colspan="16" rowspan="2">DTR_DEV</td></tr>
<tr><td>13</td></tr>
</table>

Figure 5-8 – Discarded Measurement Event Format

Short Name	Long Name	Values and Interpretation
EID	Event ID	See Table 5-6 on page 51
FILLER	Filler	0, this filler is needed for compatibility to all Sentinels Note: the Sentinel-3 SRDB interprets the EID and this FILLER field together as the EID parameter. Therefore the EID values are bigger as in the Sentinel-1&2 case. See Table 5-6 above for more details. This applies to all TM(5,1/2/3/4) packets.
N/U	Not Used	0
LEN	Event length	28, number of bytes in the event report
IMT	Instrument Measurement Time	Instrument Measurement Time of the occurrence of the event
CONS	Constellation identifier	See Table 5-29 on page 85
SV_ID	Space Vehicle Identifier	See Table 5-29 on page 85
ANT	Antenna Identifier	See Table 5-29 on page 85
MF_CHN	Channel number	See Table 5-29 on page 85
PSR_DEV	Pseudo range deviation	Difference between estimate and measurement in [m]
DTR_DEV	Delta range deviation	Difference between estimate and measurement [mm/s]

Table 5-8 – Discarded Measurement Event Definition

Note:
The fields PSR_DEV and DTR_DEV are of signed type. They will hold saturated values if the actual figures exceed the field range.

5.4.4.4 Acquisition Failed Event

This event is generated when the GPSR attempts to acquire the first signal component of a satellite (i.e. C/A code on L1) but does not succeed after one retry. In general, an acquisition should not fail during normal operation. The generation of this event is a strong indication for either a wrong antenna field of view or an incorrect adjustment of parameters affecting the receivers antenna field of view or search window safety factors (refer to the sections dealing with FMT_ReceiverAntField, FMT_AcquisitionPar and FMT_LoopAcqRetries for details).

Under certain circumstances acquisition failures have to be expected, in particular when the earth enters the GPSR antenna's field of view or the number of satellites currently being tracked is less than 4.

- The first case might only happen, if the platform attitude diverges significantly from the nominal attitude. In order to avoid reporting of acquisition failures, which actually have to be expected in such a situation, the GPSR checks for the attitude information provided by AOCS, and compares against thresholds. If the predefined thresholds are exceeded, tracked SV are deselected, and no further SV selected, thus preventing acquisition errors to occur. After coming back into the nominal attitude range, SVs will be selected and acquired again. For details on threshold adjustment refer to section 5.8.4.10.
- In the second case the low number of tracked satellites will cause a changed selection strategy. The normal behaviour is to consider the actual attitude uncertainties such that the antenna field of view used for selection is narrowed by the uncertainty. The changed behaviour is then to extend the field of view by the uncertainty, in order to increase the number of visible satellites, but on the other hand to accept that an acquisition might fail. If this really happens, the SV for which the acquisition failed, is blacklisted for 40 seconds, i.e. not considered for a re-selection until the blacklisting time expired.
- The third case may occur in the frame of a Cold Start. Even if 4 SV are already tracked, and eventually a First Fix has already been achieved, the GPSR continues to command cold acquisitions on the remaining channels. Cold Start mode will not be left as long as the First Fix has not been achieved and at least 18 Almanac data sets are available to perform a controlled autonomous selection based on SV visibility estimates. If the receiver changes from Cold Start to Non-Cold Start mode, and a still ongoing cold acquisition fails, this situation will also lead to generation of an Acquisition Failed event.
- In a fourth case the unobstructed antenna field of view does not match the ZENITH angle definition made via the FMT_ReceiverAntField telecommand. As for the second case, the SV for which the acquisition failed is blacklisted for 40 seconds. In case the SV is still a potential candidate for the begin of a track, another acquisition attempt will be made after the blacklisting time expired.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16">EID</td></tr>
<tr><td>1</td><td colspan="16">FILLER</td></tr>
<tr><td>2</td><td colspan="16">N/U</td></tr>
<tr><td>3</td><td colspan="16">LEN</td></tr>
<tr><td>4</td><td colspan="16" rowspan="4">IMT</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
</table>

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	CONS			SV_ID								SIG				
9	ANT				N/U				SF_CHN							

Figure 5-9 – Acquisition Failed Event Format

Short Name	Long Name	Values and Interpretation
EID	Event ID	See Table 5-6 on page 51
FILLER	Filler	0, needed to handle format differences between Sentinels Note: the Sentinel-3 SRDB interprets the EID and this FILLER field together as the EID parameter. Therefore the EID values are bigger as in the Sentinel-1&2 case. See Table 5-6 above for more details. This applies to all TM(5,1/2/3/4) packets.
N/U	Not Used	0
LEN	Event length	20, number of bytes in the event report
IMT	Instrument Measurement Time	Instrument Measurement Time of the occurrence of the event
CONS	Constellation identifier	See Table 5-29, page 85
SV_ID	Space vehicle identifier	See Table 5-29, page 85
SIG	Signal type	See Table 5-29, page 85
ANT	Antenna identifier	See Table 5-29, page 85
SF_CHN	Channel number	See Table 5-29, page 85

Table 5-9 – Acquisition Failed Event Definition

5.4.4.5 Software Warning Event

This event is either generated when the GPSR detects an internal software failure of low severity, or the receiver application software detects specific situations in the frame of GPS signal processing which might be of interest to the user. In contrary to the Software Failure event, it can be assumed that the software context is still in a shape to continue execution and therefore allows for correct transmission of the event.

No user intervention is expected in response to a Software Warning event, the goal is to provide background information for e.g. internal RAIM activities, which might lead to measurements not incorporated in PVT computation or to SV tracks being stopped prematurely.

Note: The generation of this event type can be configured by means of telecommands. For details refer to section 5.8.4.33 - FMT_DiagnosticFilter.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EID															
1	FILLER															
2	N/U															
3	LEN															
4–7	IMT															
8	EXEC_ID															
9	MOD_ID															
10	SRC_LINE															
11	ERR_CODE															
12–13	PAR1															
14–15	PAR2															
…	…															
26–27	PAR8															
28	LEVEL															
29	N/U															

Figure 5-10 – Software Warning Event Format

Short Name	Long Name	Values and Interpretation
EID	Event ID	See Table 5-6 on page 51
N/U, FILLER	Not Used, Filler	0
LEN	Event length	60, number of bytes in the event report
IMT	Instrument Measurement Time	Instrument Measurement Time of the occurrence of the event
EXEC_ID	Execution identifier	Execution ID of the task being executed when the software warning is issued, refer to Table Annex A-1
MOD_ID	Module identifier	ID of the software module causing the software warning to be issued, refer to Table Annex A-2
SRC_LINE	Line number	Line number of source code file
ERR_CODE	Error code	Application supplied error code, refer to Table Annex A-3
PAR1, … PAR8	Parameter 1 to 8	Application supplied parameters, refer to Table Annex A-3
LEVEL	Warning level	0 = Debugging Packet, no warning
		1 = progress report, no error
		2 = warning
		Other values are invalid

Table 5-10 – Software Warning Event Definition

5.4.4.6 Full Telecommand Buffer Event

In contrary to SWARM, there is no Full Telecommand Buffer Event in the Sentinel projects. Instead of this event, the overflow reply, i.e. TM(1,2) with FID 272 is sent upon receipt of a new command that does not fit into the telecommand buffer. As a matter of fact this telecommand is ignored.

5.4.5 Error / Anomaly Report – Medium Severity TM(5,3)

5.4.5.1 Software Failure Event

This event is generated when the GPSR detects an internal software failure. Since the detected failure is severe, it must be assumed that the event cannot be correctly transmitted in the current software context. Therefore it is stored in the Post Mortem report area, and a restart is initiated. The Software Failure Event is sent after the Startup Test Success Event has been reported.

Word	Bit number 0 – 15
0	EID
1	FILLER
2	N/U
3	LEN
4	IMT
5	
6	
7	
8	EXEC_ID
9	MOD_ID
10	SRC_LINE
11	ERR_CODE
12	PAR1
13	
14	PAR2
15	
16	ERR_LEVEL
17	N/U

Figure 5-11 – Software Failure Event Format

Short Name	Long Name	Values and Interpretation
EID	Event ID	See Table 5-6 on page 51
N/U, FILLER	Not Used, Filler	0
LEN	Event length	36, number of bytes in the event report
IMT	Instrument Measurement Time	Instrument Measurement Time of the occurrence of the event
EXEC_ID	Execution identifier	Execution ID of the task being executed when the software warning is issued, refer to Table Annex A-1
MOD_ID	Module identifier	ID of the software module causing the software failure to be issued, refer to Table Annex A-2
SRC_LINE	Line number	Line number of source code file
ERR_CODE	Error code	Application supplied error code, refer to Table Annex A-3
PAR1	Parameter 1	Application supplied parameter, refer to Table Annex A-3
PAR2	Parameter 2	Application supplied parameter, refer to Table Annex A-3
ERR_LEVEL	Error level	3 = Error
		Other values are invalid

Table 5-11 – Software Failure Event Definition

5.4.5.2 RTOS Resource Failure Event

This event is generated when the GPSR detects an internal RTOS resource failure. RTOS resources are tasks, semaphores, message queues, events and memory partitions. Since the detected failure is severe, it must be assumed that the event cannot be correctly transmitted in the current software context. Therefore it is stored in the Post Mortem report area, and a restart initiated. This event is sent after the Startup Test Success event has been reported. The Telemetry Data field for this CCSDS packet is defined as follows.

Word	Bit number 0–15
0	EID
1	FILLER
2	N/U
3	LEN
4	IMT
5	
6	
7	
8	EXEC_ID
9	MOD_ID
10	SRC_LINE
11	ERR_CODE
12	RES_TYPE
13	RES_NAME
14	RES_ID
15	
16	PAR1
17	
18	PAR2
19	

Figure 5-12 – RTOS Resource Failure Event Format

Name	Definition	Values and Interpretation	
EID	Event ID	See Table 5-6 on page 51	
FILLER	Filler	0, not to be used to handle format differences btw. Sentinels Note: the Sentinel-3 SRDB interprets the EID and this FILLER field together as the EID parameter. Therefore the EID values are bigger as in the Sentinel-1&2 case. See Table 5-6 above for more details. This applies to all TM(5,1/2/3/4) packets.	
N/U	Not used	0	
LEN	Event length	40, number of bytes in the event report	
IMT	Time stamp	Same interpretation as IMT in Table 5-10	
EXEC_ID	Execution Identifier	ID of the task being executing when the RTOS resource failure is issued; zero when the failure occurred outside a task (ISR or RTOS-Init), refer to Table Annex A-1	
MOD_ID	Module identifier	ID of the software module causing the RTOS resource failure to be issued, refer to Table Annex A-2	
SRC_LINE	Line number	Line number of source code file	
ERR_CODE	Error code	0	RTOS return code contained in PAR1 field (same interpretation as given for this field)
		3	RTEMS_INVALID_NAME
		4	RTEMS_INVALID_ID
		5	RTEMS_TOO_MANY
		8	RTEMS_INVALID_SIZE
		9	RTEMS_INVALID_ADDRESS
		10	RTEMS_INVALID_NUMBER
		11	RTEMS_NOT_DEFINED
		13	RTEMS_UNSATISFIED
		14	RTEMS_INCORRECT_STATE

Name	Definition	Values and Interpretation	
		19	RTEMS_INVALID_PRIORITY
		23	RTEMS_NOT_OWNER_OF_RESOURCE
		24	RTEMS_NOT_IMPLEMENTED
		25	RTEMS_INTERNAL_ERROR
		26	RTEMS_NO_MEMORY
RES_TYPE	Resource type	0	Task
		1	Memory partition
		2	Message queue
		3	Semaphore
		4	Event
		Other	Any other value is invalid
RES_NAME	Resource name	Name of RTOS resource	
RES_ID	Resource Identifier	Identifier returned from RTOS	
PAR1	Parameter 1	Application supplied parameter	
PAR2	Parameter 2	Application supplied parameter	

Table 5-12 – RTOS Resource Failure Event Definition

5.4.5.3 Processor Exception Event

This event is generated when the LEON processor in the GPSR raises an unexpected trap. The information provided by the event is an collection of the most important information found in the Post Mortem report, see chapter 0. This event is sent after a restart after the Startup Test Success Event. The Telemetry Data field for this CCSDS packet is defined as follows.

Word	Bit number 0–15
0	EID
1	FILLER
2	N/U
3	LEN
4–7	IMT
8–9	TIMC2_ME
10–11	PC
12–13	NPC
14–15	PSR
16–17	WIM
18–19	Y
20–21	TBR
22–23	FSR
24–25	ASR16
26–27	CCR
28–29	FAILAR
30–31	FAILSR
32–33	ITMP
34–35	ITP
36–37	ITF
38–39	WPR1
40–41	WPR2
42–43	PCR
44–45	TIMC1
46–47	TIMC2
48–49	MCFG1
50–51	MCFG2
52–53	MCFG3
54–55	g1

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
56	g2															
57																
58	g3															
59																
60	g4															
61																
62	g5															
63																
64	g6															
65																
66	g7															
67																

Figure 5-13 – Processor Exception Event Format

Name	Definition	Values and Interpretation
EID	Event ID	See Table 5-6 on page 51
LEN	Event length	136, Number of bytes in the event report
IMT	Event Time stamp	Same interpretation as IMT in Table 5-10, pg. 59
TIMC2_ME	Timer 2 Counter Register	Timer value of the AT697E, captured at most recent ME
PC	Program Counter	See AT697E Data Sheet.
NPC	New Program Counter	
PSR	Processor State Register	
WIM	Window Invalid Mask	
Y	Multiply/Divide Register	
TBR	Trap Base Register	
FSR	Floating Point Status Register	
ASR16	Register file protection ctrl reg	
CCR	Cache Control Register	
FAILAR	Fail Address Register	
FAILSR	Fail Address Status Register	
ITMP	Interrupt mask and priority reg.	
ITP	Interrupt pending register	
ITF	Interrupt force register	
WPR1	Write Protection Register 1	
WPR2	Write Protection Register 2	
PCR	Product configuration register	
TIMC1	Timer 1 Counter Register	
TIMC2	Timer 2 Counter Register	
MCFG1	Memory config register 1	
MCFG2	Memory config register 2	
MCFG3	Memory config register 3	
g1 – g7	Global registers	

Table 5-13 – Processor Exception Event Definition

5.4.5.4 Watchdog Expiration Event

This event is generated when a reset occurred, that was caused due to the expiration of the Watchdog. Such a situation is typically caused by program execution trapped in an endless loop (software hang). Error investigation can be based on the saved memory regions specified by FMT_ContextSaveTable, as defined in section 5.8.4.32.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	EID															
1	FILLER															
2	N/U															
3	LEN															
4	IMT															
5																
6																
7																

Figure 5-14 – Watchdog Expiration Event Format

For an interpretation of the field values, please refer to Table 5-7 on page 52.

5.4.6 Error / Anomaly Report – High Severity TM(5,4)

5.4.6.1 Startup Test Failure Event

This event is generated when the GPSR has completed its startup tests on error. The format is identical to TM(5,1), see section 5.4.3.1 on page 52. Ground may want to inspect the post mortem report area after the receipt of this event, see definition in chapter 0.

Note: Startup tests will be continued, regardless of errors detected in an earlier test step. Therefore the post mortem is representative for the entire test sequence, as far as test execution is not affected by existing memory errors.

5.4.7 Enable Event Packet Generation TC(5,210)

This telecommand is used to switch on the sending of an event I.e. when the sending of such events is disabled, as reported by TM(5,213), the GPSR will enable future reports of this event upon receipt of the command.

Word	Bit number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	Number of Event IDs = 1								FILLER = 0							
1	EID															

Figure 5-15 – Disable/Enable Event Packet TC Format

In the figure above the parameter EID is the event ID *of a low severity event* defined in Table 5-6 on page 51. When being disabled, event reports are not buffered. That means an event happened before enabling the event report will never be reported.

This TC is accepted in the modes Standby and Navigate, only. The entire command will be rejected, if a single EID is invalid. By default all event packets are enabled.

5.4.8 Disable Event Packet Generation TC(5,211)

This telecommand is used to switch off the sending of an event. The format is identical to TC(5,210). This TC is accepted in the modes Standby and Navigate, only. The entire command will be rejected, if a single EID is invalid.

5.4.9 Report Disabled Event Packets TC(5,212)

This telecommand is used to request the disabled events from the GPSR. The command does not have any application data, i.e. the Application Data Field does not exist and has length zero. This TC is accepted in the modes Standby and Navigate, only.

5.4.10 Disabled Event Packets Report TM (5,213)

This telemetry is the reply to TC(5,212). The parameter NEID gives the number of events IDs (EID) found in the report. The EIDs are the IDs of the disabled events. The EID definition is found in Table 5-6 on page 51.

Word	Bit number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	NEID															
1	EID															
	…															
NEID	EID															

Figure 5-16 – Disable Event Packets Report TM Format

5.5 MEMORY MANAGEMENT SERVICES

Table 5-14 defines the service subtypes supported in the different receiver modes. In case of no support in the current receiver mode, execution of telecommands is refused by sending TM(1,8). Ongoing execution across a mode transition will be generally aborted and indicated by sending a TM(1,8). There is one exception: A RAM memory dump started in Navigate mode will not be aborted during a mode transition into Standby.
All Memory Management services, except the Abort Memory Service Command, are long duration services. The consequence is parallel background execution of those services, while telecommands of other services (and the Abort Memory Service Command) can be treated in the foreground. It has to be noted that all those long duration services are mutual exclusive: a telecommand requesting another long duration Memory Management service while an earlier one is still executing in background, will be rejected by sending TM(1,8).

Service Type	Service Subtype	Direction	Service Subtype Name	Receiver Modes											
				Startup				Standby				Navigate			
				NVM1	NVM2	RAM	IO	NVM1	NVM2	RAM	IO	NVM1	NVM2	RAM	IO
6	212	TC	Load Memory	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓
6	215	TC	Dump Memory	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓
6	216	TM	Memory Dump Report	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	✓
6	219	TC	Check Memory	✓	✓	✓	-	✓	✓	✓	-	-	-	-	-
6	218	TM	Check Memory Report	✓	✓	✓	-	✓	✓	✓	-	-	-	-	-
6	210	TC	Copy Memory to RAM	✓	✓	✓	-	✓	✓	✓	-	✓	✓	✓	-
6	210	TC	Copy Memory from RAM	✓	✓	✓	-	✓	✓	✓	-	-	-	-	-
213	1	TC	Periodical Memory Diagnosis	-	-	-	-	-	-	✓	-	-	-	✓	-
213	2	TM	Periodical Memory Diagnosis Report	-	-	-	-	-	-	✓	-	-	-	✓	-
213	3	TC	Abort Memory Service Command	✓				✓				✓			

Table 5-14 – Memory Management Service Mode Constraints

Notes:

1) NVM1 refers to the Non-Volatile Memory holding the Startup SW. NVM1 can only be programmed when the test connector is connected and by using the Memory Load TCs.
2) NVM2 refers to the Non-Volatile Memory holding the Application SW. NVM2 can be patched in orbit.
3) In a Copy Memory command at least one Memory ID must be set to RAM.
4) In a Copy Memory command NVM1 may only act as the data source (except when the test connector is connected). That is why some of the check marks in Table 5-14 are greyed out.
5) Access to I/O requires 32-bit alignment of addresses and a length granularity of 4 bytes.
6) The address ranges for NVM1 and NVM2 given in Table 5-15 below refer to 75% of the physical memory corresponding to the useable data areas in the EEPROMs. The syndrome area beyond the 75% limit is implicitly handled by the GPSR SW, i.e. at a write access to the data area the corresponding syndrome bits are computed and updated autonomously. In case of a read access the LEON EDAC autonomously performs a read access to the syndrome bits, as well. Therefore there is basically no need for the user to access the NVM outside the given address range.
   However, the GPSR SW will not reject memory service TCs as long as the specified address range is within the physical memory address range as given in [UML].

