

	DIFFUSION LIMITEE DORIS 	Reference : CO-SP-D14-IE-15203-CN
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External ref : D3X-SP-1300-026/TAS / C2-RS-TAS-ED-0003 / TASFR00312414		

DORIS

DORIS EGSE REQUIREMENTS FOR INSTRUMENT LEVEL TESTS (DERIL)

Prepared by :

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Date and Signature

19/09/2018

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Date and Signature

19/09/2018

Project	DS2	TP	DS4	DPP	DJ1	DS5	DH2	DJ2	DCY2	D3S	DOA	DHY2	DOR
Concerned													X
Models	EGSE LINUX Issue Only												

DORIS project internal management :			
Applicable configuration :	OUI	Controlled by : CCM DORIS	Since : 13/7/2004.
Applicated configuration :	OUI		

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CONTROL ELEMENT

Confidentiality : YES	Type : limited to distribution list
Keywords : EGSE, LINUX	
Software : Word	Supplementary pages :
Summary :	

DOCUMENT CHANGE RECORD

The modifications between issues are listed below.

Issue	Date	Modifications
Ind 0	13 / 07 / 2004	Creation of the document, preliminary version (derived from Cryosat1 version)
Ind A	09 / 03 / 2006	Update after review by CNES, DACTEM and THALES (see minute TASFR00394645-)
Ind B	10 / 10 / 2006	Implementation of CRYOSAT2 requirements and DGXX corrections
1.0	29/06/2007	Issue managed and referenced by CNES as per TSA/DAC/CNES review (MoM : DCY2-CR-D14-EA-16033-CN). Derived from Thales doc old ref: D3X-SP-1300-026/TAS Ind B_draft / C2-RS-TAS-ED-0003 Iss. 1.0_draft / TASFR00312414 -B_draft ; CNES CONTRACT N° 04/1471/00 ; ASTRIUM CONTRACT N° TBD Issue introduced by DCR : 430rev2
1.1	10/09/2007	Issue as per CCM 162 (06/07/2007): - including remarks from Dactem and TSA - including DM 454 : virtual printer This issue also includes the update of R95 requirements as per Dactem action taken in CCM 162. Rectification of reference: CO-SP-D14-IE-15203-CN (CN and not ESD)
1.2	19/03/2009	Issue as per CCM 179 (12/05/2009) including DM529
1.3	12/11/2009	Issue as per CCM 184 (10/11/2009) including DM542 and 544

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1.3+D M CO- DM- D14- 559- CN	17/11/2009	Issue as per DM CO-DM-D14-EA-559-CN Introduction of Sentinel3 A&B and Jason3 : - update of the applicable and reference documents list - update of the distribution list Correction of residual errors : - Addition of missing references to HY2 Ads - Deletion of obsolete requirements R59 and R263 both covered by R264 and update of the requirements list
1.4	11/03/2010	Issue as per CCM 187, including DM559
1.5	12/10/2010	Issue as per CCM 192, including DM CO-FT-2596 : *Specification of plots w.r.t. TAI date to start from the first significant TAI date (>1/1/2000) unless otherwise required in all paragraph *Clarification of R213 as per CNES action FA2522 pt1 of MoM CO-CR-D14-EA-16421-CN. *Evolution of orbit number processing as per CNES action FA2522 pt3a of MoM CO-CR-D14-EA-16421-CN. *Evolution of R212 : • change of automatic scale to fixed scale in date increment plotting as expected value is always 1s • addition of min/max processing for date increment as it was currently performed, interesting and not specified. Addition of the associated sanction w.r.t. a given threshold. • Evolution of integrity processing to make it consistent with current processing • Addition of out of range processing for datation error *Reorganisation of datation packet availability checking requirement which was previously badly inserted in datation packets analysis; creation of a specific requirement R 212bis for this purpose; change of automatic scale to fixed scale in plotting number of packets between 2pulses as expected value is always 1. *Addition of a distance processing in ITRF and J2000 Navigation analysis *10 first Time correction reports replaced by 3 first Time correction reports in R259 *Wording consistency
1.6	22/04/2011	Issue as per CCM of 08/03/2011 including DM2622 : TC AUM and Event_Id 5 deleted ; update of the TC_EUP format for the upload of the ZQS DORIS, ZQS DIODE, ZQS System : update of the § TMD5 requirements

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1.7	09/10/2012	DM 2737 Duration of TMD1 is expressed in number of seconds in R110 DM2738 Clarification of R-260 and applicability of this requirement to Sentinel3. The required verification shall be consistent with on board time management as per TMTC Packet Definition document. DM2739 Cancellation of TDI-SI bias file pop-up in $\Delta T3$ variance processing DM2740 Addition of 3D plot in R213 DM 2741 Limits of acceptable level in TMD3 (R 204) DM 2742 Initialization sequence of TMD4 : waiting for first status word in R210 DM 2690 rev1 TMD5 DGXX-S consistent with EGSE DGXX-S software group v1.0.7 DM 2743 TMD5 DGXX consistent with EGSE DGXX-S software group v4.2.22 DM 2744 Some clarifications and corrections of residual typos (particularly the printer related requirements have been replaced by recorded retrievable file as printer is no more commonly used). Since this issue, it is agreed that requirements 169, 188, 189, 208, 209, 228, 236, 237, 238, 239 are unused. Requirement R-262 in § 7.5.2 is renamed R-266 (doublet). AD22 suppressed (idem than AD9); AD23 is added.
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1.8	13/01/2015	DM 2966 : Prise en compte des évolutions concernant les Requirments « DISS Interface » DM2967 : Prise en compte des évolutions concernant les Tests Requirments DM2968 : Prise en compte des évolutions concernant les REQUIREMENTS SPECIFIQUES au DTP DM2969 : Prise en compte des évolutions concernant les autres requirements EGSE et les livrables DM 2971 Reformatage des Requirements 110_8 et 110_9. DM 2972 Correction de l'organigramme TMD5 (Req 132_2) DM 2973 Corrections cosmétiques des Requirements 117 et 118 DM 2974 Prise en compte du FT2512(FA sur bit VM) et FT2681 (FA sur simulation BM).
2.0	10/11/2015	DM 2710 : Changes in IT3 computation time transit in TMD6 Report DM2711 : redesign of TMD6 Report. DM3073 : New AD concerning DSW DST3C&D and DJCS1&2 Missions. This release is the first one applicable only with EGSE LINUX. AD8 deleted and annex insertion for replacement on 1553 chronogram (Proteus)
2.1	18/09/2018	DM 3210 : Corrections cosmétiques et modifications techniques DM 3211 : Introduction et suppression de Req

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APPLICABLE AND REFERENCE DOCUMENTS

The contents of applicable documents, in their common edition, have to be applied as a supplement to the text of the present document. If an applicable document, listed in the table below, is not called in the text of the present document with detailed application condition, he can be considered to be a reference document for supplementary benefit of information and, because of that, not mandatorily applicable.

Reference	Document title
CO-SP-D1-EA-15704-CN	AD1. SPECIFICATION TECHNIQUE DE BESOIN DE L'INSTRUMENT DORIS DGXXS
CO-SP-D0-EA-14861-CN	AD2. DELETED
CO-IF-D1/B-EA-10823-CN	AD3. INTERFACE SPECIFICATIONS BETWEEN DORIS NETWORK BEACONS AND THE ONBOARD INSTRUMENTS
TASFR00726465	AD4. SRS DE TEST LV DGXX-S
- CNES / Draft 00	AD5. DELETED
TP3-ASO-SP-0033	AD6. DELETED
PLHR.SP.234.T.ASTR	AD7. DELETED
D3S-IF-D1-EA-11705-CN	AD8. DELETED
CO-CI-D1-EA-15055-ESD rev G (D3X-CI-1000-001/TAS)	AD9. DELETED
CO-IF-D1-EA-16629-CN	AD10. FORMAT DU FICHIER DU MONITEUR DIODE EN GENERATION DGXX-S
DCY2-DF-O-EA-12814-CN	AD11. DELETED
CS-ID-DOR-SY-0005	AD12. DELETED
C2-RS-DOR-DR-0001	AD13. DELETED
C2-ID-TAS-DR-0002	AD14. DELETED
DHY2-DF-0-EA-15949-CN	AD15. DELETED
DHY2-IF-THA-008	AD16. DELETED
MIL-STD-1553B Notice 3 31-01-93	AD17. DIGITAL TIME DIVISION COMMAND / RESPONSE MULTIPLEX DATA BUS
DHY2-ID-THA-002	AD18. DELETED
CO-SP-D0-EA-16222-CN	AD19. DEFINITION OF DORIS TM PACKETS AND TC FORMATS
DST3-SP-051-EA-16221-CN	AD20. DATA COMMUNICATION PROTOCOLE FOR DORIS SENTINEL3
S3-ID-TAF-SY-10593	AD21. SENTINEL-3 C/D SATELLITE TO DORIS INTERFACE CONTROL DOCUMENT / REF.IF-8 - DORIS
CO-CI-D1-EA-15055-ESD rev G	AD22. DELETED
DXS-ID-1000-0001-TSA ind D	AD23. INTERFACE CONTROL DOCUMENT (ICD) FOR DORIS DGXX-S
DSW-SP-D0-EA-16807-CN	AD24. DEFINITION TM PACKETS AND TC FORMATS
DJCS-SP-0-EA-16710-CN	AD25. DEFINITION TM PACKETS AND TC FORMATS
CO-IF-D1/B-EA-16314-CN	AD26. DORIS BROADCAST UPLOADS DEFINITION
SWOT-TAS-F-IR-106	AD27. IRD SWOT
JC.RS.ASG.DR.00006	AD28. DORIS INSTRUMENT SPECIFICATION

TBC AND TBD LIST

TBC/TBD	Section	Brief description
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TBC		None
TBD		None

ABREVIATIONS

Sigle	Definition
AD	Applicable Document
ASR	Analyse Spectrale Rapide
BDR	Boîtier DORIS Redondé
CAG	Contrôle Automatique de Gain = AGC
CDMU	Control and Data Management Unit
CRT	Cathode Ray Tube
CW	Continuous Wave
DBL	Digital Bi-Level (logical status – 2 bits)
DBS	DORIS Beacon Simulator
DERIL	DORIS EGSE Requirements for Instrument Level tests
DISS	DORIS Interfaces Satellite Simulator
DORIS	Détermination d'Orbite et Radio positionnement Intégré par Satellite
DSPF	DORIS Standard Parameters File
DTP	DORIS Telemetry Processor
EEPROM	Electrically Erasable PROM (designated as MNVR in some documents)
EGSE	Electrical Ground Support Equipment
EMC	Electro Magnetic Compatibility
FFT	Fast Fourier Transform
HMI	Human/Machine Interface
ITRF	Coordinate reference frame
J2000	Coordinate reference frame
LCD	Liquid Crystal Display
MST	Mise Sous Tension = Switch On
CHAIN1	DORIS receiver and processing unit 1
CHAIN2	DORIS receiver and processing unit 2
PPS	Pulse Per Second
RD	Reference Document
RFC	Radio Frequency compatibility
RPTD	Report Packet TAI Date
S	S band, designates the 2036.25 MHz DORIS band
S/C	Space Craft
SADL	Standard Acceptance Data Log
SI	reference pulse of the 10s beacon sequence
TAI	International Atomic Time
TAS	THALES AIRBORNE SYSTEMS
TBC	To Be Confirmed

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TBD	To Be Defined
TC	Telecommand
TCH	Téléchargement = Uploading
TDDP	TAI Date Datation Packet
TDI	Reference pulse of the BDR CHAIN1 or CHAIN2 internal 10s sequence
TEB	Taux d'erreur de bit = Bit error rate
TM	TeleMetry
TMA	Analog TeleMetry
TMD	Test Module
TSD	TS(I) Départ
TSF	TS(I) Final
TSQ	Sequence Automatique
UHF	UHF band, designates the 401.25 MHz DORIS band
USO	Ultra Stable Oscillator
UT	Unité de Traitement = Processing Unit
VSWR	Voltage Stationary Wave Ratio

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1. PURPOSE

CNES has awarded a contract to DACTEM related to the development of a new generation modular DORIS EGSE suitable for all DORIS instrument tests from admittance tests at the THALES level through performance and functional tests at the satellite level.

The purpose of this specific DORIS EGSE Requirements for instrument level tests (DERIL) is to define all requirements applicable to the DORIS EGSE related to the tests of DORIS at the instrument level before delivery.

2. APPLICATION DOMAIN

The DERIL covers the following units and tests requirements:

- BDR: acceptance and qualification tests, software qualification tests, verification tests
- BDR: EMC/RFC tests

The DERIL addresses the following technical items:

- requirements related to the interfaces to DORIS units on the EGSE side
- hardware functional requirements
- software operational requirements

This version of the document is applicable for the tests of the all the DORIS DGXX and DGXX-S instruments.

This document is written by CNES with the support of T-DMS France and Dactem. It is submitted to CNES, T-DMS France and DACTEM for approval and application.

Documents identified as “AD” or “RD” here in are under separate configuration control.

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3. DERIL GENERAL INFORMATION

3.1 DERIL STATUS

This version is coherent with DORIS DGXX and DGXX-S current on-board software.

Changes to this document are only valid after they have successfully passed through the approval process.

3.2 APPROVAL PROCESS

The DERIL shall be approved by THALES, CNES and DACTEM.

The signature on cover page indicates the approval of this document by THALES, CNES and DACTEM.

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4. DORIS AND EGSE GENERAL INFORMATION

The discussion presented in chapter 4.2 is for information only and has not to be considered applicable to the DORIS EGSE.

4.1 DORIS INFORMATION

The documentation listed in the ‘APPLICABLE AND REFERENCE DOCUMENTS’ table shall be applicable to the DORIS EGSE depending on the satellite to be simulated according to the table here below:

Title : DORIS EGSE REQUIREMENTS FOR INSTRUMENT LEVEL TESTS (DERIL)

Satellite simulated	ST3C	ST3D	DSW	DJCS-1 (ST6A)	DJCS-2 (ST6B)
Applicable Document					
AD1	YES	YES	YES	YES	YES
AD2	DELETED				
AD3	YES	YES	YES	YES	YES
AD4	YES	YES	YES	YES	YES
AD5	DELETED				
AD6	DELETED				
AD7	DELETED				
AD8	DELETED(1)				
AD9	DELETED				
AD10	YES	YES	YES	YES	YES
AD11	DELETED				
AD12	DELETED				
AD13	DELETED				
AD14	DELETED				
AD15	DELETED				
AD16	DELETED				
AD17	YES	YES	YES	YES	YES
AD18	DELETED				
AD19	YES	YES	NO	NO	NO
AD20	YES	YES	YES	YES	YES
AD21	YES	YES	NO	NO	NO
AD22	DELETED				
AD23	YES	YES	YES	YES	YES
AD24	NO	NO	YES	NO	NO
AD25	NO	NO	NO	YES	YES
AD26	YES	YES	YES	YES	YES
AD27	NO	NO	YES	NO	NO
AD28	NO	NO	NO	YES	YES

Table 4-1 Applicable documents table

Note 1 : concerns 1553 chronogram only (Proteus) AD 8 deleted and annex insertion for replacement.

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4.1.1 DORIS Instrument configuration

See AD9 and AD14 and AD18, AD21 *and* AD23 according to **Table 4-1**.

4.1.2 Interfaces characteristics

The DORIS EGSE incorporates electrical interfaces with one BDR including two chains (chain 1 and chain 2). Test of both chains is done by swap of the test harness.

No mechanical or thermal interfaces with DORIS units are required.

All electrical interfaces characteristics of the DORIS units are defined in AD9, AD14, AD18, AD21 *and* AD23 according to the Table 4.1.