The Memory Services identify the memory by the following IDs:

Memory ID	Memory Type	Start Address	End Address
1	NVM1	0x00000000	0x00017FFF
11	NVM2	0x10000000	0x100BFFFF
21	RAM	0x40000000	0x401FFFFF
23	I/O	0x20000000	0x20CFFFFC
		0x80000000	0x9008001C

Table 5-15 – GPSR Memory IDs

Please note that the NVM2 has a software controlled write protection. The write protection makes the GPSR reject all TCs trying to modify the NVMs' content. That are TC(6,212) & TC(6,210) with NVM1 or NVM2 as destination and TC(211,1) FMT_ParamSave. To disable the write protection the user has to write a signature to a specific GPSR RAM address area. The signature can be written with a Load Memory TC(6,212) as follows:

Parameter Name	**Parameter Value**
MEMORY_ID	21 (RAM data)
START_ADDR	0x40191080
U_LENGTH	30
DATA	0x42 0x41 0x4E 0x43 0x4F 0x4D 0x46 0x4C 0x48 0x47 0x52 0x49 0x47 0x52 0x53 0x48 0x4F 0x43 0x48 0x4F 0x57 0x4F 0x4C 0x53 0x52 0x45 0x48 0x5A 0x41 0x4E

Table 5-16 – TC(6,212) to disable the NVM write protection

The NVM can be write protected again by a GPSR mode change, power cycle or by overwriting the signature in RAM with any other value, for example with a Load Memory TC(6,212):

Parameter Name	**Parameter Value**
MEMORY_ID	21 (RAM data)
START_ADDR	0x40191080
U_LENGTH	30
DATA	0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Table 5-17 – TC(6,212) to enable the NVM write protection

5.5.1 Load Memory TC(6,212)

Load Memory commands into RAM areas in use by the executing software inherently have a high potential for corruption of the software context. Thus, such commands need to be used with utmost care. The Command Data field for this CCSDS packet is defined as follows.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	MEMORY_ID															
1	START_ADDR															
2																
3	U_LENGTH															
4																
5	DATA															
…																
…																

Figure 5-17 – Load Memory Command Format

Name	Definition	Values and Interpretation
MEMORY_ID	Memory ID	See Table 5-15.
START_ADDR	Start Address	Start address of the memory to be overwritten [byte address].
U_LENGTH	Length of Data Field (upload)	Number of Smallest Addressable Units (SAU) to be written. In case of I/O the SAU is [32-bit-word], in any other case it is [byte]. This number ranges from 1 to 51 for I/O access and from 1 to 204 for byte access.
DATA	Patch Data	U_LENGTH SAU of data to be patched

Table 5-18 – Load Memory Command Definitions

5.5.2 Dump Memory TC(6,215)

The format of the Command Data field of the Dump Memory command is as follows.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	MEMORY_ID															
1 2	START_ADDR															
3 4	D_LENGTH															

Figure 5-18 – Dump Memory Command Format

Name	Definition	Values and Interpretation
MEMORY_ID	Memory ID	See Table 5-15.
START_ADDR	Start Address	Start address of the memory to be read [byte address]. A memory map is given in the [UML].
D_LENGTH	Length of Data Field (download)	Number of SAU to be read. In case of I/O the SAU is [32-bit-word], in any other case it is [byte]. If the data requested cannot be packed into a single Memory Dump Report, the GPSR will send several TM(6,216) with consecutive memory addresses to be able to deliver the entire requested memory dump.

Table 5-19 – Dump Memory Command Definitions

5.5.3 Memory Dump Report TM(6,216)

This command is the GPSR's response to the Memory Dump TC.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	MEMORY_ID															
1 2	START_ADDR															
3 4	U_LENGTH															
5 … …	DATA															

Figure 5-19 – Memory Dump Report Format

Name	Definition	Values and Interpretation
MEMORY_ID	Memory ID	See Table 5-15.
START_ADDR	Start Address	Start address of the memory area delivered in this dump packet. The packet might be one of many packets in reply to the Memory Dump TC, if the requested area cannot be fed into a single CCSDS packet.
U_LENGTH	Length of Data Field (segment)	Number of SAU dumped. In case of I/O the SAU is [32-bit-word], in any other case it is [byte].
DATA	Patch Data	U_LENGTH SAU of data

Table 5-20 – Memory Dump Report Definitions

In case the requested dump does not fit into a single Memory Dump Report TM, the GPSR will split it into several self-contained Memory Dump Reports, i.e. the fields START_ADDR and U_LENGTH of each packet will be independent from other TM packets participating in the response. The GPSR limits the number of Memory Dump Reports to one packet per second. Note that a complete dump of all 2MB RAM will thus need 2½ hours.

Please note that because of a defect in the GPSR SW up to including version SBGR-V2.3, the dumping of large data areas from NVM1 and NVM2 was not limited to one TM(6,216) memory dump report per second. Actually the SBGR-V2.3 and earlier generated 10 TM(6,216) memory dump report packages per second. See S1-TN-AAE-SC-0064 for further information on what the user constraints are for those software versions.

5.5.4 Check Memory TC(6,219)

The format of the Command Data field of the Check Memory command is identical to the Command Data field of the Dump Memory Command. Please refer to section 5.5.2.

Note: Calculation of a CRC16 checksum for large memory areas is time consuming, so this command is a “long duration” command. It can take several seconds until the command gets completed. This command is not supported in Navigate mode.

5.5.5 Check Memory Report TM(6,218)

TM(6,218) is the GPSR’s response to the Check Memory command. Its Telemetry Data field is defined as follows. The start address and the length fields are a copy of the respective fields of the Check Memory telecommand.

Word	Bit number 0 … 15
0	MEMORY_ID
1–2	START_ADDR
3–4	D_LENGTH
5	CRC16

Figure 5-20 – Check Memory Report TM Format

5.5.6 Copy Memory TC(6,210)

The Command Data field of the Copy Memory command is defined as follows.

Word	Bit number 0 … 15
0	MEMORY_ID_SOURCE
1–2	START_ADDR_SOURCE
3–4	D_LENGTH
5	MEMORY_ID_DEST
6–7	START_ADDR_DEST

Figure 5-21 – Copy Memory Command Format

The fields MEMORY_ID_SOURCE and MEMORY_ID_DEST describe the memory identifiers according to Table 5-15 of the source and destination with the constraints given in Table 5-14. START_ADDR_SOURCE and START_ADDR_DEST describe the start address of the source and destination memory, D_LENGTH describes the number of bytes to be copied.

5.6 PERIODICAL MEMORY SERVICE

5.6.1 Periodical Memory Diagnosis TC(213,1)

For diagnostic purposes this service allows to report the contents of memory locations in RAM at a fixed rate of 1 Hz and at a well defined point in time (the PPS leading edge). Upon successful receipt of this TC, the GPSR replies with a TM(1,1) and consequently one Periodical Memory Diagnosis Report is generated every second. This service can be stopped by sending an Abort Memory Service TC. In that case the GPSR generates a TM(1,8) with FID = 5222. The GPSR will not send a TM(1,7) for TC(213,1). The GPSR generates a TM(1,8) with FID 5214 in case parameter N is not in range and FID 5225 in case the number of provided pairs (LEN, START_ADDR) does not match N.

Word	Bit number 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15
0	REQUEST_ID
1	N
2	START_ADDR(1)
3	
4	LEN(1)
5	
6	START_ADDR(2)
7	
8	LEN(2)
9	
…	…
…	START_ADDR (N)
…	
…	LEN (N)
…	

Figure 5-22 – Periodical Memory Diagnosis Command Format

Name	Definition	Values and Interpretation
REQUEST_ID	Identifier of the command	This value is copied to the corresponding telemetry.
N	Block Count	Number of memory blocks to be assembled in the report. The GPSR supports up to 26 blocks
START_ADDR(X)	Start Address	Start address of the memory block X. If the address does not exist in RAM, the GPSR will reject the command with FID 5212.
LEN(X)	Length of the Block	Number of bytes delivered in the memory block that follows If the sum of all LEN(x)-in case of 0 or fields does not fit into TM(213,2), the GPSR SW will reject the Telecommand with FID 5211.

Table 5-21 – Periodical Memory Diagnosis Definitions

5.6.2 Periodical Memory Diagnosis Report TM(213,2)

The creation of the report defined in Figure 5-23 is triggered by sending the Periodical Memory Diagnosis TC to the GPSR. DATA(x) in this figure refers to the x-th data block requested in TC(213,1), DATA_LEN is the total number of bytes of all n data blocks. The value of REQUEST_ID is a copy of the respective field in the TC(213,1).

The reports are created at a rate of 1Hz. The report (re)creation can be stopped by forcing a mode transition from Standby Mode to Navigation Mode, a mode transition between Standby Mode and Startup Mode in each direction, and with the Abort Memory Service Command.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	REQUEST_ID															
1	DATA_LEN															
…	DATA(1)															
…	DATA(2)															
…	…															
…	DATA(n)															

Figure 5-23 – Periodical Memory Service Report Format

5.6.3 Abort Memory Service Command, TC(213,3)

This command allows stopping a memory service without changing the GPS receiver mode. The parameters of this command give the exact reference of the command to stop; i.e., the PACKET SEQUENCE COUNT refers to the ~~TC~~ header parameter Sequence Count of the long duration ~~command~~ TC to be aborted. The TC_PID shall have the value of the Process Id (PID) of the TC to be aborted. The SERVICE TYPE and SERVICE SUB-TYPE parameters shall have the value of the corresponding fields in the long duration TC to be aborted. See Figure 4-1 for TC header parameter definitions.

In case the specified memory telecommand is not (or no longer) executing, the GPSR will reply with TM(1,8). Note that SERVICE TYPE can be either 6 or 213.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0	0	0	0	0	0	0	0	TC_PID						
1	SERVICE TYPE								SERVICE SUB-TYPE							
2	0	0	PACKET SEQUENCE COUNT													

Figure 5-24 – Abort Long Duration Memory Service TC Format

5.7 MODE CHANGE TC(210,1)

Table 5-22 defines the mode change commands allowed in the different receiver modes. In case of no support in the current receiver mode, the execution of the telecommand is refused by sending TM(1,8). When changing the receiver mode, the GPSR aborts the execution of ongoing long duration telecommands. In the table the state “Startup 5s Transient” denotes the first 5 seconds of Startup Mode, i.e. the time when the GPSR is in Startup Mode after a reset but will transmit automatically to Navigate. However, if the GPSR receives “Mode change hold Startup” in this transient mode, it will remain in Startup Mode and accept more mode change commands as seen in the table.

Service Type	Service Subtype	Direction	Service Subtype Name	Receiver Modes			
				Startup 5s Transient	Startup	Standby	Navigate
210	1	TC	Mode change into Startup mode	-	✓	✓	-
	1	TC	Mode change into Standby mode	-	✓	✓	✓
	1	TC	Mode change into Navigate mode	-	-	✓	✓
	1	TC	Mode change hold Startup	✓[9]	✓	-	-

Table 5-22 – Mode Change Constraints

The format of the Mode Change command is as follows.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	MODE_ID															
1	ACT_PAR															

Figure 5-25 – Mode Transition Command Format

Name	Definition	Value	Interpretation
MODE_ID	ID of the mode switching activity	0	Switch receiver into Startup Mode
		1	Switch receiver into Standby Mode
		2	Switch receiver into Navigate Mode
		Other	Any other value is invalid
ACT_PAR	Activity Parameter Only relevant for mode changes into the Startup mode, must be zero otherwise	0	Put receiver into ‘Hold’, i.e. do not perform an autonomous transition into Standby and Navigate mode
		1	Reboot to enter Startup (via watchdog and processor reset)
		Other	Any other value is invalid

Table 5-23 – Perform Activity for Mode Transitions Definition

[9] “Mode change hold Startup” is accepted the first 5 seconds in Startup mode. If this TC is not received in these 5 seconds, then the GPSR will automatically transit to Navigate mode via Standby Mode.

5.8 FUNCTION PARAMETER HANDLING

Table 5-24 defines the support of the different parameter handling service in the different receiver modes. In case of no support in the current receiver mode, the GPSR replies by sending TM(1,8).

Service Type	Service Subtype	Direction	Service Subtype Name	Receiver Modes		
				Startup	Standby	Navigate
211	1	TC	Pre-load Function Parameters – FMT_GPS_CNAV_GroupDelay	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_GPST	-	✓	-
	1	TC	Pre-load Function Parameters – FMT_AttitudeVector	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_DiagnosticFilter	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_SampleRate	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_SatelliteMask	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_ReceiverAntField	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_KALMAN	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_RCPVT	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_Antenna	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_SVMPR	-	✓	✓
	1	TC	Pre-load Function Parameters – FMT_FORCE	-	✓	✓
	1	TC	Pre-load Function Parameters – All other types	-	✓	-
	2	TC	Report Function Parameters – All types	-	✓	✓
	3	TM	Function Parameter Report – All types	-	✓	✓

Table 5-24 – Function Management Service Mode Constraints

5.8.1 Pre-load Function Parameters TC(211,1)

The main purpose of this command is to pre-load new parameters in the Standby mode of the GPSR. Table 5-24 lists preloads that are also allowed in other modes. The parameters loaded in Standby mode become effective in the frame of the mode transition from Standby to Navigate. Please refer to [UML] for details.

FMT_AttitudeVector information must be updated in particular in Navigate mode to support the receiver's autonomous selection. FMT_SampleRate has to be supported in Navigate to allow for the request of telemetry packets of periodic type. FMT_ReceiverAntField and FMT_SVMPR: support autonomous selection in Sentinel-3 Safe Mode. FMT_KALMAN and FMT_RCPVT support PVT calculation during manoeuvres

The common layout of this telecommand is given in Figure 5-26, the corresponding definitions in Table 5-25. The Function ID determines the type of data records to be pre-loaded and implicitly also the format of those data records. The data records are contained in PAR_FIELD, which can consist of either one record or a predefined, type-dependent number of records.

The Format ID implicitly specifies the number of records to be sent within one telecommand for the parameter type selected by Function ID:

- Basically, for all parameter types a FORMAT_ID of 1 is defined and has the meaning of one data record per telecommand. For parameter types with more than one record the transmission overhead could be unacceptable, in particular for parameter types with a high number of small records. Therefore, two additional Format ID values are defined.
- An FORMAT_ID of 3 is used for parameter types with more than one record, where all records fit into a single telecommand. A FORMAT_ID of 3 implicitly means that all records for this Function ID are contained within the telecommand.
- In case all records of a parameter type do not fit into a single telecommand, a FORMAT_ID of 2 is used to load several records of that type.

References to the format definitions of the different record types can be found in Table 5-28 on page 84.

Word	Bit number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FUNC_ID								FORMAT_ID							
1	PAR_FIELD															
..																
N																

Figure 5-26 – Pre-load Function Parameters Format

Name	Definition	Field width	Values and Interpretation
FUNC_ID	Function ID	8	Specifies the parameter type to be pre-loaded, valid values are defined in Table 5-28 on page 84.
FORMAT_ID	Format identifier for the parameters	8	The allowed values 1 to 3 implicitly specify the number of records contained in the telecommand. The mapping between Format ID and a number of records is Function ID dependent and defined in Table 5-28 on page 84.
PAR_FIELD	Activity Parameter	32*n	Parameters for pre-load function defined by Function ID and Format ID

Table 5-25 – Pre-load Function Parameters Definition

5.8.2 Report Function Parameters TC(211,2)

The purpose of this command is to request a report of parameters, either pre-loaded or already effective.

The layout of this telecommand is given in Figure 5-27, the corresponding definitions in Table 5-26. The Function ID determines the type of data records to be reported, and implicitly also the format of those data records.

The decision if pre-loaded or applied parameters are reported depends on the current receiver mode, when the Report Function Parameters request is received. A request in Navigate mode will always lead to a report of applied parameters, whereas a request in Standby mode will cause a report of pre-loaded parameters.

Word	Bit number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FUNC_ID								ACT_ID							

Figure 5-27 – Report Function Parameters Format

Name	Definition	Values & Interpretation
FUNC_ID	Function ID	Identifies the parameter type to be reported, values are defined in Table 5-28 on page 84. Many of the Function IDs require a detailed specification of the records to be reported, see interpretation of ACT_ID.
ACT_ID	Activity ID	For the parameter FMT_GPS_CNAV_GroupDelay, ACT_ID=0 requests records 0 to 7 ACT_ID=1 requests records 8 to 15 ACT_ID=2 requests records 16 to 23 ACT_ID=3 requests records 24 to 31
		For the parameter FMT_MultipathMitSeg, ACT_ID=0 requests records 0 to 15 ACT_ID=1 requests records 16 to 31
		For the parameter FMT_CorrSpacing, ACT_ID=0 requests records 0 to 11 ACT_ID=1 requests records 12 to 23
		For the parameter FMT_LoopAcqRetries, ACT_ID=0 requests records 0 to 17 ACT_ID=1 requests records 18 to 36
		For the parameter FMT_Discriminator, ACT_ID=0 requests records 0 to 23 ACT_ID=1 requests records 24 to 47
		For the parameter FMT_LoopFilterPar, ACT_ID=0 requests records 0 to 11 ACT_ID=1 requests records 12 to 13 ACT_ID=2 requests records 24 to 35 ACT_ID=3 requests records 36 to 47
		For the parameter FMT_StateRetention, ACT_ID=0 requests records 0 to 31, ACT_ID=1 requests 32 to 63, ACT_ID=2 requests records 64 to 95, ACT_ID=3 requests 96 to 127, ACT_ID=4 requests records 128 to 159, ACT_ID=5 requests 160 to 191, ACT_ID=6 requests records 192 to 223, ACT_ID=7 requests 224 to 255, ACT_ID=8 requests records 256 to 287, ACT_ID=9 requests 288 to 319, ACT_ID=10 requests records 320 to 351, ACT_ID=11 records 352 to 383, ACT_ID=12 requests records 384 to 415, ACT_ID=13 records 416 to 447, ACT_ID=14 requests records 448 to 479, ACT_ID=15 records 480 to 511, ACT_ID=16 requests records 512 to 543, ACT_ID=17 records 544 to 577, ACT_ID=18 requests records 576 to 607, ACT_ID=19 records 608 to 639, ACT_ID=20 requests records 640 to 671, ACT_ID=21 records 672 to 703, ACT_ID=22 requests records 704 to 735, ACT_ID=23 records 736 to 767, ACT_ID=24 requests records 768 to 799, ACT_ID=25 records 800 to 831, ACT_ID=26 requests records 832 to 863, ACT_ID=27 records 864 to 895, ACT_ID=28 requests records 896 to 927, ACT_ID=29 records 928 to 959

Name	Definition	Values & Interpretation
		For the parameter FMT_LoopThresholds, ACT_ID=0 requests records 0 to 25 ACT_ID=1 requests records 26 -> 51 ACT_ID=2 requests records 52 -> 77
		For the parameter FMT_LoopIntPeriods, ACT_ID=0 requests records 0 to 14 ACT_ID=1 requests records 15 -> 29 ACT_ID=2 requests records 30 -> 44 ACT_ID=3 requests records 45 -> 59 ACT_ID=4 requests records 60 -> 74 ACT_ID=5 requests records 75 -> 89
		For the parameter FMT_SatelliteForce, ACT_ID=0 requests records 0 to 3, ACT_ID=1 requests records 4 to 7 ACT_ID=2 requests records 8 to 11 ACT_ID=3 requests records 12 to 15 ACT_ID=4 requests records 16 to 19 ACT_ID=5 requests records 20 to 23 ACT_ID=6 requests records 24 to 27 ACT_ID=7 requests records 28 to 31 ACT_ID=8 requests records 32 to 35 ACT_ID=9 requests records 36 to 39 … ACT_ID=39 requests records 156 to 159
		For FMT_GPS_NAV_Ephemeris and for FMT_GPS_NAV_Almanac, the Activity ID specifies which SV ID shall be reported: ACT_ID=0 => SV ID 1 is requested ACT_ID=1 => SV ID 2 is requested … ACT_ID=31 => SV ID 32 is requested
		For all other parameters ACT_ID = 255 has to be chosen, which requests all records.
		Any other value is invalid

Table 5-26 – Report Function Parameters Definition

5.8.3 Function Parameter Report TM(211,3)

This telemetry subservice is the response to TC(211,2). The layout of this report is given in Figure 5-28, the corresponding definitions in Table 5-27. The Function ID determines the type of data records being reported, and implicitly also the format of those data records. The GPSR automatically takes care that the packets do not exceed the maximum size of 256 bytes.

References to the format definitions of the different record types can be found in Table 5-28. TC/TM Format names in this tables marked with an asterisk (*) indicate features not part of the requirements baseline. These features are not tested formally in qualification tests but tested on unit or integration test level.

Byte	Bit number 0	1	2	3	4	5	6	7
0	FUNC_ID							
1	ACT_ID							
2	N/U							
3	FE_TEMP							
4	N/U							
5	SN				V	R_MODE		
6	N							
7	PAR_FIELD RECORD #1 32-bit WORD #1							
8								
9								
10								
.	.							
.	.							
.	.							
.	.							
.	PAR_FIELD RECORD #1 32-bit WORD #n							
.								
.								
.								
.	.							
.	.							
.	.							
.	.							
.	PAR_FIELD RECORD #N 32-bit WORD #1							
.								
.								
.								
.	.							
.	.							
.	.							
.	.							
.	PAR_FIELD RECORD #N 32-bit WORD #n							
.								
.								
.								
x	N/U							

Figure 5-28 – Function Parameter Report Format

Name	Definition	Value	Interpretation
FUNC_ID	Function ID	Specifies the parameter type being reported, values are defined in Table 5-28	
ACT_ID	Activity ID	A copy of ACT_ID of TC(211,2)	
N/U	Not used	0	
FE_TEMP	R/F front-end temperature	Raw value, scaling and calibration on ground. Zero in Startup Mode. See [HWSWICD], section Temperature Measurment, Table – DAC code temperature relation for conversion table to degree Celsius.	
SN	Serial Number	Not used, set to zero	
V	Data valid flag	0	Not all data in the block are valid
		1	All data in the block are valid
R_MODE	Receiver mode	1	Startup mode
		2	Standby mode
		3	Navigate mode
		Other	Any other value is Invalid
N	Number of PAR_FIELD records	Unsigned	N corresponds to the number of records reported, refer to column 'Number of Records per TM' in Table 5-28, page 84
PAR_FIELD	Parameters	Any	n corresponds to the number of 32-bit words per record, refer to column 'Record Size [bytes]' in Table 5-28, page 84, values to be divided by 4
N/U	Filler	0	For 32 bit alignment of the report

Table 5-27 – Function Parameter Report Definition

Telecommand / Telemetry Format Name	Section	FUNC_ID	FORMAT_ID	Number of Records per TC	TCs to preload all records	Number of Records per TM	TM packets to report all records	Record Size [bytes]	For in-flight diagnostic purposes	For on-ground verification and optimisation purposes[10]	TM Packet Size [bytes]
FMT_ParamSave	5.8.4.1	1	1	1	1	1	1	4	-	-	32
FMT_GPS_NAV_Almanac	5.8.4.2	10	1	1	32	1	32	36	-	-	64
			2	4	8						
FMT_GPS_NAV_Ephemeris	5.8.4.3	11	1	1	32	1	32	68	-	✓[11]	96
FMT_GPS_NAV_UTC_Ionosphere	5.8.4.4	12	1	1	1	1	1	28	-	-	56
FMT_ConstellationStatus	5.8.4.6	13	-	-	-	32	1	4	-	-	156
FMT_GPS_CNAV_GroupDelay	5.8.4.5	16	1	1	32	8	4	16	-	-	156
			2	8	4						
FMT_GPST	5.8.4.7	30	1	1	1	1	1	8	-	-	36
FMT_InitialStateVector	5.8.4.8	31	1	1	1	1	1	36	-	-	64
FMT_AttitudeVector	5.8.4.9	32	1	1	1	1	1	24	-	-	52
FMT_AttitudeThresholds*	5.8.4.10	33	1	1	1	1	1	8	-	-	36
FMT_SatelliteMask	5.8.4.11	40	1	1	2	2	1	8	-	-	44
			3	2	1						
FMT_ReceiverAntField	5.8.4.12	41	1	1	1	1	1	4	-	✓	32
FMT_GNSS_SV_AntField*	5.8.4.13	42	1	1	4	4	1	4	-	-	44
			3	4	1						
FMT_MultipathMitSeg*	5.8.4.14	43	1	1	32	16	2	12	-	-	220
			2	16	2						
FMT_MultipathMitMask*	5.8.4.15	44	1	1	1	1	1	4	-	-	32

[10] These formats can also be useful for in-flight maintenance and error investigation purposes.

[11] Can be requested in-flight, but a pre-load is implemented for verification purposes only.

Telecommand / Telemetry Format Name		Section	FUNC_ID	FORMAT_ID	Number of Records per TC	TCs to preload all records	Number of Records per TM	TM packets to report all records	Record Size [bytes]	For in-flight diagnostic purposes	For on-ground verification and optimisation purposes[10]	TM Packet Size [bytes]
FMT_NavSolMethod		5.8.4.16	45	1	1	1	1	1	4	✓	-	32
FMT_IonoCorrectionPar*		5.8.4.17	46	1	1	1	1	1	12	-	-	40
FMT_Antenna		5.8.4.35	48	1	1	1	1	1	40	-	-	68
FMT_RCPVT		5.8.4.34	49	1	1	1	1	1	112	-	-	140
FMT_SVMPR		5.8.4.36	50	1	1	1	1	1	36	-	-	64
FMT_KALMAN		5.8.4.37	51	1	1	1	1	1	120	-	-	148
FMT_FORCE		5.8.4.38	52	1	1	1	1	1	68	-	-	96
FMT_SampleRate	Navigation solution	5.8.4.18	60	1	1	1	1	1	4	✓		32
	Satellites in view status*		61	1	1	1	1	1	4	✓		32
	Time correlation		62	1	1	1	1	1	4	✓		32
	Noise histogram*		63	1	1	1	1	1	4	✓		32
	Carrier amplitude		64	3	24	1	24	1	4	-		124
	Channel status*		65	1	1	1	1	1	4	✓		32
	Carrier phase		66	3	24	1	24	1	4	-		124
	Code phase		67	3	24	1	24	1	4	-		124
	Tracking state*		68	1	1	1	1	1	4	✓		32
	AGC status*		69	3	2	1	2	1	4	✓		36
	GPS NAV Almanac		70	1	1	1	1	1	4	-		32
	GPS NAV Ephemeris		71	1	1	1	1	1	4	-		32
	GPS NAV UTC and Ionosphere		72	1	1	1	1	1	4	-		32
	Constellation status		80	1	1	1	1	1	4	-		32
	Housekeeping Param Report		81	1	1	1	1	1	4	-		32
	S1 Navigation Solution		82	1	1	1	1	1	4	-		32
	IMT/GPST Correlation*		83	1	1	1	1	1	4	-		32
	Sentinel Auxiliary		84	1	1	1	1	1	4	-		32
FMT_AGC_Control*		5.8.4.19	100	1 3	1 2	2 1	2	1	4	✓	✓	36
FMT_AGC_Par*		5.8.4.20	101	1 3	1 2	2 1	2	1	12	-	✓	52
FMT_AcquisitionPar*		5.8.4.21	110	1 3	1 6	6 1	6	1	8	-	✓	76
FMT_CorrSpacing*		5.8.4.22	111	1 2	1 12	24 2	12	2	12	-	✓	172
FMT_Discriminator*		5.8.4.23	112	1 2	1 24	48 2	24	2	8	-	✓	220
FMT_LoopIntPeriods*		5.8.4.24	113	1 2	1 15	90 6	15	6	8	-	✓	148
FMT_LoopThresholds*		5.8.4.25	114	1 2	1 26	78 3	26	3	8	-	✓	236
FMT_LoopAcqRetries*		5.8.4.26	115	1 2	1 18	36 2	18	2	8	-	✓	172
FMT_LoopFilterPar*		5.8.4.27	116	1 2	1 12	48 4	12	4	12	-	✓	172

Telecommand / Telemetry Format Name	Section	FUNC_ID	FORMAT_ID	Number of Records per TC	TCs to preload all records	Number of Records per TM	TM packets to report all records	Record Size [bytes]	For in-flight diagnostic purposes	For on-ground verification and optimisation purposes[10]	TM Packet Size [bytes]
FMT_StateRetention*	5.8.4.28	117	1	1	960	32	30	4	-	✓	156
			2	32	30						
FMT_SFC_UpdateMode*	5.8.4.29	118	1	1	24	24	1	4	-	✓	124
			3	24	1						
FMT_StateTransition*	5.8.4.30	119	1	1	24	24	1	4	-	✓	124
			3	24	1						
FMT_SatelliteForce*	5.8.4.31	130	1	1	160	4	40	40	✓	✓	188
			2	4	40						
FMT_ContextSaveTable*	5.8.4.32	131	1	1	1	1	1	192	✓	-	220
FMT_DiagnosticFilter	5.8.4.33	132	1	1	1	1	1	20	-	-	48

Table 5-28 – Parameter Modification Activity Mapping Table

5.8.4 Format Definitions used for Parameter Modification Activities

The following sections define the record formats being used in the frame of the services Preload Function Parameters and Function Parameter Report.

Table 5-29 below defines values for commonly used fields and is intensively referred to from the different format definitions.

Name	Definition	Field width	Value	Interpretation
CONS	Constellation identifier	3	0	GPS Constellation
			Other	Any other value is invalid
BLOCK	GPS SV Block type	3	0	GPS Block I
			1	GPS Block II/IIA/IIR
			2	GPS Block IIR-M
			3	GPS Block IIF
			Other	Any other value is invalid
SV_ID	Space vehicle identifier	8	1 .. 32	GPS SVs
			Other	Any other value is invalid
SIG	Signal type	5	0	GPS L1 C/A
			1	GPS L1 P
			2	GPS L2 C/A (N/A for Sentinel)
			3	GPS L2 P
			4	GPS L2 CM (Sentinel B only)
			5	GPS L2 CL (N/A for Sentinel)
			Other	Any other value is invalid
ANT	Antenna identifier	4	0	First antenna
			1	Second antenna (N/A for Sentinel)
			Other	Any other value is invalid
CHAIN	Down-conversion chain identifier	4	0	Antenna 1, L1 carrier
			1	Antenna 1, L2 carrier
			Other	Any other value is invalid
SF_CHN	Single-frequency Channel number	8	0 .. 23	Physical single frequency channel number for which data are provided / requested
			Other	Any other value is invalid
MF_CHN	Multi-frequency Channel number	8	0 .. 7	Logical multi frequency channel number
			Other	Any other value is invalid
TS_MIN TS_MAX	Tracking state	8	See [MDIS] section on “Channel Status Record”	Internal logical tracking state range which defines the applicability of all adjustable tracking loop parameter
TS_Trigger	Triggering tracking state	8	-	The allowed values are the same as for TS_MIN and TS_MAX.
R_MODE	Receiver mode	3	1	Startup mode
			2	Standby mode
			3	Navigate mode
			Other	Invalid

Table 5-29 – Common Parameter Field Definition

5.8.4.1 FMT_ParamSave

This format is used to make parameter changes performed by means of the Pre-load Function Parameters service in RAM persistent in NVM2.

To use the FMT_ParamSave TC, the user has to to send the signature to disable the write protection of NVM2 first (see 5.5 for more information). Otherwise the GPSR will reject the FMT_ParamSave TC with FID=5219.

Note: A telecommand of this type is internally translated into a Copy Memory TC(6,210). Because data is stored in NVM2, such a Copy Memory telecommand might require several seconds to complete its execution. Therefore it is under the user's responsibility to wait for an execution complete TM(1,7) before the next FMT_ParamSave TC or any other long duration TC is sent.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FUNC_ID								REC_IND							
1	N/U															

Figure 5-29 – FMT_ParamSave Format

Name	Definition	Field width	Format	Interpretation	Initial	Ver.
FUNC_ID	Function Identifier	8	Unsigned	Specifies for which parameter format the save operation shall be performed. For supported values refer to Table 5-28.	0	Y
REC_IND	Record index	8	Unsigned	Specifies for which parameter record the save operation shall be performed. All records for the specified parameter are saved when this field holds 255.	0	Y
N/U	Not used, 0	16	-	32 bit padding	0	Y

Table 5-30 – FMT_ParamSave Definition

5.8.4.2 FMT_GPS_NAV_Almanac

This format is used to pre-load and report legacy almanac data sets as defined for the GPS constellation. The data structure for a single almanac data record is defined in [MDIS §5.4.2.1].

Constraint: In the Pre-load Function Parameters TC(211,1) the ACQ_SV_ID field shall be set to zero in order to indicate that the data were uploaded by ground.

5.8.4.3 FMT_GPS_NAV_Ephemeris

The format is used to pre-load and report legacy ephemeris and clock correction data sets as defined for the GPS constellation. The data structure for a single data record is defined in [MDIS §5.4.2.2].

5.8.4.4 FMT_GPS_NAV_UTC_Ionosphere

This format is used to pre-load and report legacy UTC and ionosphere data for the GPS constellation. The data structure for the data record is defined in [MDIS §5.4.2.3].

Constraint: In the Pre-load Function Parameters TC(211,1) the ACQ_SV_ID field shall be set to zero to indicate that the data were uploaded by ground.

5.8.4.5 FMT_GPS_CNAV_GroupDelay

This format is used to pre-load and report inter-signal correction and group delay values as defined in the GPS CNAV message. The data structure for the data record is defined in [MDIS §5.4.3.1].

5.8.4.6 FMT_ConstellationStatus

The format is used to report the health summary of the GPS constellation and additional information on the availability of navigation data for the different GPS satellites in the GPSR. The data structure for a single data record is defined in [MDIS §5.4.1.4].

Note: This format does not support a pre-load of parameters, it is foreseen for reporting only.

5.8.4.7 FMT_GPST

This format is used to provide the GPSR with an estimate of the GPS time. This time estimate is required by the receiver to predict position and velocity of GPS satellites in view of the antenna, which is the pre-requisite to perform a warm start. On reception of an FMT_GPST telecommand the GPSR assigns the GPS time to the upcoming internal PPS event. The internal PPS event is unknown outside the receiver as long as no First Fix has been achieved. Therefore, the uncertainty of the time information provided is one second by design.

The time information has to be provided in the GPST scale, as defined in section 3.3.3, the corresponding time format definition is given in section 3.4.4.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SEC															
1																
2	SUBSEC															
3																

Figure 5-30 – FMT_GPST Format

Name	Definition	Field width	Format	Interpretation	Initial	Ver.
SEC	GPS Time, seconds part	32	Unsigned	Number of seconds since 6th Jan 1980 0:00. Supported range: 861235200 ... 1479945600 [s] corresponds to a time span from 1024+400 weeks to 1024+1024+399 weeks.	861235200	Y
SUBSEC	GPS Time, subseconds part	32	Unsigned	Fractional part of a second in [2^{-32}s]	0	N

Table 5-31 – FMT_GPST Definition

If a function parameter report of this type is requested, the GPS Receiver returns the values previously set, or, if no telecommand FMT_GPST has been received so far, the initial value will be reported.

5.8.4.8 FMT_InitialStateVector

This format is used to pre-load and report initialisation values for position and velocity. A time tag related to the provided vector information is provided to allow state propagation. Additionally, uncertainty information is provided for both the position and the velocity vectors.

Note: The GPSR will be implicitly put into ground mode, if it receives an Initial State Vector with all velocity components (VEL_X, VEL_Y, VEL_Z) set to zero. In ground mode the orbit propagation is disabled and the navigation solution is computed exclusively by means of the least-square algorithm.

Note: If all 3 position components POS_X, POS_Y and POS_Z are set to zero, the telecommand will be rejected with FID 5218 in order to avoid a division by zero in the frame of receiver internal coordinate transformations.

Note: The parameter PV_GPST can be either the reference time tag for the Initial State Vector given in the telecommand, or, if set to zero, the Initial State Vector is assumed to be valid for the time of TC reception.

Note that this is <u>not</u> a time-tagged telecommand, i.e. the provided time information in PV_GPST is not the time the Initial State Vector shall become effective in the GPSR. PV_GPST refers to the point in time the given POS_X/Y/Z and VEL_X/Y/Z figures were valid for. If this point in time is 10 seconds in the past, the GPSR will compute the new internal state vector by propagating the provided state vector 10s into the future. If PV_GPST refers to a point 10s in the future, the internal state vector will be propagated 10s into the past.

Before a first fix, the GPSR propagates its internal representation of the State Vector (starting from the Initial State Vector). After a first fix, the GPSR updates its State Vector with each new PVT solution. Once per second the GPSR overwrites the FMT_InitialStateVector parameter table with the internal State Vector. This means that if the user sends a TC FMT_InitialStateVector and then requests an FMT_InitialStateVector report, the GPSR will report the state vector values form the TC. If the user one second later again requests an FMT_InitialStateVector report, the GPSR will report its internal state vector.