DORIS TM/TC interfaces specific characteristics are defined in AD2 or AD11 or AD15 or AD19 depending on the mission, according to the Table 4.1.

4.1.3 Functional characteristics

DORIS functional characteristics are defined in different user manual depending on the mission.

4.2 DORIS EGSE INFORMATION

The DORIS EGSE is usable at all stages of DORIS tests.

It is constituted of three independent but interconnected units:

- DORIS Beacon Simulator (DBS):
 - allows static or dynamic simulation of a beacon signal received at the satellite level,
 - up to 2 simultaneous beacons or 1 beacon + 1 spurious signal,
 - simulation of RF level and Doppler shift taking into account satellite ephemerides (batch or real time processing),
 - provides direct RF interfaces to the BDR or through the DORIS Antenna.

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– DORIS Interfaces Satellite Simulator (DISS):

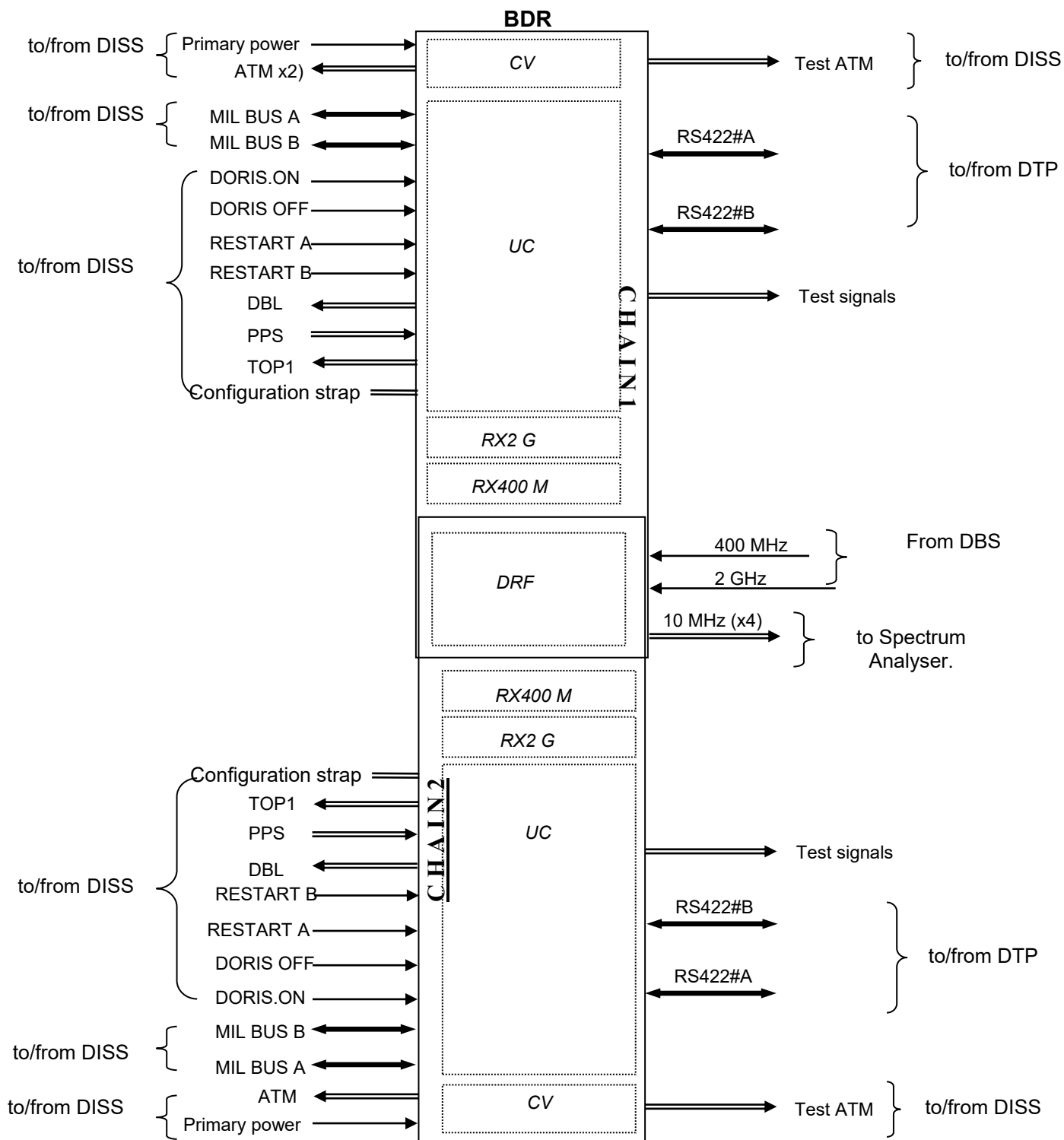
- provides all electrical Interfaces to BDR,
- manages low level commands and telecommands formatting and transmission,
- manage low level telemetry acquisition,
- manages test modules automatic execution,
- manages primitives manual execution,
- manages DORIS monitoring and safety procedures,
- DBS and DTP remote control,
- records in log files actions, anomalies and data as defined in the subsequent paragraphs.

– DORIS Telemetry Processor (DTP):

- high level DORIS telemetry processing,
- DORIS performances statistical analysis,
- DORIS performances control,
- DORIS internal parameters control,
- acceptance logbook edition,
- DORIS TM/TC interface through RS 422 #A link.

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General interfaces between DORIS and EGSE



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5. DBS REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS

R 1 The DBS shall be able to provide RF signals coming from up to two simultaneous DORIS beacons from 4.0 version.

R 2 The DBS shall be able to be configured under manual control, in order to deliver permanent CW beacon signals with constant frequency and level.

R 3 The DBS shall be able to be configured under DISS control in order to deliver permanent modulated beacon signals with constant frequency and level (static mode).

R 4 The DBS shall be able to be configured in order to deliver simulated RF signals received by a DORIS BDR in orbit (dynamic mode with simulation of Doppler shift and level variation).

Note: the requirement is limited to the simulation of two simultaneous DORIS beacons. No spurious simulation is required.

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R 5 Deleted.

R 6 In dynamic mode, the DBS shall be able to process an input file defining every 10 s the ephemerides of the satellite and an input file defining the position of the DORIS beacons (ephemerid mode).

R 7 In static mode, the DBS shall be able to maintain a continuous emission for at least 72 hours.

R 8 In dynamic mode, the DBS shall be able to maintain a continuous emission for at least 72 hours.

R 9 The DBS shall be able to shut off its RF emission (off mode).

R 10 In dynamic mode, the start of the DBS emission shall be driven by the DISS.

R 11 The DBS shall provide a test output of one of its internal USO references.

R 12 The SI time reference of the beacons shall be accessible for test purpose.

Note: from the DBS or from the DISS.

5.2 RF SIGNALS REQUIREMENTS

5.2.1 Software requirements

R 262 Random lockout shall not appear when DBS unit is manually programmed by DISS unit

5.2.2 RF level requirements

All RF level requirements applies with the EGSE connected to a 50 ohm load with a VSWR better than 1.05.

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R 13 The reference impedance of the RF outputs shall be 50 ohm.

R 14 The VSWR of the RF outputs shall be less than 1.2 in static and dynamic modes.

R 15 Each RF signal level shall be programmable by step of 1 dB within an instantaneous range of 50 dB for the 2GHz band and 400MHz band output port.

Note: up to 4 RF signals programmable independently

R 16 The maximum level of the instantaneous range shall be adjustable by step of 10 dB in the range [-90 dBm, -40 dBm].

Note: the adjustment may be hand driven

R 17 By design, the RF level shall be limited in any circumstances to -24 dBm.

Note: this include single failure of the EGSE

R 18 Within a delay of 30 days after calibration, the absolute precision of the RF levels delivered by the EGSE in static mode shall be better than:

± 3 dBm in the [-140 dBm, -125 dBm] range

± 2 dBm in the [-125 dBm, -90 dBm] range

R 19 In dynamic modes, the EGSE shall modify the RF levels only during the time window [SI - 700 ms, SI - 500 ms] where SI is the time reference of the 10s sequence of the beacons.