Word	Bit number 0 – 15
0	PV_GPST_SEC
1	
2	PV_GPST_SUBSEC
3	
4	POS_X
5	
6	POS_Y
7	
8	POS_Z
9	
10	VEL_X
11	
12	VEL_Y
13	
14	VEL_Z
15	
16	POS_UNC
17	VEL_UNC

Figure 5-31 – FMT_InitialStateVector Format

Name	Definition	Field width	Format	Interpretation	Initial	Ver.
PV_GPST_SEC PV_GPST_SUBSEC	GPS Time for provided position and velocity	64	GPS Time Format, see §3.4.4	The time tag corresponding to the provided position and velocity vectors.	0	Y
POS_X	Position X coordinate	32	Signed	[m] in WGS84, see also [WGS84].	2582189	N
POS_Y	Position Y coordinate	32	Signed		-5130637	
POS_Z	Position Z coordinate	32	Signed		-3503811	
VEL_X	Velocity X coordinate	32	Signed	[mm/s] in WGS84, see also [WGS84].	6334025	N
VEL_Y	Velocity Y coordinate	32	Signed		669867	
VEL_Z	Velocity Z coordinate	32	Signed		3687072	
POS_UNC	Position uncertainty	16	Unsigned	[m] single sided uncertainty	65535	N
VEL_UNC	Velocity uncertainty	16	Unsigned	[mm/s] single sided uncertainty	65535	N

Table 5-32 – FMT_InitialStateVector Definition

5.8.4.9 FMT_AttitudeVector

This format is used for initialisation or update of the receiver's attitude, attitude rate and corresponding reference time. Additionally, uncertainty information is provided for each vector.

Note that the parameter ATT_GPST can be either the reference time tag for the attitude parameters given in the telecommand, or, if set to zero, the parameters are assumed to be valid for the time of TC reception.

Note that the ATT_UNC field value may change the autonomous SV selection's behaviour. For details refer to [UML] §8.1.7.

Note that this is not a time-tagged telecommand, i.e. the provided time information in ATT_GPST is not the time the attitude parameters shall become effective in the GPSR. ATT_GPST refers to the point in time the given ATT_X/Y/Z figures were valid for. If this point in time is 10 seconds in the past, the GPSR will compute the new internal attitude vector by adding the product of 10s * given ATT_RATE_X/Y/Z to the given ATT_X/Y/Z values. If ATT_GPST refers to a point 10s in the future, the internal attitude vector will be determined as (-10s) * given ATT_RATE_X/Y/Z plus the given ATT_X/Y/Z values.

Any attitude information previously commanded by means of this format is propagated internally by the GPSR with time. When telemetry of this format is requested, the GPSR provides the propagated values (and not the previously commanded values).

Consequently, in case an FMT_AttitudeVector telecommand with an ATT_RATE vector unequal to 0, 0, 0 is sent, the GPSR requires the knowledge on the current GPST, which can either be provided via a preceding FMT_GPST telecommand or will become implicitly available after a cold start first fix.
This has also to be considered if the boot defaults for the attitude vector are going to be changed in NVM2. It has to be ensured that the rate components are all set to zero, otherwise the GPSR will start with an arbitrary attitude after boot.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0 1	ATT_GPST_SEC															
2 3	ATT_GPST_SUBSEC															
4	ATT_X															
5	ATT_Y															
6	ATT_Z															
7	ATT_UNC															
8	ATT_RATE_X															
9	ATT_RATE_Y															
10	ATT_RATE_Z															
11	ATT_RATE_UNC															

Figure 5-32 – FMT_AttitudeVector Format

Name	Definition	Field width	Format	Interpretation	Initial	Ver.
ATT_GPST_SEC	GPS Time for provided attitude and attitude rate	32	GPS Time Format, see §3.4.4	The time tag corresponding to the provided attitude and attitude rate vectors. Note: The initial value corresponds to 1st January 2000 00:00:01	630720001	Y
ATT_GPST_SUBSEC		32			0	Y
ATT_X	Roll angle	16	Signed	Euler angles to transform from ORF to RRF. See [UML] for a definition of the rotation matrix. Range: -18000 .. +18000, [0.01 deg]	S-1: -3000 S-2: 0 S-3: 0	Y
ATT_Y	Pitch angle	16	Signed		0	
ATT_Z	Yaw angle	16	Signed		0	
ATT_UNC	Attitude uncertainty	16	Unsigned	Range: 0 .. 18000 [0.01 deg] Single sided uncertainty	0	Y
ATT_RATE_X	Roll angle rate	16	Signed	Euler angle rates to transform from ORF to RRF. See [UML] for a definition of the rotation matrix. Range: -18000 .. +18000, [0.01 deg/s]	0	Y
ATT_RATE _Y	Pitch angle rate	16	Signed		0	
ATT_RATE _Z	Yaw angle rate	16	Signed		0	
ATT_RATE _UNC	Attitude rate uncertainty	16	Unsigned	Range: 0 .. 18000 [0.01 deg/s] Single sided uncertainty	0	Y

Table 5-33 – FMT_AttitudeVector Definition

5.8.4.10 FMT_AttitudeThresholds

This format specifies thresholds being used to determine if GNSS satellites shall be selected for tracking or not. The background for this functionality is the earth, which may enter the antenna field of view, if the deviation of the actual spacecraft attitude from the nominal attitude exceeds certain limits. In such a case either the SV could not be acquired at all, thus leading to events of type 'Acquisition Failure' being reported, or the tracked signal could lead to incorrect measurements due to occultation effects, when the received signal passes the atmosphere. To avoid the described consequences in such a situation, the absolute values of the current attitude information (i.e. the attitude vector provided via the most recent FMT_AttitudeVector telecommand, propagated by means of the attitude rate vector and the reference GPST) is compared against the thresholds defined by the FMT_AttitudeThreshold format. If the thresholds are exceeded, tracked SV are deselected, and no further SV selected. After coming back into the nominal attitude range, SVs will be selected and an attempt to build up a first fix is initiated.

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td colspan="16">THRESH_X</td></tr>
<tr><td>1</td><td colspan="16">THRESH_Y</td></tr>
<tr><td>2</td><td colspan="16">THRESH_Z</td></tr>
<tr><td>3</td><td colspan="16">N/U</td></tr>
</table>

Figure 5-33 – FMT_AttitudeThresholds Format

Name	Definition	Field width	Format	Interpretation	Initial	Ver.
THRESH_X	Attitude Threshold X axis	16	Unsigned	Euler angles, see also Table 5-33. Range: 0 .. +18000, [0.01 deg] Single sided threshold	18000	Y
THRESH_Y	Attitude Threshold Y axis	16	Unsigned		18000	
THRESH_Z	Attitude Threshold Z axis	16	Unsigned		18000	
N/U	Not used, 0	16	-	32 bit padding	0	Y

Table 5-34 – FMT_AttitudeThresholds Definition

5.8.4.11 FMT_SatelliteMask

This format allows to adapt the SV selection behaviour based on a per SV basis, i.e. for certain features one bit per SV exists to override the specified default behaviour. The meaning of the bits assigned to the SVs (in Figure 5-34 below numbered from 1 to 32) is determined by the SEL field.

Currently two feature sets can be selected by the SEL field:

- SEL = 0: SVs can be excluded from autonomous selection (e.g. SVs, which do not provide reliable data).
  Default behaviour: SV is considered for autonomous selection
- SEL = 1: Sentinel B only. SVs may be acquired and tracked by using the L1 C/A & P(Y) scheme or by using the L1 C/A & L2 CM scheme. Under normal conditions the GPS constellation provides the SV CONFIG information in the pages 25 of subframe 4 and 5 of the GPS navigation data message, which determines the type of each GPS SV, i.e. Block II/IIA/IIR (no support of L2C) or Block IIR-M/IIF (with support of L2C).
  However, during a warm start this kind of information is not available, and there is no way to upload this constellation information. As a consequence, the GPSR would potentially select the wrong tracking scheme during warm start, either L1 C/A & L2CM for legacy GPS SV before year 2020, or L1 C/A & P(Y) after P(Y) code support has been discontinued. To overcome this problem, usage of the L1 C/A & P(Y) tracking scheme can be forced by the user. For each SV a P(Y) force flag exists, which is set by default. For each SV which is proven to be a commisioned modernised one, this P(Y) force flag can be cleared by the user. If the flag is cleared, the GPSR makes use of the L1 C/A & L2CM tracking scheme for the corresponding SV. As soon as the SV CONFIG information is available via navigation data download, the tracking scheme selection will be controlled by this information.
  Default behaviour: SV is acquired based on L1 C/A & P(Y) tracking scheme regardless of the SV CONFIG field, this is the correct initial setting for both Sentinel A and Sentinel B. Latest by 2020, i.e. when P(Y) code is no longer supported by the GPS constellation, the tracking scheme for all SVs shall be switched to 'SV CONFIG controlled' by the user. Before that point in time it is up to the user to allow the GPSR the utilisation of the new civil signals (as soon as the receiver can rely on availability and correctness of these signals) on a per SV basis.
  During a cold start these settings are ignored, in Sentinel A for each SV being acquired the L1 C/A & P(Y) tracking scheme is used, in Sentinel B for each SV being acquired during a cold start the L1 C/A only tracking scheme is used.

Note: If this TC is sent after a warm or hot start has been started, it will not effect the selection of the initial 4 satellites.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	CONS			N/U											SEL	
1	N/U															
2	32	31	…										…	19	18	17
3	16	15	…										…	3	2	1

Figure 5-34 – FMT_SatelliteMask Format

Name	Definition	Interpretation		Initial	Ver.
CONS	Constellation identifier	see Table 5-29 on page 85		-	Y
N/U	Not used	0		0	Y
SEL	Feature set selection	0	SV exclusion from autonomous selection	-	Y
		1	Tracking scheme selection control		
		Other	Any other value is invalid		
1 .. 32	Bit number corresponding to the Space vehicle identifier	SEL = 0	0 - SV is excluded	1	N
			1 - SV is included		
		SEL = 1	0 - Tracking scheme SV CONFIG controlled	1	
			1 - Tracking scheme always L1 C/A L2 P(Y)		

Table 5-35 – FMT_SatelliteMask Definition

5.8.4.12 FMT_ReceiverAntField

The format defines the settings for the field of view for each receiver antenna.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	ANT				N/U											
1	ZENITH															

Figure 5-35 – FMT_ReceiverAntField Format

Name	Definition	Interpretation	Initial	Ver.
ANT	Antenna identifier	See Table 5-29 on page 85	-	Y
N/U	Not used	-	0	Y
ZENITH	Zenith angle	Range: 0 .. 18000 [0.01 deg] The zenith angle is valid for antenna azimuth of 0 .. 360 deg and is measured from the antenna zenith direction.	80 deg	Y

Table 5-36 – FMT_ReceiverAntField Definition

5.8.4.13 FMT_GNSS_SV_AntField

The format defines the GNSS SV antenna field of view for each SV type (block).

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	CONS			BLOCK			N/U									
1	NADIR															

Figure 5-36 – FMT_GNSS_SV_AntField Format

Name	Definition	Interpretation	Initial	Ver.
CONS	Constellation identifier	See Table 5-29 on page 85	-	Y
BLOCK	SV Block type	See Table 5-29 on page 85	-	Y
N/U	not used	0	0	Y
NADIR	Nadir angle	Range: 0 .. +18000 [0.01 deg] The nadir angle is valid for antenna azimuth of 0 .. 360 deg and is measured from the antenna nadir direction.	22 deg	Y

Table 5-37 – FMT_GNSS_SV_AntField Definition

5.8.4.14 FMT_MultipathMitSeg

The purpose of this format is to configure 3-dimensional segments (by azimuth and elevation ranges) which disable selection of SVs having a line of sight within these segments. One segment is valid for a single receiver antenna. In total 32 segments can be specified. The segments can be enabled/disabled by FMT_MultipathMitMask commands, see § 5.8.4.15.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SEG_ID					ANT				N/U						
1	MIN_AZM															
2	MAX_AZM															
3	MIN_ZEN															
4	MAX_ZEN															
5	N/U															

Figure 5-37 – FMT_MultipathMitSeg Format

Name	Definition	Format	Interpretation	Initial	Ver.
SEG_ID	Segment identifier	Unsigned	Identifies one of the multipath mitigation segments 0 .. 31.	-	Y
ANT	Antenna identifier	Unsigned	See Table 5-29	-	Y
N/U	Not used	0	-	0	Y
MIN_AZM	Begin azimuth	Signed	Range: -18000 .. +18000 [0.01deg] Azimuth range definition according to Figure 5-38	0	Y
MAX_AZM	End azimuth	Signed	Range: -18000 .. +18000 [0.01deg] Azimuth range definition according to Figure 5-38	0	Y
MIN_ZEN	Begin zenith angle	Unsigned	Range: 0 .. +18000 [0.01deg] The zenith angle is measured from the antenna zenith direction. The begin zenith angle must be smaller than or equal to the end zenith angle.	0	Y
MAX_ZEN	End zenith angle	Unsigned	Range: 0 .. +18000 [0.01deg] The zenith angle is measured from the antenna zenith direction. The end zenith angle must be larger than or equal to the begin zenith angle.	0	Y
N/U	Not used	-	0	0	Y

Table 5-38 – FMT_MultipathMitSeg Definition

The azimuth range is always the area from begin azimuth with rising angle values to the end azimuth as given in Figure 5-38. The azimuth 0 deg direction is the direction of flight.

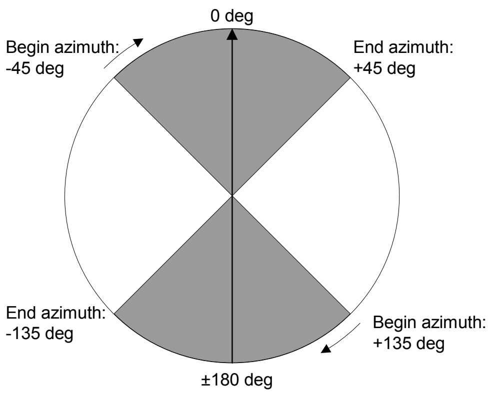

Figure 5-38 – Antenna Field of View Examples

5.8.4.15 FMT_MultipathMitMask

The purpose of this format is to enable/disable the 3-dimensional multipath mitigation segments as specified in chapter 5.8.4.14.

	Bit number															
Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	31	30	…										…	18	17	16
1	15	14	…										…	2	1	0

Figure 5-39 – FMT_MultipathMitMask Format

Name	Definition	Value	Interpretation	Initial	Ver.
0 .. 31	Mask segment identifier	0	Mask segment is disabled	0	N
		1	Mask segment is enabled		

Table 5-39 – FMT_MultipathMitMask Definition

Note:
The mask segment identifier corresponds to the SEG_ID field in Figure 5-37.

5.8.4.16 FMT_NavSolMethod

The purpose of this format is to select the navigation solution method.

This format contains one word, see the figure and table below.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	NSM			N/U												
1	N/U															

Figure 5-40 – FMT_NavSolMethod Format

Name	Definition	Value	Interpretation	Initial	Ver.
NSM	Navigation solution method	0	Least Square	1	Y
		1	Kalman filtered		
		Other	Any other value is invalid		
N/U	Not used	0	-	0	Y
N/U	Not used	0	-	0	Y

Table 5-40 – FMT_NavSolMethod Definition

5.8.4.17 FMT_IonoCorrectionPar

The purpose of this format is to set the single-frequency ionosphere correction model parameters.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	PHI															
1																
2	TH_ION															
3	DC															
4	K															
5	ENABLED															

Figure 5-41 – FMT_IonoCorrectionPar Format

Name	Definition	Value	Interpretation	Initial	Ver.
PHI	Phase of the ionosphere maximum	Unsigned 0.. 86399	Phase of day maximum [s]	50400	Y
TH_ION	Virtual thickness of the ionosphere	Unsigned 1 .. 10000	Virtual thickness in [0.1 km]	2000	Y
DC	Offset term	Unsigned 0 .. 20000	Assumed ionospheric delay during night [ps]	500	Y
K	Cosine scaling factor	Unsigned 0 .. 10000	[0.0001]	10000	Y
ENABLED	Correction model enable flag	0 .. 1	Enables the single frequency ionospheric correction model if set to ‘1’, otherwise the single frequency ionospheric correction is based on the actual dual frequency correction mean value	0	Y

Table 5-41 – FMT_IonoCorrectionPar Definition

5.8.4.18 FMT_SampleRate

The format contains parameters for the sample rates of packets generated periodically and on event. Sample rates for channel- and chain-based periodic packets can be set independently for each channel or chain. A sample rate setting of zero turns off the generation of the according packet.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	INDEX							TYPE					RATE			
1	N/U															

Figure 5-42 – FMT_SampleRate Format

Name	Definition	Value	Interpretation	Initial	Ver.
INDEX	Entity index (Channel, Chain or 0)	0	Valid f. following packet types: +) Navigation Solution +) Satellites In View Status +) Time Correlation +) Tracking State +) GPS NAV Almanac +) GPS NAV Ephemeris +) GPS NAV UTC a. Ionosph. +) Constellation Status +) Housekeeping Par. Report +) S1 Navigation Solution +) IMT/GPST Correlation +) Auxiliary Data +) Channel Status +) Noise Histogram	-	Y
		SF_CHN see Table 5-29, page 85	Channel index valid for following packet types: +) Carrier Amplitude +) Carrier Phase +) Code Phase		
		CHAIN see Table 5-29, page 85	Chain index valid for following packet types: +) AGC Status		
		Other	Any other value is invalid		
TYPE	Packet type	0	Navigation Solution	-	Y
		1	Satellites In View Status		
		2	Time Correlation		
		3	Noise Histogram		
		4	Carrier Amplitude		
		5	Channel Status		
		6	Carrier Phase		
		7	Code Phase		
		8	Tracking State		
		9	AGC Status		
		10	GPS NAV Almanac		
		11	GPS NAV Ephemeris		
		12	GPS NAV UTC a. Ionosphere		
		20	Constellation Status		
		21	Housekeeping Param. Report		
		22	S1 Navigation Solution		
		23	IMT/GPST Correlation		
		24	Auxiliary Data		
		Other	Any other value is invalid		
RATE	Sample rate Not all sample rates are valid for all packet types, see details in Table 5-43, page 102	0	Turns packet generation off	See Table 5-43 Table 5-44 Table 5-45	Y
		1	0.001 Hz sample rate		
		2	0.002 Hz sample rate		
		3	0.005 Hz sample rate		
		4	0.01 Hz sample rate		
		5	0.02 Hz sample rate		
		6	0.05 Hz sample rate		
		7	0.1 Hz sample rate		

		8	0.2 Hz sample rate		
		9	0.5 Hz sample rate		
		10	1 Hz sample rate		
		11	2 Hz sample rate		
		12	5 Hz sample rate		
		13	10 Hz sample rate		
		14	Event driven		
		Other	Any other value is invalid		
N/U	Not used	0	-	0	Y

Table 5-42 – FMT_SampleRate Definition

The following subsections hold the default sample rate settings, i.e. the boot defaults for the various missions where the GPSR is used, for Standby/Navigate Mode. Such factory settings can be obtained by configuring the GPSR accordingly and by making changes persistent in NVM2 by means of FMT_ParamSave telecommands afterwards.