R 20 In all modes, the noise spectral density of the RF output ports shall be less than -150 dBc/Hz inside the DORIS bands.

R 21 In Off mode, the RF output level shall be less than -150 dBm on 2GHz band and 400MHz band ports.

R 22 The EGSE shall be able to drive the BDR inputs with no alteration of the RF output signals, excepted RF level modification due to the VSWR of the BDR inputs.

Note: See AD9, AD14, AD18 and AD23 according to Table 4-1 for the BDR RF input interface definition.

The BDR CHAIN1 or CHAIN2 unit delivers on its 2GHz band RF inputs a CW spurious signal: ≈ -110 dBm @ 2036.25 MHz (407.25 x USO frequency).

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5.2.3 RF frequency requirements

R 23 Deleted.

R 24 In static mode, the RF 2GHz band frequencies shall be programmable in the range $[407,25 F_{USO} \pm 100 \text{ kHz}]$ with a resolution better than 1 Hz.

R 25 In static mode, the RF 400MHz band frequencies of a spurious shall be programmable in the range $[80,25 F_{USO} \pm 20 \text{ kHz}]$ with a resolution better than 1 Hz.

Note: F_{USO} is the USO frequency and is nominally 5 MHz.

R 26 In static mode, the RF 2GHz band and 400MHz band frequencies (resp. F2 and F1) of a same beacon shall be programmable independently.

Note: $F2/F1 = 543 / 107$ nominally.

R 27 In static mode, the short-term relative stability of the RF signals must be better than $5 \cdot 10^{-13}$ for an integration time of 10 s (Picinbono variance computed over 30 measurements).

R 28 In dynamic modes, the bias between the target frequency and the delivered RF frequency every 10 seconds, must be less than:

- 5 mHz in 2GHz band for integration times of 7 and 10 s
- 25 mHz in 400MHz band for integration times of 7 and 10 s

R 29 Deleted.

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5.3 TEST OUTPUTS REQUIREMENTS

R 30 Deleted.

R 31 The USO output used as a test output shall be routed directly to a BNC connector.

R 32 The jitter of the SI test output shall be less than 100 ns (3 sigma).

R 33 The requirements applicable to the SI test output interface are the following:

- Output level: $\geq 1V$ peek to peek
- Rise, fall and transit times $\leq 1 \mu s$ with a 1 Mohm//50 pF load
- Protected against short circuits to ground

5.4 CALIBRATION REQUIREMENTS

R 34 The DBS shall provide a calibration process of the RF signal levels.

The calibration process is used for RF level verification, compensation of loss uncertainties and drifts of electronic circuits.

R 35 The calibration process shall use EGSE internal measurement means or standard external means provided by the user (spectrum analyser or power meter).

Note: an internal high sensitivity power meter is recommended;

in case of external standard means, remote controlled measurements shall not be implemented in order to avoid compatibility issues.

R 36 The full calibration process shall take less than 15 minutes to complete.

Note: full automatic process is not required.

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R 37 After calibration, a printable calibration report shall be stored on the hard disk of the DBS for archiving.

R 38 The DBS shall use the compensation parameters determined during the last calibration.

R 39 The DBS shall be able to take into account two different (main or additional) attenuation or gain values defined by the user.

Example: the user calibrates the EGSE including RF external cables, and then implements the antenna test cap. The user enters the cap coupling loss into the EGSE parameters in order to compensate automatically for the loss.

5.5 DISPLAY REQUIREMENTS

R 40 Deleted.

R 41 The DBS shall display permanently on a LCD or CRT monitor the following information:

- active mode,
- modulation activity,
- information processed from the input files in dynamic mode.
 - Current simulated scenario file line
 - Current simulated beacon number

R 42 The required information displayed by the DBS shall be refreshed every 10 seconds.

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6. DISS INTERFACE REQUIREMENTS

6.1 INTRODUCTION

This chapter defines the requirements related to the following DISS functions:

- electrical Interfaces to BDR (excepted RF interfaces),
- low level commands and telecommands formatting and transmission,
- low level telemetry acquisition.

The requirements related to Test Management by the DISS are addressed in the chapter 7 : “Tests requirements”.

6.2 FUNCTIONAL REQUIREMENTS

R 43 The DISS shall implement an emulation of all Sentinel3, Jason3, SWOT or Jason-CS electrical interfaces as defined in the table 5.2-1 below :

Electrical Interface	Signal Name	Source	Target	Number of I/F per BDR
Command, Control, Status & HK	MIL BUS A and B	DISS	BDR CHAIN1	2
			BDR CHAIN2	2
DBL interface	STATUS.POWER	BDR CHAIN1	DISS	3
	STATUS.UC (x2)	BDR CHAIN2		3
DORIS ON command	DORIS.ON	DISS	BDR CHAIN1	1
			BDR CHAIN2	1
DORIS OFF command	DORIS.OFF	DISS	BDR CHAIN1	1
			BDR CHAIN2	1
1Hz synchronization signal	PPS	DISS	BDR CHAIN1	2
			BDR CHAIN2	2
1Hz pulse signal	TOP1	BDR CHAIN1	not used	2
		BDR CHAIN2		2
RESTART A Command	RESTART.A	DISS	BDR CHAIN1	1

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Electrical Interface	Signal Name	Source	Target	Number of I/F per BDR
			BDR CHAIN2	1
RESTART B Command	RESTART.B	DISS	BDR CHAIN1	1
			BDR CHAIN2	1
BDR +5V Current Monitor	I.P5V.SAT	BDR CHAIN1	DISS	1
		BDR CHAIN2		1
USO +20V Current Monitor	I.OUS.SAT	BDR CHAIN1	DISS	1
		BDR CHAIN2		1
10 MHz reference	10 MHz USO	BDR	Measurement tool	4
Primary Power	BNR.P1 and BNR.P2	DISS	BDR CHAIN1	1
			BDR CHAIN2	1
Thermistor I/F to BDR (pad for thermistor only)	N/A	BDR CHAIN1	DISS	1
		BDR CHAIN2		1
Configuration pins	BDR.ADR	Harness	BDR CHAIN1	1
			BDR CHAIN2	1

Table 5.2-1: DORIS electrical interfaces to be emulated by the DORIS EGSE

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R 44 The DISS shall implement the additional electrical interfaces defined in the table 5.2-2 below.

Note: these interfaces are needed for tests at the unit level.

Electrical Interface	Number of I/F per DORIS unit	Unit connector(2)	Destination
PPS Test output	1	J2	BNC Connector
TOP 1Hz (TOP1)	2	J5	BNC Connector
TDI Test output	1	J2	BNC Connector
+5V BDR (U.P5.SAT) (1)	1	J3	analog acquisition
+12V BDR (U.P12.SAT) (1)	1	J3	analog acquisition
-12V BDR (U.M12.SAT) (1)	1	J3	analog acquisition
-5V BDR (U.M5.SAT) (1)	1	J3	analog acquisition
USO voltage (U.P20.SAT) (1)	1	J3	analog acquisition
+3.3V (U.P3.SAT) (1)	1	J3	analog acquisition

Table 5.2-2: DORIS test electrical interfaces to be implemented by the DORIS EGSE

Note 1: not formally required but highly appreciated.

Note 2: BDR J2, J3 and J5 connectors are defined in AD9, AD14 and AD18 according to the Table 4-1.

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R 45 In case of EGSE failure or main power loss, the EGSE shall be able to retrieve and process in batch mode all the acquired telemetry up to the last successful test module.

R 46 The DISS shall provide a measurement of the time bias between the active edge of the SI synchronization signal (from the DBS) and the active edge of the TDI.TEST signal (from BDR-J2) with a precision equal or better than 100 ns.