The sample rate is only settable in Standby and Navigate mode. In Startup Mode the GPS Receiver always sends the Housekeeping Parameter Report with 1Hz sample rate. In Standby and Navigate Mode a changed sample rate setting becomes effective delayed depending on the old and the new sample rate. See [UML] for further details.

5.8.4.18.1 Sample Rate Boot Defaults for Sentinel-1

In this subsection and the subsections that follow the default sample ratings programmed at RUAG are given[12]. In the respective table showing these settings there are three different symbols used to indicate:

☐ ... This sample rate is allowed for the packet type

☑ ... This sample rate is the default sample rate for the packet type

\- ... This sample rate is not supported for the packet type

The ‘Off’ setting in the context of the table below means that no packet is generated.

The ‘Event triggered’ setting in the context of Table 5-43 means for *periodic telemetry packet types* that one packet is generated (single shot feature). After a ‘single shot’ TM has been sent, the sample rate setting for this TM is set to ‘Off’.

Note: The described implementation of periodic telemetry requests requires that FMT_SampleRate function parameter telecommands are supported in the Navigate mode, as well.

For most of the packet types marked as *event driven* in Table 5-43 it is possible to query the current status with a Report Function Parameters TC. That, however, is not the case for the AGC status. In order to obtain the data that was sent (or would have been sent) with the latest AGC Status Event Packet, ground needs to send a telecommand FMT_SampleRate for the AGC Status. The GPSR will send a telemetry packet with the current AGC Status at the next AGC processing timeslot (the AGC operates at 5Hz). However, in this case the provided sample rate setting will remain active (in contrast to the single shot feature for periodic telemetry packet types).

Note: The sample rate setting entry for GPS CNAV Group Delay Data Records as defined in [MDIS] is omitted in the following default sample rate tables by intention. The reason for this is that GPS CNAV Group Delay information is actually not extracted from the CNAV data message. It can only be uploaded by telecommand and reported on explicit request by telecommand. Therefore a sample rate setting in those tables could give someone the impression that the information might be automatically transmitted via event driven telemetry, which is not the case.

[12] Not all of the packets shown in this and the subsequent tables are subject to qualification tests. For the verification level of the packet contents please refer to Table ‘Record Type Dependent Information’ in [MDIS].

Packet	Service Type Note: redundant with [MDIS]	Service Subtype Note: redundant with [MDIS]	SID Note: redundant with [MDIS]	Reporting Type	Off	0.001 Hz	0.002 Hz	0.005 Hz	0.01 Hz	0.02 Hz	0.05 Hz	0.1 Hz	0.2 Hz	0.5 Hz	1 Hz	2 Hz	5 Hz	10 Hz	Event triggered
Navigation Solution	3	25	213	Periodic	☑	-	-	-	☐	-	-	☐	☐	☐	☐	-	-	-	☐
Satellites in view status	212	1	223	Periodic	☑	-	-	-	☐	☐	☐	☐	-	-	☐	-	-	-	☐
Time Correlation	3	25	214	Periodic	☑	-	-	-	☐	-	-	☐	-	-	☐	-	-	-	☐
Noise Histogram*	212	1	235	Periodic	☑	-	-	-	☐	-	-	☐	-	-	☐	-	-	-	☐
Carrier Amplitude	212	1	226	Periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Channel Status	212	1	224	Periodic	☑	-	-	-	☐	-	-	☐	☐	☐	☐	-	-	-	☐
Carrier Phase	212	1	225	Periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Code Phase	212	1	227	Periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Tracking State	212	1	215	periodic	☑	-	-	-	☐	-	-	☐	-	-	☐	-	-	-	☐
AGC status*	212	1	234	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV Almanac	212	1	230	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV Ephemeris	212	1	231	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV UTC and Ionosphere	212	1	232	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
Constellation status	212	1	229	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
Housekeeping Parameter Report**	3	25	219	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
S1 Navigation Solution	212	1	216	periodic	☐	-	-	-	☐	-	-	☐	-	☐	☑	-	-	-	☐
IMT/GPST Correlation	212	1	217	periodic	☐	-	-	-	☐	-	-	☐	-	☐	☑	-	-	-	☐
Sentinel Auxiliary Data	212	1	218	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐

Table 5-43 – Default Sample Rate Settings for Operational Mode for Sentinel-1.

* The AGC Status and Noise Histogram TMs are sent in Standby and Navigate mode. In both modes, the settings in the table apply.

** The Housekeeping parameter report is in Startup mode sent with 1 Hz, and in Standby and Navigate mode with the sample rate defined in the table.

5.8.4.18.2 Sample Rate Boot Defaults for Sentinel-2

The following table holds the Operational Mode default sample rate settings for Sentinel-2. The notes given in section 5.8.4.18.1 apply.

Packet	Service Type Note: redundant with [MDIS]	Service Subtype Note: redundant with [MDIS]	SID Note: redundant with [MDIS]	Reporting Type	Off	0.001 Hz	0.002 Hz	0.005 Hz	0.01 Hz	0.02 Hz	0.05 Hz	0.1 Hz	0.2 Hz	0.5 Hz	1 Hz	2 Hz	5 Hz	10 Hz	Event triggered
Navigation Solution	3	25	213	periodic	☐	-	-	-	☐	-	-	☐	☐	☐	☑	-	-	-	☐
Satellites in view status	212	1	223	periodic	☐	-	-	-	☐	☐	☐	☑	-	-	☐	-	-	-	☐
Time Correlation	3	25	214	periodic	☐	-	-	-	☐	-	-	☐	-	-	☑	-	-	-	☐
Noise Histogram	212	1	235	periodic	☐	-	-	-	☐	-	-	☑	-	-	☐	-	-	-	☐
Carrier Amplitude	212	1	226	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
Channel Status	212	1	224	periodic	☐	-	-	-	☐	-	-	☑	☐	☐	☐	-	-	-	☐
Carrier Phase	212	1	225	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
Code Phase	212	1	227	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
Tracking State	212	1	215	periodic	☐	-	-	-	☐	-	-	☑	-	-	☐	-	-	-	☐
AGC status	212	1	234	event driven	☐	-	-	-	-	-	-	-	-	-	-	-	-	-	☑
GPS NAV Almanac	212	1	230	event driven	☐	-	-	-	-	-	-	-	-	-	-	-	-	-	☑
GPS NAV Ephemeris	212	1	231	event driven	☐	-	-	-	-	-	-	-	-	-	-	-	-	-	☑
GPS NAV UTC and Ionosphere	212	1	232	event driven	☐	-	-	-	-	-	-	-	-	-	-	-	-	-	☑
Constellation status	212	1	229	event driven	☐	-	-	-	-	-	-	-	-	-	-	-	-	-	☑
Housekeeping Parameter Report	3	25	219	periodic	☐	-	-	-	☐	-	-	☐	-	☐	☑	-	-	-	☐
S1 Navigation Solution	212	1	216	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
IMT/GPST Correlation	212	1	217	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
Sentinel Auxiliary Data	212	1	218	periodic	☐	-	-	-	☐	-	-	☐	-	☐	☑	-	-	-	☐

Table 5-44 – Default Sample Rate Settings for Operational Mode for Sentinel-2.

5.8.4.18.3 Sample Rate Boot Defaults for Sentinel-3

The following table holds the default sample rate settings for Sentinel-3. The notes given in section 5.8.4.18.1 apply.

Packet	Service Type Note: redundant with [MDIS]	Service Subtype Note: redundant with [MDIS]	SID Note: redundant with [MDIS]	Reporting Type	Off	0.001 Hz	0.002 Hz	0.005 Hz	0.01 Hz	0.02 Hz	0.05 Hz	0.1 Hz	0.2 Hz	0.5 Hz	1 Hz	2 Hz	5 Hz	10 Hz	Event triggered
Navigation Solution	3	25	0xD5000000	periodic	☐	-	-	-	☐	-	-	☐	☐	☐	☑	-	-	-	☐
Satellites in view status	212	1	0xDF000000	periodic	☑	-	-	-	☐	☐	☐	☐	-	-	☐	-	-	-	☐
Time Correlation	3	25	0xD6000000	periodic	☐	-	-	-	☐	-	-	☐	-	-	☑	-	-	-	☐
Noise Histogram	212	1	0xEB000000	periodic	☑	-	-	-	☐	-	-	☐	-	-	☐	-	-	-	☐
Carrier Amplitude	212	1	0xE2000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Channel Status	212	1	0xE0000000	periodic	☑	-	-	-	☐	-	-	☐	☐	☐	☐	-	-	-	☐
Carrier Phase	212	1	0xE1000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Code Phase	212	1	0xE3000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Tracking State	212	1	0xD7000000	periodic	☑	-	-	-	☐	-	-	☐	-	-	☐	-	-	-	☐
AGC status	212	1	0xEA000000	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV Almanac	212	1	0xE6000000	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV Ephemeris	212	1	0xE7000000	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
GPS NAV UTC and Ionosphere	212	1	0xE8000000	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
Constellation status	212	1	0xE5000000	event driven	☑	-	-	-	-	-	-	-	-	-	-	-	-	-	☐
Housekeeping Parameter Report	3	25	0xDB000000	periodic	☐	-	-	-	☐	-	-	☑	-	☐	☐	-	-	-	☐
S1 Navigation Solution	212	1	0xD8000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
IMT/GPST Correlation	212	1	0xD9000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐
Sentinel Auxiliary Data	212	1	0xDA000000	periodic	☑	-	-	-	☐	-	-	☐	-	☐	☐	-	-	-	☐

Table 5-45 – Default Sample Rate Settings for Operational Mode for Sentinel-3.

5.8.4.19 FMT_AGC_Control

The purpose of this format is to start or stop the automatic gain control of one or more signal processing chains. The following situations may appear:

- The AGC was disabled before, and the ‘Enabled’ flag is cleared in the telecommand:
  The new GAIN setting becomes effective, the threshold flags in the AGC status report are initially set, see [MDIS].
- The AGC was disabled before, and the ‘Enabled’ flag is set in the telecommand:
  The loop filter is initialised, GAIN is used as the starting gain setting.
- The AGC was enabled before, and the ‘Enable’ flag is cleared in the telecommand:
  The control loop is disabled, and GAIN is used as the new setting.
- The AGC was enabled before, and the ‘Enabled’ flag is set in the telecommand:
  The new GAIN value is ignored, no effect on the current loop filter status.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	CHAIN				N/U			E	GAIN							
1	N/U															

Figure 5-43 – FMT_AGC_Control Format

Name	Definition	Interpretation	Initial	Ver.
CHAIN	Chain number	See Table 5-29 on page 85, any other value is invalid	-	Y
N/U	Not used	-	0	Y
E	Enabled	AGC disabled for E = 0 and enabled for E = 1	1	N
GAIN	Analogue Gain Setting	Gain DAC setting (unsigned value) in [0.65dB/LSB] - If the AGC is disabled this value represents the fixed setting - If the AGC is enabled this is the initial setting of the control loop	200	Y
N/U	Not used	-	0	Y

Table 5-46 – FMT_AGC_Control Definition

5.8.4.20 FMT_AGC_Par

The purpose of this format is to set the automatic gain control parameters for one or more signal processing chains.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	CHAIN				ORDER		BANDWIDTH									
1	SETPOINT															
2	WLOW															
3	WHIGH															
4	DEADBAND															
5	GAIN_LOW								GAIN_HIGH							

Figure 5-44 – FMT_AGC_Par Format

Name	Definition	Format	Interpretation		Initial	Ver.
CHAIN	Chain number	Unsigned	See Table 5-29, any other value is invalid		-	Y
ORDER	Filter order	Unsigned	0 = First order filter		0	Y
			1 = Second order filter			
			2 = Third order filter			
			3 = invalid			
BANDWIDTH	Filter bandwidth	5 .. 300	[0.01Hz]		100	Y
SETPOINT	AGC setpoint	-1000 .. 3000	[0.01 dB/LSB]	Chain 0 (L1)	675	Y
				Chain 1 (L2)	675	
WLOW	Lower settling threshold	-1000 .. 3000	[0.01 dB/LSB]	Chain 0 (L1)	575	Y
				Chain 1 (L2)	575	
WHIGH	Upper settling threshold	-1000 .. 3000	[0.01 dB/LSB]	Chain 0 (L1)	775	Y
				Chain 1 (L2)	775	
DEADBAND	Double-sided control loop deadband	0 .. 2000	[0.01 dB/LSB] If the absolute value of the control deviation (= current noise power minus set point) does not exceed half of this value, the control loop will not be executed, and the previous gain setting remains active		100	Y
GAIN_LOW	Gain setting lower limit	Unsigned	The lowest setting the enabled AGC loop may write to the RF ASIC in [0.65dB/LSB]		30	Y
GAIN_HIGH	Gain setting higher limit	Unsigned	The highest setting the enabled AGC loop may write to the RF ASIC in [0.65dB/LSB]		220	Y

Table 5-47 – FMT_AGC_Par Definition

5.8.4.21 FMT_AcquisitionPar

The purpose of this format is to set the acquisition parameters to be used during a warm start or a single 'warm' acquisition, i.e. when the navigation satellite almanacs are available and the knowledge of PVT is sufficient to avoid a full code search. Acquisition parameter settings in a data record apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 6 (1 setting x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FL	N/U		SIG					SET_INST				SET_IND			
1	SD_BIN_W								FFT_INP							
2	CODE_SF															
3	FREQ_SF															

Figure 5-45 – FMT_AcquisitionPar Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29, page 85	Y
SET_INST	Setting instance	0	Multiple instances are not applicable for this parameter type	Y
		Other	Any other value is invalid	
SET_IND	Setting index	0	Multiple settings are not applicable for this parameter type	Y
		Other	Any other value is invalid	
SD_BIN_W	Second dwell code bin width	1 .. 100	Search bin width in [0.01 code chips]	Y
FFT_INP	FFT input samples	0	Omit the initial frequency error reduction	Y
		1 .. 64	Number of samples to be used for the FFT based initial frequency error reduction	
CODE_SF	Code search window safety factor	1 .. 50000	In [0.001], factor to widen or tighten the code search window that was determined by the selection based on position uncertainty estimates	Y
FREQ_SF	Frequency search window safety factor	1 .. 50000	In [0.001], factor to widen or tighten the frequency search window that was determined by the selection based on velocity and receiver clock uncertainty estimates	Y

Table 5-48 – FMT_AcquisitionPar Parameter Definition

5.8.4.22 FMT_CorrSpacing

The purpose of this format is to set the correlator spacing for the signal tracking. Spacing specifications in a data record, for a certain setting index, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Note: The GPSR performs a plausibility check to ensure that the fields IN_EE, EE_E, E_P, P_L and L_LL hold the same value, otherwise the TC will be rejected with FID 5218.

Number of records: 24 (4 settings x 6 signal types)

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td>FL</td><td colspan="2">N/U</td><td colspan="5">SIG</td><td colspan="4">SET_INST</td><td colspan="4">SET_IND</td></tr>
<tr><td>1</td><td colspan="8">IN_EE</td><td colspan="8">EE_E</td></tr>
<tr><td>2</td><td colspan="8">E_P</td><td colspan="8">P_L</td></tr>
<tr><td>3</td><td colspan="8">L_LL</td><td colspan="6">N/U</td><td colspan="2">CR_AID</td></tr>
<tr><td>4</td><td colspan="8">TS_MIN</td><td colspan="8">TS_MAX</td></tr>
<tr><td>5</td><td colspan="16">N/U</td></tr>
</table>

Figure 5-46 – FMT_CorrSpacing Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29, page 85	Y
SET_INST	Setting instance	0	Multiple instances are not applicable for this parameter type	Y
		Other	Any other value is invalid	
SET_IND	Setting index	0 .. 3	Index of the parameter setting	Y
		Other	Any other value is invalid	
IN_EE	Delay Input - EarlyEarly tap	1..100	Spacing [0.01 code chips]	Y
EE_E	Delay EarlyEarly - Early tap	1..100	Spacing [0.01 code chips]	Y
E_P	Delay Early - Punctual tap	1..100	Spacing [0.01 code chips]	Y
P_L	Delay Punctual - Late tap	1..100	Spacing [0.01 code chips]	Y
L_LL	Delay Late - LateLate tap	1..100	Spacing [0.01 code chips]	Y
CR_AID	Cross-Aiding configuration for slave channels (ignored on master channels)	0	Code and carrier cross-aiding	N
		1	Carrier cross-aiding only	
		2	Code cross-aiding only	
		3	No cross-aiding	
TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29	Y

Table 5-49 – FMT_CorrSpacing Parameter Definition

5.8.4.23 FMT_Discriminator

The purpose of this format is to set the discriminator type for the code or carrier loops. The specified discriminator type in a data record, for a certain setting instance and setting index, applies to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 48 (2 instances x 4 settings x 6 signal types)

<table>
<tr><th rowspan="2">Word</th><th colspan="16">Bit number</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>0</td><td>FL</td><td colspan="2">N/U</td><td colspan="5">SIG</td><td colspan="4">SET_INST</td><td colspan="4">SET_IND</td></tr>
<tr><td>1</td><td colspan="4">DISC_TYPE</td><td colspan="12">N/U</td></tr>
<tr><td>2</td><td colspan="8">TS_MIN</td><td colspan="8">TS_MAX</td></tr>
<tr><td>3</td><td colspan="16">N/U</td></tr>
</table>

Figure 5-47 – FMT_Discriminator Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29, page 85	Y
SET_INST	Setting instance	0	Code loop	Y
		1	Carrier loop	
		Other	Any other value is invalid	
SET_IND	Setting index	0 .. 3	Four settings for the following instances: Code loop Carrier loop	Y
		Other	Any other value is invalid	
DISC_TYPE	Discriminator type	0	Early minus late power	?
		1	Dot-product	
		2	Generic Costas	
		3	PLL (Arc tangent)	
		4	FLL	
		Other	Any other value is invalid	
TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29, page 85	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29, page 85	Y

Table 5-50 – FMT_SetDiscriminator Parameter Definition

5.8.4.24 FMT_LoopIntPeriods

The purpose of this command is to set the sample integration periods for a number of different purposes (e.g. acquisition threshold decisions, loop discriminators, lock verification). The specified integration settings in a data record, for a certain setting instance and setting index, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 102 (17 settings x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FL	N/U		SIG					SET_INST				SET_IND			
1	IT_COH															
2	IT_NCOH / BANDWIDTH															
3	TS_MIN								TS_MAX							

Figure 5-48 – FMT_LoopIntPeriods Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29	Y
SET_INST	Setting instance	0	Code loop discriminator	Y
		1	Code loop lock verification	
		2	Code loop loss of lock verif.	
		3	Carrier loop discriminator	
		4	Carrier loop lock verification	
		5	Carrier loop loss of lock verif.	
		6	FFT input samples	
		Other	Any other value is invalid	
SET_IND	Setting index	0	One setting for the following instances: Code loop lock verification Carrier loop lock verification FFT input samples	Y
		0 .. 1	Two settings for the following instances: Code loop loss of lock verif. Carrier loop loss of lock verif.	
		0 .. 3	Four settings for the following instances: Code loop discriminator Carrier loop discriminator	
		Other	Any other value is invalid	
IT_COH	Integration time coherent	Unsigned	[ms]	Y
IT_NCOH / BANDWIDTH	Integration time non-coherent or Filter bandwidth	Unsigned	Integration time in [ms] for the instances 0, 3, 6 Filter bandwidth in [0.01Hz] for the instances 1, 2, 4, 5 Note: For instance 6 the fields IT_COH and IT_NCOH have to hold the same value. For instances 0 and 3 the field IT_NCOH has to hold an integer multiple of IT_COH. In the special case of IT_NCOH being less than IT_COH, IT_NCOH determines the internal cross-aiding update period, and IT_COH determines the loop update period.	Y

TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29.	Y

Table 5-51 – FMT_LoopIntPeriods Parameter Definition

5.8.4.25 FMT_LoopThresholds

The purpose of this format is to set the loop threshold factors for a number of different purposes (e.g. first and second dwell, lock and loss of lock verification). The specified threshold settings in a data record, for a certain setting instance and setting index, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

The setting instances for Code phase quality checks and for Carrier phase quality checks can be used to determine the characteristics of the deterioration flags which are part of both the Code phase and Carrier phase data records specified in [MDIS] (fields D).
If the threshold factor for such a setting instance, e.g. Code phase quality, is set to a value less or equal to the Code loop loss of lock verification threshold factor, the deterioration flag is set, whenever the energy accumulated in a specific code quality filter goes at least once within the measurement interval (typical a PPS interval) below the current threshold.
If the threshold factor for the quality setting instance is configured to be greater than the corresponding loss of lock threshold factor, the loop loss of lock filter is used for the quality decision, i.e. the deterioration flag is set whenever the accumulated energy in that filter goes at least once within the measurement interval below the current quality threshold.
The bandwidth of the loop loss of lock filters is determined by parameters described in section 5.8.4.24 - FMT_LoopIntPeriods.

The bandwidth of the quality filters is determined based on the code and carrier phase fitting interval and is therefore 1Hz for fitting intervals of 1 second (used for all sample rates of 1Hz and below) and 10Hz for fitting intervals of 0.1s (used for all sample rates higher than 1Hz).

Number of records: 78 (13 settings x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FL	N/U		SIG					SET_INST				SET_IND			
1	THRESHOLD															
2	TS_MIN								TS_MAX							
3	N/U															

Figure 5-49 – FMT_LoopThresholds Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29	Y
SET_INST	Setting instance	0	First dwell	Y
		1	Code loop lock verification	
		2	Code loop loss of lock verif.	
		3	Code phase quality check	
		4	Carrier loop lock verification	
		5	Carrier loop loss of lock verif.	
		6	Carrier phase quality check	
		Other	Any other value is invalid	
SET_IND	Setting index	0	One setting for the following instances: First dwell Code loop lock verification Code phase quality check Carrier loop lock verification Carrier phase quality check	Y

		0 .. 3	Four settings for the following instances: Code loop loss of lock verif. Carrier loop loss of lock verif.	
		Other	Any other value is invalid	
THRESHOLD	Threshold factor	Unsigned	[0.001]	Y
TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29.	Y

Table 5-52 – FMT_LoopThresholds Parameter Definition

5.8.4.26 FMT_LoopAcqRetries

The purpose of this format is to set the number of re-acquisition retries for a number of different purposes (e.g. first and second dwell search failed, lock verification failed). The specified retry settings in a data record, for a certain setting instance and setting index, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 36 (6 settings x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FL	N/U		SIG					SET_INST				SET_IND			
1	RETRIES															
2	TS_MIN								TS_MAX							
3	N/U															

Figure 5-50 – FMT_LoopAcqRetries Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29	Y
SET_INST	Setting instance	0	First dwell threshold	Y
		1	Code loop lock verification	
		2	Carrier loop lock verification	
		Other	Any other value is invalid	
SET_IND	Setting index	0 .. 1	Two setting for all instances	Y
		Other	Any other value is invalid	
RETRIES	Number of acquisition retries	Unsigned	Number of retries after a certain threshold check failed	Y
TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29.	Y
N/U	Not used	0	-	Y

Table 5-53 – FMT_LoopAcqRetries Parameter Definition

5.8.4.27 FMT_LoopFilterPar

The purpose of this format is to set the loop filter parameters for the code or carrier loop. The specified filter parameters in a data record, for a certain setting instance and setting index, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 48 (2 instances x 4 settings x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	FL	N/U		SIG					SET_INST				SET_IND			
1	ORDER		BANDWIDTH													
2	GAIN_INITIAL															
3	GAIN_FINAL															
4	GAIN_TIME															
5	TS_MIN								TS_MAX							

Figure 5-51 – FMT_LoopFilterPar Parameter Format

Name	Definition	Value	Interpretation	Ver.
FL	Final state flag	0	The setting does not belong to the final tracking state	N
		1	The setting belongs to the final tracking state	
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29	Y
SET_INST	Setting instance	0	Code loop	Y
		1	Carrier loop	
		Other	Any other value is invalid	
SET_IND	Setting index	0 .. 3	Four settings for the following instances: Code loop Carrier loop	Y
		Other	Any other value is invalid	
ORDER	Filter order	0	First order filter	Y
		1	Second order filter	
		2	Third order filter	
		Other	Any other value is invalid	
BANDWIDTH	Filter bandwidth	Unsigned	[0.01Hz]	Y
GAIN_INITIAL	Initial gain value	Unsigned	[0.001]	Y
GAIN_FINAL	Final gain value	Unsigned	[0.001]	Y
GAIN_TIME	Gain modification time	Unsigned	[ms]	Y
TS_MIN	Minimum logical tracking state	Unsigned	Start of applicability range. Tracking state definition see Table 5-29	Y
TS_MAX	Maximum logical tracking state	Unsigned	End of applicability range. Tracking state definition see Table 5-29	Y

Table 5-54 – FMT_LoopFilterPar Parameter Definition

5.8.4.28 FMT_StateRetention

The purpose of this format is to set the loop state retention time parameters. The specified time parameters in a data record, for a certain logical tracking state, apply to a certain signal type, depending on the SIG field. Initial values applicable for the different signal types can be found in [UML].

Number of records: 768 (128 logical tracking states x 6 signal types)

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	N/U		SIG						TS							
1	N/U						MAG		TICS							

Figure 5-52 – FMT_StateRetention Parameter Format

Name	Definition	Value	Interpretation	Ver.
N/U	Not used	0	-	Y
SIG	Signal type	Unsigned	See Table 5-29	Y
TS	Logical tracking state	Unsigned	Tracking state the time parameter apply to. Tracking state definition see Table 5-29	Y
N/U	Not used	0	-	Y
MAG	Magnitude of specified state retention time	0	One tic corresponds to 10ms	N
		1	One tic corresponds to 100ms	
		2	One tic corresponds to 1s	
		3	One tic corresponds to 10s	
TICS	Tics of MAG magnitude	0 .. 254	Number of tics with a magnitude given by MAG to hold the logical tracking state specified by TS, if no other state change criterion applies	N
		255	Keep for the rest of the track	

Table 5-55 – FMT_StateRetention Parameter Definition

5.8.4.29 FMT_SFC_UpdateMode

The purpose of this format is to set the single frequency channel update mode of one or more SFCs.

Number of records: 24

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SF_CHN								U	R	N/U					
1	N/U															

Figure 5-53 – FMT_SFC_UpdateMode Format

Name	Definition	Value	Interpretation	Initial	Ver.
SF_CHN	Channel number	Unsigned	See Table 5-29	-	Y
U	Update flag	0	Direct update of tracking parameters (loop thresholds, acquisition retries) disabled	0	N
		1	Direct update of tracking parameters (loop thresholds, acquisition retries) enabled		
R	Restart flag	0	Restart of tracking on parameter reception disabled	0	N
		1	Restart of tracking on parameter reception enabled		
N/U	Not used	0	-	0	Y

Table 5-56 – FMT_SFC_UpdateMode Definition

5.8.4.30 FMT_StateTransition

The purpose of this format is to initiate a tracking loop state transition on the single-frequency channel specified by the SF_CHN field to the logical tracking state specified by the NEW_TS field.

Number of records: 24

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SF_CHN								NEW_TS							
1	N/U															

Figure 5-54 – FMT_StateTransition Format

Name	Definition	Value	Interpretation	Initial	Ver.
SF_CHN	Channel number	Unsigned	See Table 5-29, page 85	-	Y
NEW_TS	New logical tracking state	0...152	Logical tracking state a transition shall be performed to	0	Y
N/U	Not used	0	-	0	Y

Table 5-57 – FMT_StateTransition Definition

5.8.4.31 FMT_SatelliteForce

This format is used to force specific SV signals to be acquired and tracked on a specific single-frequency channel with given initial parameters. It also allows to specify a second, slaved single-frequency channel for the acquisition of additional signal components of the same SV (e.g. L1 C/A on the first channel and L2 CM on the second channel). The slaved channel starts acquisition when the master channel reaches a triggering tracking state (TS TRIGGER field). Once a single telecommand containing a FM_SatelliteForce is issued, autonomous selection is disabled. The satellite force list is cleared by a mode transition to standby.

Because of the single frequency channel granularity this interface is very flexible and powerful. However, the flexibility makes the interface vulnerable for inapropriate usage. In order to improve robustness against inadmissible parameter sets, the following plausibility criteria apply to telecommands of this format:

- The subsequently sent force entries must form a registered tracking scheme, e.g. L1 CA & P1 & P2, or L1 CA & L2 CM.
- The force entries allocating the SFCs (Single Frequency Channels) of one MFC (Multi Frequency Channel) must be properly linked together, i.e. the SLAVE_CHN field of the master SFC must hold the index of its slave SFC, and this one must hold the index of its slave, or 24 if no slave SFC exists.
- The force entries allocating the SFCs of one MFC have to be sent in reverse order, e.g. SFC 2, SFC 1, SFC 0. This constraint comes from the SFC links introduced by the SLAVE_CHN field - the master holds a reference to its slave channel, and so on. The references must exist before they are actually used.
- The force entries allocating the SFCs of one MFC must hold the same BEGIN_GPST_SEC and BEGIN_GPST_SUBSEC field contents.
- BEGIN_GPST_SEC and END_GPST_SEC must be within the bounds [630720000 1577491200].
- The code phase estimate provided via INITIAL_CC and INITIAL_CP must be in the range 0...Number of chips per week (chips according to the signal type in SIG).
- In case the commanded acquisition is of type Cold or Cool (CODE_SW = 0) the FREQ_BIN field must hold 1000Hz, the Loop Auto Frequency Error detection must be disabled (AF = 0) and the code code phase estimate must be set to zero (INITIAL_CC = 0 and INITIAL_CP = 0).
- In case the commanded acquisition is of type Warm (CODE_SW > 0 and AF = 1) the FREQ_BIN field must hold a value not greater than 250Hz.
- In case the commanded acquisition is not of type Cold (CODE_SW > 0 or CARR_SW < 100) the receiver needs orbit parameter for aiding frequency calculation. This means that either Almanacs or Ephemeris data must be available.
- Acquisitions of type Cold, Cool (CODE_SW = 0) or Warm (AF = 1) are only allowed on a master SFCs, i.e. the first SFC within an MFC (e.g. SFC 0, SFC 3, etc.).

Note: The first FMT_SatelliteForce pre-load function parameter record received by the GPSR is written to GPSR internal data-base record index 0. The next FMT_SatelliteForce pre-load function parameter record will be written to record index 1 and so on until the list is full. If the list is full, the pre-load parameter TC will be rejected. This behavior applies to FMT_SatelliteForce parameter type only. The other parameter types have an identifier in the record defining to which record index it belongs.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	CONS			SV_ID								SIG				
1	ANT				SF_CHN								N/U	AF	STAT	
2	BEGIN_GPST_SEC															
3																
4	BEGIN_GPST_SUBSEC															
5																
6	END_GPST_SEC															
7																
8	END_GPST_SUBSEC															
9																
10	SLAVE_CHN								TS_TRIGGER							
11	TS_MIN								TS_MAX							
12	INITIAL_CC															
13																
14																
15	INITIAL_CP															
16	CODE_SW								CARR_SW							
17	FREQ_BIN															
18	DOPPLER															
19																

Figure 5-55 – FMT_SatelliteForce Format

Name	Definition	Value	Interpretation	Initial	Ver.
CONS	Constellation identifier	Unsigned	See Table 5-29, page 85	0	Y
SV_ID	Space vehicle identifier	Unsigned	See Table 5-29, page 85	0	Y
SIG	Signal type	Unsigned	See Table 5-29, page 85	0	Y
ANT	Antenna identifier	Unsigned	See Table 5-29, page 85	0	Y
SF_CHN	Channel number	Unsigned	See Table 5-29, page 85	0	Y
N/U	Not used	0	-	0	Y
AF	Auto Frequency Error Detection	0	No frequency error handling (warm acquisition)	0	N
		1	Frequency error handling needs to be done autonomously be the tracking loop (first warm acquisition)		
STAT	Action status for current entry	0	Entry disabled (no data)	0	N
		1	Entry is scheduled (current time < BEGIN_GPST)		
		2	Entry is currently being processed (BEGIN_GPST < current time < END_GPST)		
		3	Entry inactive (current time > END_GPST)		
BEGIN_GPST_SEC BEGIN_GPST_SUBSEC	GPS time begin time tag	GPS Format, see §3.4.4	Begin time of acquisition for the selected signal.	0	Y
END_GPST_SEC END_GPST_SUBSEC	GPS time end time tag	GPS Format, see §3.4.4	End time of tracking for the selected signal.	0	Y
SLAVE_CHN	Slave Channel number	Unsigned	See Table 5-29, page 85	0	Y

		24	Indicates that no channel shall be slaved		
TS_TRIGGER	Triggering tracking state	Unsigned	Trigger for the selection of the slave channel (SLAVE CHN field). Tracking state definition see Table 5-29, page 85	0	Y
TS_MIN	Minimum logical tracking state	Unsigned	Tracking state range for current signal. Tracking state definition see Table 5-29, page 85.	0	Y
TS_MAX	Maximum logical tracking state			0	
INITIAL_CC	Initial chip count	Unsigned	Number of code chips since start of GPS week. In the SRDB this parameter is divided in INITIAL_CC_MSB (the 32 most significant bits) and INIAL_CC_LSB (the 16 least significant bits). The aggregate parameter can be calculated as follows: INITIAL_CC = INITIAL_CC_MSB<<16 | INITIAL_CC_LSB	0	Y
INITIAL_CP	Initial code phase	Unsigned	[2^{-16} code chips]	0	N
CODE_SW	Code search window	Unsigned 1 .. 255	Single sided window width [code chips]	0	N
		0	Full code sequence search (cold or cool acquisition)	0	
CARR_SW	Carrier search window	Unsigned	Total window width [frequency bins]	0	N
FREQ_BIN	Frequency bin width	Unsigned 0 .. 1000	Frequency spacing at two-dimensional code search [Hz]	0	Y
DOPPLER	Initial Doppler frequency	Signed ±500kHz	Physical initial Doppler frequency [Hz]	0	Y

Table 5-58 – FMT_SatelliteForce Definition

5.8.4.32 FMT_ContextSaveTable

The purpose of this format is to define memory blocks which shall be saved into the RAM margin area for software maintenance purposes. The intention is to preserve relevant parts of the software context after a software problem has caused a reset of the GPSR. The specified memory blocks are copied to the RAM margin area as part of the boot sequence, i.e., before the destructive memory test erases all the information required for error investigation. This format allows to adapt the memory regions to be saved according to the actual needs during an error investigation. Unused entries shall have a LENGTH field of zero.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SRC_ADDR1															
1																
2	LENGTH1															
3																
4	.															
…																
…	.															
91																
92	SRC_ADDR24															
93																
94	LENGTH24															
95																

Figure 5-56 – FMT_ContextSaveTable Format

Name	Definition	Value	Interpretation	Initial	Ver.
SRC_ADDRx	Source block start address	Unsigned	32-bit aligned RAM address of the memory region to be saved	0	Y
LENGTHx	Source block length	Unsigned	Number of bytes to be saved, integer multiple of 4	0	Y

Table 5-59 – FMT_ContextSaveTable Definition

Notes:

- x corresponds to a number in the range of 1 to 24.
- Verification of SRC_ADDRx field includes the check of 32-bit alignment and if the specified address is located within the physical RAM area.
- Verification of LENGTHx field includes the check of 32-bit alignment, the check if the specified block is entirely located within the physical RAM area and the check if all specified memory blocks fit into the RAM margin area.

5.8.4.33 FMT_DiagnosticFilter

The purpose of this format is to allow configuration of the GPSR internal diagnostic level. The diagnostic level influences the generation of ‘Software Warning’ events, as defined in section 5.4.4.5. In addition, generation of these events can be enabled/disabled on a per task basis and on a per SW module basis by means of bitmasks. By default, generation is enabled for all tasks and all SW modules. However, only warnings with LEVEL = ‘Warning’ will be delivered to avoid reporting of internal events with low relevance.

Note: The configurable filtering mechanism applied in the receiver first checks for the appropriate level, then, if reporting is enabled for the task currently executing and finally, if reporting is enabled for the module generating the warning. Only in case all three criteria are fulfilled, the ‘Software Warning’ event will be sent.

Note: Some of the defined Software Warning events are expected to be only generated in case of memory corruption or due to an unknown software bug. To avoid excessive TM data rates due to frequent reporting in such an error case, Software Warnings of this type will be suppressed if they have been reported once since start of the software, i.e. each warning of a specific type ERR_CODE might be reported just once during execution of StartupSW and just once during execution of OperationalSW.

Other Software Warning events have either a dedicated filter to be only reported once per anomaly occurrence even if the detection cycle repeats itself, or the detection cycle period is long enough to avoid frequent reporting.