R 47 The rate of measurement of TDI-SI shall be 0.1 Hz.

6.3 MONITORING TASK REQUIREMENT

R 173 The DISS shall implement a low level monitoring task whenever the nominal application software of the DISS is running, excepted during the configuration mode.

Note: the monitoring task shall be running whatever the status of the BDR is.

R 174 The monitoring task shall include the following actions:

- 1553 bus management,
- acquisition and storage every 25 seconds of the DBL (2 digital status),
- acquisition and storage every 25 seconds of all analog telemetries (as defined in § 6.12),
- PPS permanent broadcast,
- acquisition and storage of:
 - every bus 1553 status changes
 - PPS date sending information

Note: this task shall retain only a copy of the last acquired data of each type (1553 packet, DBL, analog telemetries). It is assumed that the DBS is ON and connected to the DISS for proper PPS emission.

R 175 When BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall acquire every 10seconds the time bias TDI-SI.

Note: only the last data shall be retained.

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R 176 During any monitoring session, the DISS shall record any anomalies concerning the monitoring task in the general log file or in the TMD log file if a TMD is running.

Note: acquired data shall not be stored in the log file excepted in case of a reported anomaly or in the beginning of a TMD.

R 177-1 When BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall test the following analog telemetries:

- if (primary current > *Primary_max_current*) for 3 successive acquisitions,
 - or if (+5V current telemetry > *Max_TM_IP5V*) for 3 successive acquisitions,
 - or if (+20V current telemetry > *Max_TM_IP20V*) for 3 successive acquisitions,
 - or if (base plate temperature > *Max_base_temperature*) for 3 successive acquisitions,
 - or if (base plate temperature < *Min_base_temperature*) for 3 successive acquisitions,
- then the BDR CHAIN1 unit or CHAIN2 unit shall be switched off and any running test shall be stopped.

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R 177-2 Primary current shall be read in the DSPF file, and +5V current limitation, +20V current limitation, temperature Min limitation and temperature Max limitation are read on the database.

R 178 The DISS shall report anomalies from the above test on its standard display and record in the log file all useful information (date, time, anomalous parameter and value).

R 179-1 The DISS shall record in the log file any change of the DBL value between two successive acquisitions, and the date and time of occurrence.

R 179-2 Note: the DISS shall not send any RESTART or OFF/ON command to the BDR in case the DBL reports an anomaly (unexpected status of DBL signals) except when TMD0 is running see R-109.

R 180 Deleted.

R 181 When the BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall monitor the following 1553 bus anomalies:

- no response from the powered BDR chain,
- error bit in the Status Word, raised by the BDR chain,

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R 182 The DISS shall report on its standard display and record in the log file, the first occurrence of the above anomalies (date, time and type).

6.4 ELECTRICAL INTERFACES GENERAL REQUIREMENTS

R 48 The DISS shall implement electrical interfaces compliant with AD21, AD23, AD27 and AD28 according to **Table 4-1**. If there are differences between the interfaces of the considered satellites, the DISS shall implement the interface depending of the satellite interface simulated for the unit under test.

R 49 The DISS shall implement to all possible extent the same interface circuits as the S/C.

R 50 The DISS shall be compliant with AD21, AD23, AD27 and AD28 according to **Table 4-1** (fault emission) in case of an EGSE single failure and when the EGSE is off.

R 51 The grounding concept of the EGSE shall be compliant with AD21, AD23, AD27 and AD28 in agreement with **Table 4-1**.

6.5 INTERFACES DISPLAY REQUIREMENTS

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R 52 Deleted

R 53 The DISS shall display permanently the last acquired STATUS.POWER and STATUS.UC statuses through two LEDs on the DISS display.

R 183 The DISS shall display permanently the last acquired analog telemetries after conversion (primary current, +5V current, OUS current in mA, temperature of the test base plate).

R 184 The DISS shall display permanently the last acquired TDI – SI bias in seconds with 10 ms resolution when BDR is ON.

R 185 The DISS shall display permanently information about current activity running and EGSE status (for instance, equipment under test, phase of test, Test Sequence and Test Module running if any, current calculator date and time, LAN status).

R 186 The DISS shall display permanently the status of the 1553 bus

- Status power
- Vector word
- Status word

Note: display in real time, of additional information regarding TM/TC data transmission through the 1553 bus, would be appreciated.

6.6 TEST INTERFACES REQUIREMENTS

R 54 The DISS shall make available through BNC connectors the following test signals from BDR-J2:

- TDI.TEST
- TOP.PPS.TEST

Note: no specific protection or conditioning is required.

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R 55 Deleted.

R 56 Deleted

R 57 Deleted.

6.7 MIL-STD 1553 BUS INTERFACES REQUIREMENTS

R 58 The DISS shall implement MIL-STD 1553 redundant bus interface compliant with AD17.

R 59 deleted

R 263 deleted

R 264 The DISS shall use the adequate 1553 bus protocol depending on the satellite to be simulated for the unit under test in agreement with table **Table 4-1**.

R 60 The DISS shall be able to select EEPROM A or B by a test directive.

R 61 The bus management shall be maintained permanently as long as the DISS is in nominal operating mode.

Note: i.e. the bus management is activated when the configuration mode of the DISS is done.

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R 62 The DISS shall be able to communicate with the instrument for every possible value of the mission configuration pins interface as defined in **Table 4-1**)

R 63 Deleted.

R 64 Deleted (reported in R – 174).

R 65 Deleted (reported in R – 174).

R 66 Deleted

R 67 Deleted (reported in R – 179).

6.8 PRIMARY POWER INTERFACES REQUIREMENTS

For information, the BDR CHAIN1 unit or CHAIN2 unit primary power input interface is described in AD9, AD14, AD18 and AD23 according to **Table 4-1**.

The DISS shall implement an interface as close as possible to the requirements defined in AD6 and AD7 filtered by AD8, AD13 and AD21 according to **Table 4-1** on the source side.

However, the following specific requirements shall be considered.

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R 68 The DISS shall provide a programmable voltage source in the range [0V, 40V].

R 69 The programming step shall be less or equal to 100 mV.

R 70 The precision of the programmed voltage at the BDR CHAIN1 unit or CHAIN2 unit input shall be better than 100 mV.

R 71 The power supply shall provide an over voltage limiter adjustable to 39 V (not programmable for safety reasons).

R 72 The current capability of the source shall be 3A or above.

R 73 The power supply shall provide a programmable current limitation programmable in the range [0, 3A] by step of 100 mA.

R 74 The source impedance shall be less than 100 mOhm from 0 to 100 Hz.

Note: a slow regulation loop by software is admitted, however the source impedance requirement shall be met.

R 75 The noise at the voltage source output shall be less than 50 mV RMS in the 30 Hz-50 MHz band, when connected to the BDR.

R 76 The spurious lines at main frequency (50 Hz and harmonics) at the voltage source output shall be less than 10 mV.

R 77 At the DISS rack switch ON, the voltage source shall be off by default ($|V_{out}| < 1V$).

6.9 DORIS BDR POWER COMMAND INTERFACES REQUIREMENTS

The following requirements apply to Power Commands and related status lines :

- DORIS ON
- DORIS OFF

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R 78 Deleted.

R 79 The DISS shall provide software drivers for execution of the Power Command telecommands (HMI for manual control, low level primitives).

R 80 After execution of a Power Command, the DISS shall control proper execution by monitoring of the related status line and record and report on the DISS standard display and in a retrievable file in case of non-acknowledgement by the status power.

Note: All the information shall be stored in the test log.

R 81 The design of the Power Command interface shall allow easy modification of the pulse length for trouble shooting facility and for different satellite accommodations

*For information, the Power Command and related status interfaces on the BDR side are defined in AD21, AD23 and AD27, according to the **Table 4-1**.*

6.10 RESTART A&B INTERFACES

R 82 Deleted.

R 83 The DISS shall provide software drivers for execution of the RESTART A&B telecommands (HMI for manual control, low level primitive).