	Bit number															
Word	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	N/U													LEVEL		
1	N/U															
2	T31	T30	T29	...									...	T18	T17	T16
3	T15	T14	T13	...									...	T2	T1	T0
4	M95	M94	M93	...									...	M82	M81	M80
5	M79	M78	M77	...									...	M66	M65	M64
6	M63	M62	M61	...									...	M50	M49	M48
7	M47	M46	M45	...									...	M34	M33	M32
8	M31	M30	M29	...									...	M18	M17	M16
9	M15	M14	M13	...									...	M2	M1	M0

Figure 5-57 – FMT_DiagnosticFilter Format

Name	Definition	Value	Interpretation	Initial	Ver.
N/U	Not used	0	-	0	Y
LEVEL	‘Software Warning’ event reporting level	0	Report events at error level ‘Debug’ and above	2	Y
		1	Report events at error level ‘Info’ and above		
		2	Report events at level ‘Warning’		
		Other	Any other value is invalid		
N/U	Not used	0	-	0	Y
T31 ... T0	Task ID the reporting shall be enabled/disabled for	0	‘Software Warning’ event reporting disabled for the corresponding task	1	N
		1	‘Software Warning’ event reporting enabled for the corresponding task		
M95 ... M0	Software module ID the reporting shall be enabled/disabled for	0	‘Software Warning’ event reporting disabled for the corresponding SW module	1	N
		1	‘Software Warning’ event reporting enabled for the corresponding SW module		

Table 5-60 – FMT_DiagnosticFilter Definition

5.8.4.34 FMT_RCPVT

The purpose of this format is to support the Kalman Filter based navigation solution during spacecraft manoeuvres. A telecommand of this type is expected to be sent at the begin of the manoeuvre, providing the additional acceleration introduced by the thrusters during the manoeuvre. At the end of the manoeuvre a telecommand of this type with all D_ACC_X,Y,Z fields set to zero is expected.

Note: The FMT_RCPVT parameter definition is given here for reference, in particular for the case it becomes mandatory to send such a TC in order to reach the required PVT performance during manoeuvres. In case the required manoeuvre performance will be reached without support of FMT_RCPVT parameters (which is currently the baseline), this parameter TC will not be available in the Sentinel Flight software.

Word	Bit number 0 – 15
0	D_ACC_X
1	
2	D_ACC_Y
3	
4	D_ACC_Z
5	
6	RESERVED
7	
…	.
…	
54	RESERVED
55	

Figure 5-58 – FMT_ RCPVT Format

Name	Definition	Value	Interpretation	Initial	Ver.
D_ACC_X	Acceleration deviation due to the manoeuvre in x direction	-1e7..1e7	In local level coordinate system in [1e-9 m/s^2]	0	Y
D_ACC_Y	Acceleration deviation due to the manoeuvre in y direction	-1e7..1e7	In local level coordinate system in [1e-9 m/s^2]	0	Y
D_ACC_Z	Acceleration deviation due to the manoeuvre in z direction	-1e7..1e7	In local level coordinate system in [1e-9 m/s^2]	0	Y
RESERVED	Field reserved for future extensions	0	-	0	Y

Table 5-61 – FMT_ RCPVT Definition

5.8.4.35 FMT_Antenna

The purpose of this format is to adapt the differential vector between the GPS antenna phase center and the Center Of Gravity (COG) during the mission. This might be necessary when the COG of the spacecraft changes over time due to propellant consumption.

Note: Due to a vector plausibility check a telecommand with all 3 vector components PV_X, PV_Y and PV_Z set to 0 will be rejected by the GPSR.

Word	Bit number 0 – 15
0	PV_X
1	
2	PV_Y
3	
4	PV_Z
5	
6	RESERVED
7	
…	.
…	
18	RESERVED
19	

Figure 5-59 – FMT_ Antenna Format

Name	Definition	Value	Interpretation	Initial	Ver.
PV_X	X component of vector pointing from the CoG to the antenna phase center	-5e7..+5e7	In Receiver Reference Frame in [1e-6 m]	See [UML] for value	Y
PV_Y	Y component of vector pointing from the CoG to the antenna phase center	-5e7..+5e7	In Receiver Reference Frame in [1e-6 m]	See [UML] for value	Y
PV_Z	Z component of vector pointing from the CoG to the antenna phase center	-5e7..+5e7	In Receiver Reference Frame in [1e-6 m]	See [UML] for value	Y
RESERVED	Field reserved for future extensions	0	-	0	Y

Table 5-62 – FMT_ Antenna Definition

5.8.4.36 FMT_SVMPR

The purpose of this format is to adapt the SV selection behaviour during the Sentinel-3 safe mode. Because of the unknown spacecraft attitude during the first phase of the safe mode the antenna field of view should be enlarged from 80deg to 180deg zenith angle by sending a TC FMT_ReceiverAntField. This results in an omni directional antenna mask, and the autonomous selection will therefore try to select any GPS SV being part of the constellation. Whenever an acquisition attempt has been made for an SV actually not visible, the SV is banned for a while to give the next one a chance. By default the ban time is 40s, which is not enough for the specific situation. In order to cycle through all SVs when performing the acquisition attempts, the ban time should be increased to 450s.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	BAN_TIME															
1																
2	RESERVED															
3																
…	.															
…																
16	RESERVED															
17																

Figure 5-60 – FMT_ SVMPR Format

Name	Definition	Value	Interpretation	Initial	Ver.
BAN_TIME	Ban duration in non cold start case	0..3600	Time in [s] an SV is banned for acquisition after the preceding acquisition attempt for it has failed	40	Y
RESERVED	Field reserved for future extensions	0	-	0	Y

Table 5-63 – FMT_ SVMPR Definition

5.8.4.37 FMT_KALMAN

The purpose of this format is to adapt the Kalman Filter bandwidth during manoeuvres. The first six diagonal elements of the system error matrix shall be adjusted for that purpose. A telecommand of this type is expected to be sent at the begin of the manoeuvre, providing the system error matrix coefficients for increased filter bandwidth during the manoeuvre. At the end of the manoeuvre a telecommand of this type with all fields set to initial values is expected.

Please note that the SRDB has three pre-defined telecommand packets with fix parameter values to set the FMT_KALMAN parameter table. With the telecommand Parameter Service Telecommand “FMT_KALMAN_Manoeuvre_with_delta” (names varies slightly between the S-1, S-2 and S-3 SRDBs) or “FMT_KALMAN_Manoeuvre_without_delta” the GPSR is prepared for a manoeuvre. After the manoeuvre is completed the GPSR is configured for normal operation again with the telecommand Parameter Service “FMT_KALMAN_Manoeuvre_normal”.

Note: In order to cover the big magnitude of parameters and still preserve a sufficient high resolution, the parameter values have been split into a mantissa (MAN) and exponent (EXP) part.

Word	Bit number 0 – 15
0	RPE_MAN_X
1	
2	RPE_EXP_X
3	
4	RPE_MAN_Y
5	
6	RPE_EXP_Y
7	
8	RPE_MAN_Z
9	
10	RPE_EXP_Z
11	
12	RVE_MAN_X
13	
14	RVE_EXP_X
15	
16	RVE_MAN_Y
17	
18	RVE_EXP_Y
19	
20	RVE_MAN_Z
21	
22	RVE_EXP_Z
23	
24	RESERVED
25	
…	.
…	
58	RESERVED
59	

Figure 5-61 – FMT_ KALMAN Format

Name	Definition	Value	Interpretation	Initial	Ver.
RPE_MAN_X	Squared residual position error in X direction, mantissa	-1e9..1e9	Squared Residual Position Error X = RPE_MAN_X * 10^RPE_EXP_X (m)^2	0	Y
RPE_EXP_X	Squared residual position error in X direction, exponent	-100..100		1	Y

RPE_MAN_Y	Squared residual position error in Y direction, mantissa	-1e9..1e9	Squared Residual Position Error Y = RPE_MAN_Y * 10^RPE_EXP_Y (m)^2	0	Y
RPE_EXP_Y	Squared residual position error in Y direction, exponent	-100..100		1	Y
RPE_MAN_Z	Squared residual position error in Z direction, mantissa	-1e9..1e9	Squared Residual Position Error Z = RPE_MAN_Z * 10^RPE_EXP_Z (m)^2	0	Y
RPE_EXP_Z	Squared residual position error in Z direction, exponent	-100..100		1	Y
RVE_MAN_X	Squared residual velocity error in X direction, mantissa	-1e9..1e9	Squared Residual Velocity Error X = RVE_MAN_X * 10^RVE_EXP_X (m/s)^2	0	Y
RVE_EXP_X	Squared residual velocity error in X direction, exponent	-100..100		1	Y
RVE_MAN_Y	Squared residual velocity error in Y direction, mantissa	-1e9..1e9	Squared Residual Velocity Error Y = RVE_MAN_Y * 10^RVE_EXP_Y (m/s)^2	0	Y
RVE_EXP_Y	Squared residual velocity error in Y direction, exponent	-100..100		1	Y
RVE_MAN_Z	Squared residual velocity error in Z direction, mantissa	-1e9..1e9	Squared Residual Velocity Error Z = RVE_MAN_Z * 10^RVE_EXP_Z (m/s)^2	0	Y
RVE_EXP_Z	Squared residual velocity error in Z direction, exponent	-100..100		1	Y
RESERVED	Field reserved for future extensions	0	-	0	Y

Table 5-64 – FMT_KALMAN Definition

5.8.4.38 FMT_FORCE

The purpose of this format is to adapt the Earth Orientation parameters which will slightly change over mission time.

Word	Bit number 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0 1	PMA_X															
2 3	PMA_Y															
4 5	RESERVED															
… …	.															
32 33	RESERVED															

Figure 5-62 – FMT_ Force Format

Name	Definition	Value	Interpretation	Initial	Ver.
PMA_X	Polar motion angle in X direction	-1e9 .. 1e9	Deviation from nominal angle in [1e-9 arc seconds]	27400000	Y
PMA_Y	Polar motion angle in Y direction	-1e9 .. 1e9	Deviation from nominal angle in [1e-9 arc seconds]	284000000	Y
RESERVED	Field reserved for future extensions	0	-	0	Y

Table 5-65 – FMT_ Force Definition

The Earth orientation parameters supported by the telecommand FMT_FORCE are the coordinates of the pole, relative to the z-axis of the International Terrestrial Reference Frame (the geographic pole axis). The coordinates of the pole undergoes variations mostly because of the atmospheric and oceanic mass distributions changing over time. An update of once every second week is considered as sufficient to meet the Sentinel performance requirements.

5.9 SERVICE 17: TEST

5.9.1 Perform Connection Test TC(17,1)

This telecommand is supported in all modes and is used as an end-to-end communication test. The length of the Command Data field (see Figure 4-1 on page 36) varies from 0 to 214 bytes (an even number) of dummy data bytes. The GPSR replies with TM(17,2) in the nominal case. The use of a non-zero length of the Command Data field is supported for debugging and protocol testing purposes only.

Error Handling:

The GPSR will report TM(1,2), if one of the “static” checks according to Table 5-2 on page 44 fails.

5.9.2 Link Connection Report TM(17,2)

The GPSR sends this report in reply to TC(17,1), upon successful reception of the TC. The Source Data field within the TM Packet Data field has the same length as the corresponding telecommand data field.

5.10 SCIENCE DATA TRANSFER SERVICE TM(212,1)

The science data transfer details, i.e. the Science Data Sets are described in [MDIS].

The generation of all data formats listed in [MDIS] is restricted to the Navigate mode, except AGC Status Data Records and Noise Histogram Data Records, which are available in Standby mode, as well.

Note: Science data records with a variable number of records, as defined in [MDIS] Table 5-5 in column 'Variable number of records in TM', are only generated if certain preconditions are fulfilled:

- For Carrier Phase data records, Code Phase data records and Carrier Amplitude records the SV must be tracked in a certain tracking state, as specified in [MDIS] Table 5-11 and Table 5-12, respectively.
- For Constellation Status data records, GPS NAV Almanac data records, GPS NAV Ephemeris data records and GPS NAV UTC and Ionosphere data records the successful download of the corresponding navigation data objects is mandatory. This includes that the downloaded navigation data objects are new compared to the previously downloaded data objects.
- For Satellites In View Status records at least a preliminary first fix is required, in addition for each SV being reported Almanacs must be available, and the SV must be indicated 'healthy' in both the Almanacs and in the page 25 health summary.

In case the given preconditions are not fulfilled, and therefore no data record is generated, no TM of that record type will be generated at all. This rule applies also to the situation where TM data is explicitly requested by setting the sample rate to 'Event driven' for a periodic TM type (i.e. using the single shot feature, as described in §5.8.4.18.1).

POST MORTEM REPORT

Any medium severity event causes the generation of a post mortem report in the GPSR RAM. Because of the size of the report, it is not sent to ground but can be dumped via Memory Dump commands from the Post Mortem Copy Area, see [UML] on anomaly handling.

The processor~~software~~ context saved in the post mortem area is the context when the failure was detected, not necessarily when the failure occurred. The provided information shall support a software engineer when investigating the failure cause, typically after an unexpected reboot. In such a case the operator should dump the post mortem information from section RAM__PostMortemDataCopy at addresses 0x401FB000 to 0x401FB7FF for inspection by RUAG, see [UML] The GPSR dumps the full SW context (see 5.8.4.32 FMT_ContextSaveTable) into the SW margin region. To provide additional information, the section RAM__MarginArea at addresses 0x401B2000 to 0x401FB000 should be dumped.

The interpretation of the post mortem format requires in-depth knowledge of the GPSR SW. The table below captures its content.

Name	Definition	Field width	Value	Interpretation
SIGNATURE	Signature	32	'PMRP'	Fixed pattern indicating the begin of the Post Mortem area
BOOT_STAT	Boot status - Reflects the reason for entering the Startup mode	32	0x4E4F4F50	'NOOP' - Normal operation after power-up
			0x434D4E44	'CMND' - Commanded transition
			0x4550524F	'EPRO' - Event Processor exception
			0x45574447	'EWDG' - Event Watchdog expired
			0x454F5448	'EOTH' – Other medium severity event
			Other	Any other value is invalid
COREDMP_STAT	Core Dump status	32	0x2D2D2D2D	'----' - No dump stored
			0x444F4E45	'DONE' - Dump data stored
			Other	Any other value is invalid
N/U	Not Used	16	0	
N/U	Not Used	13	0	
R_MODE	Receiver Mode	3	1	Startup mode
			2	Standby mode
			3	Navigate mode
			Other	Any other value is invalid
BT_RST, offset 0x10				**Boot CPU Reset Context** Contents of registers during hardware reset. (See LEON-User manual for bits which are directly affected by reset). After power-on reset the contents of the registers are undefined.

Name	Definition	Field width	Value	Interpretation
SR	Processor State Register	32	Unsigned	PSR.cwp, WIM, Y, FSR, G6, G7 contain the values of the registers before the reset occurred. PSR.cwp shows how to interpret the contents of the dumped register windows in WIN0-WIN7. O0 and O7 are values of the registers of the register window used by the BOOT SW (PSR has been already initialised in BOOT SW) before they are overwritten.
TBR	Trap Base Register	32	Unsigned	
WIM	Window Invalid Mask Register	32	Unsigned	
Y	Multiply/Divide Register	32	Unsigned	
FSR	Floating point status register	32	Unsigned	
O0	Out register 0	32	Unsigned	
O7	Out register 7	32	Unsigned	
G6	Global register 6	32	Unsigned	
G7	Global register 7	32	Unsigned	
BT_STAT, offset 0x34				**Boot CPU Status** Maintained during execution of BOOT SW
EDAC_CNT	EDAC Single bit error counter	32	Unsigned	Number of EDAC single bit errors occurred during Boot Code execution. Zero if no EDAC error occurred.
TRAP_TYPE	Trap Type	32	Unsigned	Trap Type field of the processor TBR register at the first unexpected trap during boot code execution. Zero if no unexpected trap occurred.
TRAP_CNT	Trap Counter	32	Unsigned	Number of unexpected traps during boot code execution. Zero if no unexpected trap occurred.
FAILAR	Fail address register	32	Unsigned	Address of last occurred internal bus error (EDAC)
FAILSR	Fail status register	32	Unsigned	Status of last occurred internal bus error (EDAC)
ASR16	Register file protection control reg	32	Unsigned	ASR16 value at the end of `BOOT_Main`
CCR	Cache control register	32	Unsigned	CCR value at the end of `BOOT_Main`
OPST_STAT, offset 0x50				**Operational/Startup CPU Status** Maintained during execution of Startup and Operational SW
RAM_EDAC_CNT	Ram EDAC single bit error counter	32	Unsigned	
NVM_EDAC_CNT	NVM1 and NVM2 EDAC single bit error counter	32	Unsigned	
FAILAR	Fail address register	32	Unsigned	
FAILSR	Fail status register	32	Unsigned	
HW_STAT, offset 0x60				**Hardware Test Status**
N/U	Not Used	16	0	
N/U	Not Used	12	0	
DB	NVM2 load block test for data	1	0	Test failed
			1	Test passed
CD	NVM2 load block test for code	1	0	Test failed
			1	Test passed
MX	Comparator status at maximum output voltage value V_{DAC} (temperature measurement circuit)	1	0	Thermistor voltage > V_{DAC} - test failed
			1	Thermistor voltage < V_{DAC} - test passed
MN	Comparator status at minimum output voltage value V_{DAC} (temperature measurement circuit)	1	0	Thermistor voltage < V_{DAC} - test failed
			1	Thermistor voltage > VDAC - test passed
Offset 0x64				**Checksums**
NVM1_REF_CRC	Reference CRC of non-volatile memory holding the Startup SW	32	Unsigned	32-bit CRC according to CCITT polynom
NVM2_REF_CRC	Reference CRC of non-volatile memory holding the application	32	Unsigned	32-bit CRC according to CCITT polynom
RAM1_CAL_CRC	Calculated CRC of volatile memory holding the Startup SW	32	Unsigned	32-bit CRC according to CCITT polynom
RAM2_CAL_CRC	Calculated CRC of volatile memory holding the application	32	Unsigned	32-bit CRC according to CCITT polynom
Offset 0x74				**Mission Params**
MT	Mission Type	32	0	Sentinel-1
			1	Sentinel-2
			2	Sentinel-3
			Other	Any other value is invalid
SN	Serial Number	32	X	Board serial number. Internal use by RSA only.