*For information, the RESTART A&B interfaces on the BDR side, are defined in AD21, AD23 and AD27, according to the **Table 4-1**.*

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6.11 PPS INTERFACE

R 84 Deleted.

R 85 The PPS signal shall be synchronous of MIL-STD 1553 bus activity.

R 86 Deleted.

R 87 Deleted.

R 88 Deleted (reported in R – 174).

*For information, the PPS interface on the BDR side, is defined in AD9, AD14, AD18 and AD23, according to the **Table 4-1**.*

6.12 ANALOG TELEMETRY INTERFACE

The BDR provides the following active analog telemetry signals on the J3 connector:

- +5V secondary current ,
- + 20 V secondary current (USO),
- +5V secondary voltage,
- +3,3V secondary voltage,
- +12V secondary voltage,
- -12V secondary voltage,
- -5V secondary voltage,
- +20V secondary voltage (USO).

R 89 The DISS shall implement an input interface for at least the above current telemetries on J3 connector (i.e. +5V current and +20 V USO current).

Note : the satellites acquire only the +5V and +20V USO current telemetries but the other telemetries might be used by THALES for BDR test monitoring and for troubleshooting.

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R 90 Deleted.

R 91 The DISS shall implement an interface for the acquisition of the test plate temperature provided by a thermistor. The temperature is computed by interpolation verify two thermistance values in the table defined in Annex5 .

R 92 The DISS shall be able to measure the BDR CHAIN1 unit or CHAIN2 unit primary current with a precision of ± 20 mA.

R 93 The DISS shall provide adequate measurement means and software drivers for acquisition and decoding of the analog telemetries defined in R 89, R 91, R 92 above (HMI for manual control, low level primitive).

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7. TESTS REQUIREMENTS

7.1 OBJECT OF THE TESTS

THALES will use the DORIS EGSE for electrical integration tests and acceptance tests and in some occasion for troubleshooting.

The object of the electrical acceptance tests of the BDR is the following:

- verification of all hardware functions (ambient, thermal, vacuum),
- control of interfaces in specified environments,
- verification of critical performances in specified environments,
- determination of correction laws and calibration parameters (propagation times),
- complement to software validation tests,
- EMC tests.

These tests have to be executed automatically and in a quite reproducible way by the EGSE.

For integration tests and troubleshooting, THALES needs tools allowing to drive the BDR and the DBS at a lower level and to analyse the raw telemetry.

7.2 CONVENTION

A limited set of standard predefined **Test Modules** (TMD) allows to cover all acceptance tests needs.

A Test Module is composed of elementary actions or **Primitives**, which are executed in sequence automatically.

Several Test Modules can be grouped inside a **Test Sequence** allowing automatic execution of successive TMD for hours in a specific environment.

A Test Module is generally composed of 3 phases:

- a preparation phase (BDR and DBS configuration) under the DISS control

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- an execution phase under the DISS control (real time beacon emission, software upload, spectrum analysis, ...) where the BDR is fully active
- an exploitation phase under the DTP control but initiated by the DISS (DORIS telemetry analysis and edition)

A Test Module can be configured by a set of input parameters (RF level and frequency, active bus unit, DORIS modes, ...).

Tools for integration tests and troubleshooting can be based on direct execution of Primitives under user control (manual tools) and specific Test Modules build by the user.

7.3 TEST GENERAL REQUIREMENTS

R 94 The DORIS EGSE shall manage one or several parameter files gathered in the same directory which provide whenever needed standard parameters values to hardware and software modules of the EGSE. In the remainder of this document, a generic name is used for these files: DORIS Standard Parameters Files (or DSPF).

R 95 The DSPF shall be ASCII files which can be easily modified by standard editing tools. All the modifiable parameters will be changed through specific HMI software either for specific mission adaptation purpose or for test purpose.

The preliminary and non-exhaustive list of these parameters is the following:

Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Velocity_bias "VELOCITY_BIAS"	Integer	m/s		0	TMD 6 Macro: ConfigMVR_Tmd6 Bias added to each velocity parameter sending in MTUT TC	SDDDDD	P	TEST

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	LSB/ entry mask	Use (1)	HMI
Frequency write TDF "FREQ WRITE TDF VALUE"	integer	s		30	Frequency for writing the acquisition of background thread in a dedicated file	DDD	P	TEST
RF_2GHz_ref_level beacon 1 "NIVEAUX_RF_X_REF_BEAI" X = 400 or 2000 i = 1 or 2	Float	dBm	-150 to -90	-113.4 for 400 - 124.3 for 2000	Reference RF level in 2GHz or 400MHz band used in TMD1, 3 and 6 for DBS emission. - default value of the parameter of LLP Set Dbs Static 1bea and Set Dbs Static 2bea - TMD1,3 and 6, in macros "dbs set simu static 1 bea" and "dbs set simu static 2 bea"	SDDD.D	P	TEST
Beacon velocity "VELOCITY_BEAI" I = 1 or 2	Integer	m/s	-15000 to 15000	0	Reference velocity for DBS emission for each beacon. - default value of the parameter of LLP Set Dbs Static 1bea and Set Dbs Static 2bea - TMD1,3 and 6, in macros "dbs set simu static 1 bea" and "dbs set simu static 2 bea"	SDDDDD	P	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
DBS_emission_time “NOMBRE_SEQUEN- CE”	Integer	s	2 to 4000	30	Corresponding to the number of sequence 10S of DBS simulation - in TMD1,3 and 6 in macros dbssimu1beacon and dbssimu2beacon - corresponding to the default value proposed by the IHM for configuring this macros	DDDD	P	TEST
Beacon message “MESSAGE_BALISEi” I from 1 to 4	integer		0 to 65535	2548 65527 65527 11	Corresponding to each word of beacon message. - default value of the parameter of LLP Set Dbs Static 1bea and Set Dbs Static 2bea - TMD1,3 and 6, in macros “dbs set simu static 1 bea” and “dbs set simu static 2 bea”	DDDDD	P	MIS
Primary_voltage “TENSION_PRIMAIRE_VALUE”	Float	V	28	28 V	standard primary voltage used in - TMD0 and 4: parameter of macro prim power source conf - primitive MvrPower: default value proposed for configuring voltage	DD.D	P	TEST

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	LSB/ entry mask	Use (1)	HMI
Min_primary_voltage “TENSION_PRIMAIRE_MIN”	Float	V	-1 to 30 V	20 V	min allowed primary voltage - it's the limit of current min accepted by the background thread - in primitive mvr power: it's the max value accepted by the IHM for configuring current value	SDD.D	P	TEST
Max_primary_voltage “TENSION_PRIMAIRE_MAX”	Float	V	20 to 40 V	39 V	max allowed primary voltage - it's the limit of current min accepted by the background thread - in primitive mvr power: it's the max value accepted by the IHM for configuring current value	DD.D	P	TEST
Primary_current_limit “COURANT_LIM”	Integer	A	1000 to 2500 mA	2000 mA	power source programmable current limit - TMD0 and 4: macro prim power source conf used for configuring current limitation of the BNR - LLP mvrpower: default value of the current parameter proposed by default by the IHM	DDDD	P	TEST

Title : DORIS EGSE REQUIREMENTS FOR INSTRUMENT LEVEL TESTS (DERIL)

Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Primary_max_current “COURANT_PRIMAIRE_MAX”	Integer	mA	500 to 2000 mA	2000 mA	valid max input current of the BDR - it's the limit of current max accepted by the background thread - in primitive mvr power: it's the max value accepted by the IHM for configuring current value	DDDD	ST	TEST
Primary_min_current “COURANT_PRIMAIRE_MIN”	Integer	mA	0 to 2000 mA	500 mA	valid min input current of the BDR - it's the limit of current min accepted by the background thread - in primitive mvr power: it's the min value accepted by the IHM for configuring current value	DDDD	ST	TEST
Primary current after Doris switch off “COURANT_PRIMAIRE_OFF_DORIS”	Integer	mA		17 mA	In TMD2, used in macro “Prim Cur Control After Off”: it's the default value proposed by the IHM for this macro	DDDD	AT	TEST
Velocity of TC MTUT “MEAN_VELOCITY_i_TC MTUT” i = 1 to 7	Integer	m/s	-15000 to +15000	0 m/s	Used in TMD3, default value proposed by the IHM for the macro “ConfigMVR_Tmd3”	SDDDDD	P	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Delay before Switch ON “DELAY1_AV_ON_DORIS_TMD4”	Integer	s	0 to 50	0	Used in TMD4, it's the default value of the parameter of macro “Doris Simu And Autoinit Start”	DD	P	MIS
Delay 2 of commute in doppler mode “DELAY2_AV_MODE_DOP”	Integer	s	0 to 54000	240	Delay for waiting Doris switch on Doppler mode (it's a timeout) Used in TMD4, it's the default value of the parameter of macro “Doris Simu And Autoinit Start”	DDDDD	P	MIS
Delay 3 of commute in doppler mode “DELAY3_AP_MODE_DOP”	Integer	s	0 to 100	0	Wait delay after Doris switch in Doppler mode Used in TMD4, it's the default value of the parameter of macro “Doris Simu And Autoinit Start”	DDD	P	MIS
Manoeuver file “TC_MANOEUVRE_FILE”	String				Used in TMD4, it's the default value proposed by the IHM of macro “Doris Simu And Autoinit Start”		P	MIS
Temporisation between 2 print log “TEMPO”	Integer	min		60	Used in TMD8, default value proposed in macro “Tempo And Print Log” It's the delay between 2 print of log	DDDD	P	TEST

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Tdi-Si tolerance “TOLERANCE_TDI-SI”	Float	s	0 to 0.2	0.05	It's the tolerance accepted for TDI-SI value Used in TMD1: it's the default value proposed in macro “Verif Synchro”	D.DDD	AT	TEST
Tdi-Si nominal value “NOMINAL_TDI-SI”	Float	s	-10 to 0	-1.15	It's the nominal value waited for TDI-SI value Used in TMD1: it's the default value proposed in macro “Verif Synchro”	SDD.DD	AT	TEST
Max sigma doppler 400 or 2000 “MAX_SIGMA_DOP_X” X = 400 or 2000	Integer	mHz	1 to 100	10	max valid sigma Doppler @ 400MHz or 2 GHz Used in TMD6, default value proposed by the IHM for macro “Perfo Eval TMD6” for parameter Dop4PicVarTol and Dop2PicVarTol	D.DD	AT	MIS
Max_sigma_T3 “MAX_SIGMA_T3_X” X = 400 or 2000	Integer	μs	0 to 1000	1	max valid sigma T3 Used in TMD6, default value proposed by the IHM for macro “Perfo Eval TMD6” for parameter MaxSigmaT3_400 and MaxSigmaT3_2000	DDDD.DD	TP	MIS
Min or max delta_T3 400MHz or S “Y_DELTA_T3_X” Y= MIN or MAX X = 400 or 2000	Integer	μs	0 to 2000	1	Min or max T3 propagation time @ 400 MHz or 2GHz	DDDD	TP	MIS

Title : DORIS EGSE REQUIREMENTS FOR INSTRUMENT LEVEL TESTS (DERIL)

Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	LSB/ entry mask	Use (1)	HMI
Max_CAG_error "MAX_CAG_ERROR_X" X= 400 or 2000	Integer	dB	0 to 100	6	max error between BDR CAG value and BDR input level Used in TMD6, default value proposed by the IHM for macro "Perfo Eval TMD6" for parameter MaxCAGError400 and MaxCAGError2000	DDD	AT	MIS
RF_floor_400 or 2000 "RF_FLOOR_NOISE_X" X = 400 or 2000	Integer	dBm	-150 to -120	-137	noise floor in jamming mode @ 400 MHz or 2GHz Used in TMD3, default value proposed by the IHM for macro "Spectral analysis" for parameter MaxNoiseFloor400 and MaxNoiseFloor2000	SDDD	TP	MIS
Datation noise requirement "DAT_RMS_THRESHOLD"	float	μs	0 to 1	5. 10 ⁻⁶	Datation noise requirement Used in TMD4, in macro "Datation Performance", it's the default value proposed by the IHM for the parameter "RMSThreshold"	DDDD.DD	TP	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
% integrity max datation "MAX_%_INTEGRITY_DAT"	float	%	0 to 100	0,1%	% max of datation paquet where datation integrity is KO Used in TMD4, in macro "Datation Performance", it's the default value proposed by the IHM for the parameter "Integrity Level"	DDD.D	TP	MIS
% integrity max navigation "MAX_%_INTEGRITY_X" X = « ITRF » or « J2000 »	float	%	0 to 100	0.1%	% max of navigation ITRF/J2000 paquet where navigation integrity is KO Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "MAX%NbPacketIntegrity"	DDD.D	TP	MIS
% navigation packet where delta pos is KO "%_MAX_N_PACKET_DELTA_POS_X" X = « ITRF » or « J2000 »	float	%	0 to 100	0.3	% max of navigation ITRF/J2000 paquet where delta pos is KO Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "MAX%NbPacketDeltaPos"	DDD.D	TP	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Navigation scale position "NAV_SCALE_POS_X" X = « ITRF » or « J2000 »	float	m	0 to 1000 (ITRF) 0 to 10000 (J2000)	10	Scale for plot delta pos Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "ScalePos"	DDDDD	TP	MIS
Navigation scale velocity "NAV_SCALE_VELOCITY_X" X = « ITRF » or « J2000 »	float	mm/s	0 to 1000 (ITRF) 0 to 10000 (J2000)	10	Scale for plot delta velocity Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "ScaleVelocity"	DDDDD	TP	MIS
Max nb packet where delta velocity is KO "%_MAX_N_PACKET_DELTA_VELOCITY_X" X = « ITRF » or « J2000 »	float	%	0 to 100	0.5 (ITRF) 0.3 (J2000)	Limit of number of navigation packet where delta velocity is Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "MAX%NbPacketDeltaVelocity"	DDD.D	TP	MIS
Tolerance max for position "ABS_TOL_POS_X" X = « ITRF » or « J2000 »	float	m	0 to 10000	0.9 (ITRF) 100 (J2000)	Tolerance max of position Used in TMD4, in macro "navigation Performance", it's the default value proposed by the IHM for the parameter "MaxPosTol"	DDDDD.DD D	AT	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Tolerance max for position “ABS_TOL_VELOCITY_X” X = « ITRF » or « J2000 »	float	mm/s	0 to 1000 (ITRF) 0 to 10000 (J2000)	2	Tolerance max for velocity Used in TMD4, in macro “navigation Performance”, it’s the default value proposed by the IHM for the parameter “MaxSpeedTol”	DDDDD	AT	MIS
Tolerance on Picinbono variance X “TOLERANCE_VAR_PICINBONO_X” X = 400 or 2000	float	mHz	Min = 0	0.4 mHz for 400 2mHz for 2000	Tolerance on Picinbono variance Used in TMD6, default value proposed by the IHM for macro “Perfo Eval TMD6” for parameter Dop4PicVarTol and Dop2PicVarTol	DDDD.DD	AT	MIS
Ratio on valid bloc “MIN_DOP_PROBA_X” X = 400 or 2000	float	%	0-100	100%	UT processing probability (Doppler) Used in TMD6, default value proposed by the IHM for macro “Perfo Eval TMD6” for parameter “Valid 400M Packet Rate” and “Valid 2G Packet Rate”	DDD.D	AT	MIS
Ratio on valid bloc “MIN_MEAS_PROBA”	float	%	0-100	100%	UT processing probability (Full Measurement)Used in TMD6, default value proposed by the IHM for macro “Perfo Eval TMD6” for parameter “Valid Packet Rate”	DDD.D	AT	MIS