Name	Definition	Field width	Value	Interpretation
SW_VERSION	Software Version Identifier	32	Unsigned	Identifies the software version. This field is read from NVM2 during boot process. See description in Table 5-7
OPTION_BITS	Option Bits	32	Unsigned	Internal use by RSA (for testing purposes)
RES_05	Reserved	32		
RES_06	Reserved	32		
RES_07	Reserved	32		
RES_08	Reserved	32		
Offset 0x94				**Memory Pattern Tests [1..7]**
PT1_BEG_ADDR	Pattern test begin address	32	Unsigned	Pattern test 1 – See [UML]
PT1_END_ADDR	Pattern test end address	32	Unsigned	
PT1_REF_VAL	Pattern test reference value	32	Unsigned	
PT1_ERR_VAL	Pattern test error value	32	Unsigned	
PT1_ERR_CNT	Pattern test error counter	32	Unsigned	
PT1_ERR_ADDR	Pattern test location of 1st error	32	Unsigned	
…				
PT7_BEG_ADDR	Pattern test begin address	32	Unsigned	Pattern test 7 – See [UML]
PT7_END_ADDR	Pattern test end address	32	Unsigned	
PT7_REF_VAL	Pattern test reference value	32	Unsigned	
PT7_ERR_VAL	Pattern test error value	32	Unsigned	
PT7_ERR_CNT	Pattern test error counter	32	Unsigned	
PT7_ERR_ADDR	Pattern test location of first error	32	Unsigned	
Offset 0x13c				**Memory Address Test**
ADT_BEG_ADDR	Address test begin address	32	Unsigned	Address test – See [UML]

DT_END_ADDR	Address test end address	32	Unsigned	
ADT_REF_VAL	Address test reference value	32	Unsigned	
ADT_ERR_VAL	Address test error value	32	Unsigned	
ADT_ERR_CNT	Address test error counter	32	Unsigned	
ADT_ERR_ADDR	Address test location of 1st error	32	Unsigned	
				Reserved
DBCRC	CRC16 value of NVM2 ‘database’ image	32	Unsigned	After copy from NVM2 into Ram. The Ram contents are used for CRC calculation.
NVDEC	NVM1 and NVM2 uncorrectable access error counter	32	Unsigned	Uncorrectable access error caused by data load instruction.
NVFAR	Fail address register	32	Unsigned	
NVFSR	Fail status register	32	Unsigned	
N/U	Not Used	32	0	Reserved for extensions
Offset 0x168				**Register Windows [0..7]**
WIN0	Registers i0 to i7, l0 to l7 w. CWP 0	16*32	not defined	Register values in case of a CPU-Exception, RTOS_ResFail, SW_Fail or Watchdog Reset. Zero otherwise (commanded transition into Startup or Power-On) Refer to AT697E Data Sheet.
WIN1	Registers i0 to i7, l0 to l7 w. CWP 1	16*32	not defined	
WIN2	Registers i0 to i7, l0 to l7 w. CWP 2	16*32	not defined	
WIN3	Registers i0 to i7, l0 to l7 w. CWP 3	16*32	not defined	
WIN4	Registers i0 to i7, l0 to l7 w. CWP 4	16*32	not defined	
WIN5	Registers i0 to i7[13], l0 to l7 w. CWP 5	16*32	not defined	
WIN6	Registers i0 to i7, l0 to l7 w. CWP 6	16*32	not defined	
WIN7	Registers i0 to i7, l0 to l7 w. CWP 7	16*32	not defined	
Offset 0x368				**FP Registers**
f0 – f31	Floating point registers	32*32	Float	See description of WIN0-WIN7
CPU, offset 0x3e8				**CPU**
PC	Program Counter	32	Unsigned	Register values in case of a CPU-Exception: - not valid Register values in case of a RTOS_ResFail or SW_Fail: - PC contains not the originate address, - NPC is invalid - PSR, WIM, g1 – g7 may be modified by subfunction call (to be decided after a crash by inspection of the code) - all other registers are valid. Register values in case of Power-On reset, Watchdog Reset or commanded transition: - Undefined Refer to the AT697E Data Sheet.
NPC	Program Counter of next instruction	32	Unsigned	
PSR	Processor State Register	32	Unsigned	
WIM	Window Invalid Mask Register	32	Unsigned	
Y	Multiply/Divide Register	32	Unsigned	
TBR	Trap Base Register	32	Unsigned	
FSR	Floating point status register	32	Unsigned	
ASR16	Register file protection control reg	32	Unsigned	
CCR	Cache control register	32	Unsigned	
FAILAR	Fail address register	32	Unsigned	
FAILSR	Fail status register	32	Unsigned	
ITMP	Interrupt mask and priority reg.	32	Unsigned	
ITP	Interrupt pending register	32	Unsigned	
ITF	Interrupt force register	32	Unsigned	
WPR1	Write protection register 1	32	Unsigned	
WPR2	Write protection register 2	32	Unsigned	
PCR	Product configuration register	32	Unsigned	
TIMC1	Timer 1 counter register	32	Unsigned	
TIMC2	Timer 2 counter register	32	Unsigned	
MCFG1	Memory config register 1	32	Unsigned	
MCFG2	Memory config register 2	32	Unsigned	
MCFG3	Memory config register 3	32	Unsigned	
g1	Global register	32	Unsigned	
g2	Global register	32	Unsigned	
g3	Global register	32	Unsigned	
g4	Global register	32	Unsigned	
g5	Global register	32	Unsigned	
g6	Global register	32	Unsigned	
g7	Global register	32	Unsigned	
				ASR Registers
ASR24	Watch point address register	32	Unsigned	Not used, undefined
ASR26	Watch point address register	32	Unsigned	
ASR28	Watch point address register	32	Unsigned	
ASR30	Watch point address register	32	Unsigned	
ASR25	Watch point mask register	32	Unsigned	
ASR27	Watch point mask register	32	Unsigned	

[13] Register Window 6 is the window used by the Boot Code and it uses o0 and o7. These are the inputs to register window 5. Consequently the content of i0 and i7 is useless but captured in BT_RST, see comment there.

ASR29	Watch point mask register	32	Unsigned	
ASR31	Watch point mask register	32	Unsigned	
				Timer Registers
TIMR1	Timer 1 reload register	32	Unsigned	Register values in case of a CPU-Exception, RTOS_ResFail, SW_Fail. Undefined otherwise.
TIMCTR1	Timer 1 control register	32	Unsigned	
WDG	Watchdog register	32	Unsigned	
TIMR2	Timer 2 reload register	32	Unsigned	
TIMCTR2	Timer 2 control register	32	Unsigned	
SCAC	Prescaler counter register	32	Unsigned	
SCAR	Prescaler reload register	32	Unsigned	
				Uart Registers
UAC1	UART 1 control register	32	Unsigned	These values have no meaning for Sentinel. Undefined.
UASCA1	UART 1 scaler register	32	Unsigned	
UAC2	UART 2 control register	32	Unsigned	
UASCA2	UART 2 scaler register	32	Unsigned	
				GPIO Registers
IODAT	I/O port data register	32	Unsigned	Register values in case of a CPU-Exception, RTOS_ResFail, SW_Fail. Undefined otherwise.
IODIR	I/O port direction register	32	Unsigned	
IOIT	I/O port interrupt register	32	Unsigned	
Offset 0x4b4				**Error Context**
RTOS_PAR1...4	RTOS internal parameter	32*4	Unsigned	RTOS may store internal status in the case of RTOS error, zero otherwise
APP_DATA	Application data	32*64	Unsigned	Application supplied data (reserved)
Offset 0x5c4				**Event Data**
EVENT_HDR	Error Event Header	32*4	Unsigned	Error / Anomaly Report Medium Severity causing the restart of the GPSR, generic
CPU_Exception	CPU Exception Event	32*34	Unsigned	Holds event information (i.e. register values etc) in case of a CPU Exception
RTOS_ResFail	RTOS Resource Failure Event	32*10	Unsigned	Event information for RTOS Failures
SW_Failure	SW Failure Event	32*8	Unsigned	Event information for SW Failures
WD_Expired	WD Expiration Event	32*4	Unsigned	Header for Watchdog Expiration Events
EVENT FIELD	Reserved	16*70	Unsigned	Not used

Table 0-1 – Post Mortem Report Data Definition

ANNEX A – CODES FOR SOFTWARE WARNINGS AND SOFTWARE FAILURES

This annex gives details for software warnings and software failures reported by the GPSR.

The following table provides a cross-reference list between Execution ID and Execution Instance Name:

EXEC_ID	Execution Instance Name
1	EXEC_ID__ECOM_IRQ_04
2	EXEC_ID__GNSISR_IRQ_07_10
3	EXEC_ID__ATEX_IRQ_06
4	EXEC_ID__ATEX_IRQ_05
5	EXEC_ID__GNSISR_IRQ_02
6	EXEC_ID__INIT
7	EXEC_ID__TMBIF
8	EXEC_ID__AID
9	EXEC_ID__MEM_HIGH
10	EXEC_ID__NOISPR
11	EXEC_ID__MEASPR
12	EXEC_ID__HK
13	EXEC_ID__PCKT_TX
14	EXEC_ID__PCKT_RX
15	EXEC_ID__PCKTASM
16	EXEC_ID__MODHDL
17	EXEC_ID__TCMD
18	EXEC_ID__PARHDL
19	EXEC_ID__MEM
20	EXEC_ID__NAVDIP
21	EXEC_ID__SVMPR
22	EXEC_ID__ATPREP
23	EXEC_ID__MEM_LOW
24	EXEC_ID__WD
25	EXEC_ID__IDLE

Table Annex A-1 – Execution IDs

The following table provides a cross-reference list between Module ID and Module Name:

MOD_ID	Module Name
0	AGC
1	AID
2	ATEX
3	ATPAR
4	ATPREP
5	BOOT
6	BTCHKHW
7	BTTRAP
8	CCSDS
9	CHNDB
10	COM
11	CONST
12	CPUHAL
13	CRC
14	DMABUF
15	EVT
16	FILTER
17	GNSISR
18	GNSISR_ASM

MOD_ID	Module Name
19	GNSS
20	HK
21	HKDB
22	IDLE
23	INIT
24	IRQ2_3
25	IRQ710
26	KALMAN
27	MATRIX
28	MEASPR
29	MODHDL
30	MEM
31	NAVDIP
32	NOISPR
33	PARDB
34	PARHDL
35	PCKT
36	PCKTASM
37	PMREP
38	RANGE
39	RCPVT
40	REGWIN
41	RTEMS
42	SIGDB
43	SIGHAL
44	STINIT
45	STMAIN
46	SVMPR
47	SVSDB
48	SVSEL
49	TCMD
50	THRESH
51	TIMEDB
52	TMBIF
53	TMPROC
54	TRAP
55	WD
56	WCET
57	OPMAIN
58	MSCR
59	DB
60	FORCE

Table Annex A-2 – Module IDs

The following table holds the meaning of the parameters PAR1 to PAR8 in depencence of the value of the parameter ERR_CODE used by Software Warning and Software Failure Events.

Column 3 denotes what the ERR_CODE is used for:

- INFO: the GPSR has handled an unsual situation but operates normally. This event is sent as TM(5,2) Software Warning.

- WARNING: the GPSR detected an anomaly that should be brought to the attention of RUAG, but could continue operation. This event is sent as TM(5,2) Software Warning.

- FAILURE: the GPSR cannot continue its operation. This event is sent as TM(5,3) Software Failure.

- FAILURE/W: the code is used for failures and warnings; the severity (failure/warning) depends on the use of the data that was detected to be corrupt. I.e this event is in the case of recoverable anomaly sent as TM(5,2) Software Warning and in unrecoverable cases as TM(5,3) Software Failure.

Details on different SW warning categories can be found in Appendix B of [UML].

ERR_CODE	Error Name	Warning Level	Event Code Meaning	PAR	Parameter Meaning
0	EVENT_CODE__RTOS_ERROR	FAILURE	Major data or software corruption.		
1	EVENT_CODE__ILLEGAL_PARAM	FAILURE/W	Illegal parameter detected at function call or task invocation		
2	EVENT_CODE__IDX_BOUNDS	FAILURE/W	Index exceeded the given boundaries		
3	EVENT_CODE__ENTRY_NOT_FOUND	FAILURE	Major data or software corruption.		
4	EVENT_CODE__ILLEGAL_TYPE	FAILURE	Major data or software corruption.		
5	EVENT_CODE__SPI_QUEUE_OVERRUN	FAILURE	Major data or software corruption.	1	SPI writer queue entry
6	EVENT_CODE__INVALID_DEFAULT_BRANCH	FAILURE/W	Switch statement execution ended up in the default branch which should never be executed	1	Branch number
7	EVENT_CODE__WCET_VIOLATION	FAILURE/W	Measured task execution time exceeded the given limit	1	Execution ID
				2	Tic count
8	EVENT_CODE__EPC_SETTING_EXCEEDED	WARNING	Calculated EpochClock divider setting exceeded min or max boundaries for slope limit	1	previous EPC frequency [1e-6Hz]
				2	new EPC frequency [1e-6Hz] before limiter
9	EVENT_CODE__AID_POLY_FIT_FAIL	WARNING	Preparation of AID polynomial fitting failed	1	dDelta_t1 [ns]
				2	dDelta_t2 [ns]
10	EVENT_CODE__CLK_CORR_ON_ALM	WARNING	Clock correction was based on almanacs	1	SV_ID
				2	GPST seconds
11	Not used	-	-	-	-
12	EVENT_CODE__ATEX_INVALID_STATE	FAILURE	Major data or software corruption.		
13	EVENT_CODE__RANGE_NO_VALID_CARR_PH_REC	WARNING	RANGE detects that there is no valid carrier phase record for a given SV/MFC although it was validated before	1	SV_ID
				2	SFC
14	EVENT_CODE__SVSEL_ACTIVITY_CONFLICT_ON_MFC	WARNING	SVSEL detects that there is already activity on an MFC to be scheduled	1	SV_ID
				2	MFC
15	EVENT_CODE__FIRST_FIX	INFO	First fix was achieved, also: GDOP is back in the limit	1	GDOP Actual (float)
				2	GDOP Limit (float)
				3	The first 4 IDs of contributing SV
				4	The last 4 IDs of contributing SV
				5	IMT when GPSR started first fix build-up [s]
				6	IMT when first fix was achieved [s]
				7	Time to build-up a first fix [s]
16	EVENT_CODE__ATTITUDE_EXCEEDED	WARNING	Current attitude values exceeded the thresholds	1	Actual attitude in X
				2	Actual attitude in Y
				3	Actual attitude in Z
				4	Attitude threshold in X
				5	Attitude threshold in Y

ERR_CODE	Error Name	Warning Level	Event Code Meaning	PAR	Parameter Meaning
				6	Attitude threshold in Z
17	EVENT_CODE__NAV_DATA_PARITY_ERROR	INFO	Parity error in navigation data stream detected	1	SV_ID
				2	Parity failure count
18	EVENT_CODE__OUTDATED_NAV_DATA_OBJECT	INFO	Navigation data object validity period expired	1	Navigation data object type
				2	Navigation data object index
19	EVENT_CODE__CODE_CHIP_COUNTER_SYNCHRONISED	INFO	Code chip counter initialised based on the TOW	1	SFC
				2	SV_ID
				3	New Code chip counter MSB
				4	New Code chip counter LSB
				5	Ambiguity resolution CCC
				6	Signed offset in [chips]
20	EVENT_CODE__BIT_EDGE_NOT_FOUND_IN_TIME	WARNING	Carrier loop likely locked at +/-500Hz offset	1	SV_ID
				2	SFC
21	EVENT_CODE__GOT_STUCK_IN_IDLE_LOOP	FAILURE	Major data or software corruption.		
22	EVENT_CODE__INVALID_CODE_CHIP_COUNTER	WARNING	The PreIntegration code chip counter was not an integer multiple of the C/A code sequence	1	SFC
				2	SV_ID
				3	PreIntegration CCC MSB (double)
				4	PreIntegration CCC LSB (double)
				5	Ambiguity resolution CCC
				6	Chips per 2 IEs
				7	Number of symbols (NAVDIP) or 0
				8	NavData symbols (NAVDIP) or 0 NavData carry symbols (NAVDIP) or 0
23	EVENT_CODE__DMA_SAMPLE_IMT_VIOLATION	WARNING	The delta IMT between two subsequent IE samples was not in the expected range	1	SFC
				2	SV_ID
				3	Tracking State
				4	Delta IMT lower limit
				5	Delta IMT upper limit
				6	Delta IMT actual
				7	1st IE IMT (LSBs)
				8	2nd IE IMT (LSBs)
24	EVENT_CODE__DMA_SAMPLE_CCC_VIOLATION	WARNING	The code chip count between two subsequent IE samples was not in the expected range	1	SFC
				2	SV_ID
				3	Tracking State
				4	Signal Type
				5	Delta CCC expected

ERR_CODE	Error Name	Warning Level	Event Code Meaning	PAR	Parameter Meaning
				6	Delta CCC actual
				7	1st IE CCC (LSBs)
				8	2nd IE CCC (LSBs)
25	EVENT_CODE__UNEXPECTED_LOOP_ACTIVITY	WARNING	In the frame of executing a start command it was detected that there was still activity on the SFC	1	SFC
				2	SV_ID
				3	Tracking State
				4	Signal Type
				5	Stop flag of the SFC
				6	Start (= stop acknowledge) flag
26	EVENT_CODE__RCPVT_GDOP_EXCEEDS_LIMIT	WARNING	The GDOP is above the limit, PVT is therefore not updated, the propagated one is used and provided	1	GDOP Actual (float)
				2	GDOP Limit (float)
				3	The first 4 IDs of contributing SV
				4	The last 4 IDs of contributing SV
27	EVENT_CODE__CA_TRACKING_FALLBACK	WARNING	A C/A tracking fallback from final tracking occured	1	SFC
				2	SV_ID
28	EVENT_CODE__DF_CHECK_CONTINUOUSLY_FAILED	WARNING	Plausibility check between L1 and L2 delta range or between L1 C/A and L1 P or L2 P failed	1	SV_ID
				2	MFC
29	EVENT_CODE__INT_OVER_SYMBOL_EDGE	INFO	Coherent integration over symbol edges occured due to a code chip counter synchronisation error	1	SFC
				2	SV_ID
				3	Tracking State
				4	Signal Type
				5	Level inversions checked
				6	Integration errors detected
				7	Integration errors at sync offset
				8	Synchronisation offset
30	EVENT_CODE__TASK_STACK_MARGIN_LOW	WARNING	The run-time task stack check has detected that the expected margin is no longer given. Note: This does not mean that the stack of the task with next lower or next higher priority is already corrupted (in such a case the SW would stop on a medium severity event).	1	Task name
				2	Task ID
				3	Initial task stack size
				4	Remaining unused bytes on the stack
				5	Actual margin limit
31	EVENT_CODE__IE_IMT_ERROR	WARNING	IE IMT calculation was wrong	1	SFC
				2	SV_ID
				3	PreIntegration CCC MSB (double)
				4	PreIntegration CCC LSB (double)
				5	Ambiguity resolution CCC
				6	Chips per IE

ERR_CODE	Error Name	Warning Level	Event Code Meaning	PAR	Parameter Meaning
				7	Ambiguity resolution IMT
				8	ME IMT
32	EVENT_CODE__UNHEALTHY_SV	INFO	In the ephemeris data either - Navigation data are marked unhealthy - Signals are marked unhealthy - The alert flag is set. Therefore tracking of the SV is stopped.	1	SV_ID
				2	MFC
33	EVENT_CODE__EPH_ALM_PLAUS_CHECK_FAILED	WARNING	Plausibility check between ephemeris based and almanac based position vectors failed.	1	SV_ID
				2	MFC
34	EVENT_CODE__COLD_ACQ_P_Y_TIMEOUT	WARNING	P(Y) code could not be acquired in time after a cold acquisition of C/A code. This is a strong indication for cross correlation peak tracking.	1	SV_ID
				2	MFC
35	EVENT_CODE__MFC_START_COMMAND_INVALID	WARNING	MFC start command issued by the SV selection contained at least one invalid parameter.	1a	CONS
				1b	SV_ID
				1c	Tracking scheme
				1d	Antenna
				2a	SFC
				3	Initial Code Phase MSB (double)
				4	Initial Code Phase LSB (double)
				5	Code search window (float)
				6	Frequency search window (float)
				7	MFC allocation MFC0 .. MFC3
				8	MFC allocation MFC4 .. MFC7

Table Annex A-3 – Event Codes and Parameter Meaning