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Parameters name (2)	Type	Unit	Nominal range	Default value at EGSE delivery	Definition	Lsb/ entry mask	Use (1)	HMI
Value max of TEB accepted in TMD1 "MAX_TEB_TMD1"	Integer	Nb bits	Min = 0	0	TEB max authorized on TMD1 Used in TMD1, default value proposed by the IHM for macro "Perfo Eval TMD1" for parameter "BitErrorNumber"		AT	MIS
Value max of TEB accepted in TMD6 "MAX_TEB_TMD6"	integer	Nb bits	Min = 0	2	TEB max authorized on TMD6 Used in TMD6, default value proposed by the IHM for macro "Perfo Eval TMD6" for parameter "BitErrorNumber"		AT	MIS
Navigation noise requirement "NAV_RMS_POSITION_X_THRESHOLD" X = "ITRF" or "J2000"	Float	m	0 to 10000	0.03	Navigation noise requirement Used in TMD4, in macro "Navigation Performance", it's the default value proposed by the IHM for the parameter "RMSThreshold"	DDDDD.DD D	TP	MIS
Memory file loading during TMD5 "UMEM_FILE_NAME"					Used in TMD5, in macro "Upload_Memory". It's the default value of the parameter TcUmemFileName			MIS

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Note 1:

- P : hardware programming,
- ST : Safety Test → BDR CHAIN1 unit or CHAIN2 unit switch off in case of anomaly,
- AT : strong Anomaly Test → test abort in case of strong anomaly,
- TP : Telemetry Processing parameter,
- Specific HMI software for parameters value updates : MIS for mission specific and TEST for test specific experiment.

Note 2: parameters names are given for information and for reference within this document but may be modified by DACTEM.

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7.4 TEST MODULES REQUIREMENTS

7.4.1 Definition of standard TMD

R 96 The EGSE shall implement the following standard Test Modules:

- TMD0 : DORIS switch ON procedure
- TMD1 : BDR configuration and interface and functions quick control
- TMD2 : DORIS switch OFF procedure
- TMD3 : Spectral Analysis Measurements
- TMD4 : Navigation performances verification
- TMD5 : Software or memory load
- TMD6 : Raw performances verification
- TMD7 : PPS interface verification
- TMD8 : temporisation with no specific test

It is considered that TMD3, TMD5, TMD6 and TMD7 are always preceded by a TMD1 for proper configuration of the BDR and the EGSE.

7.4.2 Test Modules common requirements

The following requirements apply to all TMD.

In the expression of these requirements, the term EGSE can be read as DISS or DTP depending on the software and hardware architecture retained by CNES and DACTEM.

R 97 Before any TMD processing, the EGSE shall record in a log file:

- the name of the TMD,
- the current local date and time,
- the input parameters, if any, in decoded format,
- a user comment attached to the TMD,

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- the name of the device under test (global test parameter),
- the name of the current test phase (global test parameter),

R 98 During processing of any TMD, the EGSE shall record in a log file the current local time, the name, the parameter values (if any) in decoded format before every Primitive execution and its overall execution status.

R 99 At the beginning of any TMD processing, the EGSE shall conduct the following actions:

- record in the TMD log file the last analog telemetry acquired by the monitoring task (+5V current, USO current, primary current, primary voltage, base plate temperature),
- acquisition and record in the log file of the current TDI-SI time bias.

R 100 During processing of any TMD, the following action/primitive shall be executed:

1. configuration and initialization of the DISS, the DTP and the DBS depending on the nature of the TMD and its input parameters,
2. configuration of the BDR depending on the nature of the TMD and its input parameters,
3. start of the DORIS raw telemetry storage inside the DISS,
4. start of RF emission by the DBS (if required by the test),
5. start of TDI-SI time bias storage (TMD4, TMD6, TMD7)
6. record in the TMD log file of the current local time (time of start of emission),
7. execute TMD specific core actions if any,
8. wait until the end of RF emission, if any,
9. stop of time bias storage, if any,
10. record in the TMD log file of the current local time (time of end of emission),
11. stop of the DORIS raw telemetry storage inside the DISS,
12. processing and control of the TMD telemetry by the DTP (See TMD specific requirements), curves are stored in files in pdf format,
13. record in the log file of the telemetry processing results,

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14. supply a printable file of the telemetry processing results, if required in TMD,
15. supply a printable file of standard TMD acceptance data log, if required in TMD,
16. record in the TMD log file of the current local time (end of TMD).

R 101 After processing any TMD, the TMD log file shall be archived in the EGSE.

R 102 The DTP (and the DISS) shall provide a way for retrieving old log files and telemetry files. Useful files will be stored in a specific test folder for archiving purpose.

R 103 The DTP shall be able to execute in batch time the actions 12, 14 and 15 of the requirement R100 by retrieving the archived telemetry file.

R 104 The EGSE shall provide to the user a mean to stop immediately the execution of a TMD.

R 105 In case of abnormal termination of a TMD (due to DORIS or EGSE anomaly or user action), the EGSE shall archive the current log file and a partial telemetry file in order to facilitate the analysis of the anomaly.

R 106 The duration of the configuration phase of a TMD shall be minimised and not exceed 5 mn.

R 107 The duration of the exploitation phase (telemetry processing) of TMD1, TMD3, TMD6 and TMD7 shall be minimised and not exceed 10 mn (printing time not included).

R 108 Source code of the standard TMDs and executable code of development tools shall be provided to allow customisation of the TMDs by the user.

Note: DACTEM carries no responsibility on such modified TMDs.

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7.4.3 Standard TMD acceptance data log requirements

R 206 The EGSE shall record in files and print when required an abstract of the performance and functional tests results (TMD1, TMD3, TMD4, TMD6, and TMD7).

Note: this abstract (or Standard Acceptance Data Log - SADL) is used for automatic generation of the BDR acceptance logbook.

The SADL includes:

- general conditions of the TMD
- TMD input parameters
- synthesis of test results
- expected test results (which can depend on TMD parameters) or test requirements

Note: separate files for input parameters and test results may be used; in that case files names shall allow linking easily the different files.

The assessment of the overall test validity is under the responsibility of THALES.

For information:

If the "strong anomaly" level is reached, the test operator shall abort the test sequence and alert the Test Manager for further analysis.

If the "nominal requirement" level only is not met, the operator shall pursue the tests. The non-compliant test result is analyzed later on by the Test Manager for further action.

For satellite level tests, automatic test results assessment might be implemented based on the level 1 or 2 requirements.

R 207 The test telemetry results shall also be exportable in an Excel file for further analysis.

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7.4.4 TMD0 requirements

7.4.4.1 Object of the TMD0

The standard Test Module 0 is used as a safe switch on procedure of the BDR.

7.4.4.2 TMD0 actions requirements

R 109-1 The TMD0 shall execute sequentially the following actions, depending on the input parameters value:

N°	Action description	Input parameter name	Parameter values
1	DORIS switch off command (to be sure chain is OFF)	-	-
2	temporisation 30 seconds	-	-
3	Power source configuration at no load	Primary_voltage	20 V to 39 V (valid allowed range) or DEFAULT
4	DORIS switch on command	-	-
5	Digital status verification	-	-
6	Analog telemetry's edition	-	-

DORIS switch OFF command

The DISS shall send the relay command "DORIS OFF" to ensure the OFF state of the BDR CHAIN1 unit or CHAIN2 unit before the execution of the switch ON procedure. This approach is still valid even now that the DORIS DGXX AND DGXX-S have no electromechanical relay but an electronic switch (power supply could be already ON and hence a chain could be powered). Then the DISS shall verify proper switch off through DBL status reading of the addressed Chain (STATUS.POWER).

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R 109-2 In case of anomaly, the DISS shall immediately stop the TMD0 execution and report the anomaly.

Temporisation

R 109-3 The DISS shall wait for 30 seconds before execution of the switch ON procedure after switch OFF in order to allow for proper relaxation of the DC/DC converter inside the BDR CHAIN1 unit or CHAIN2 unit.

Power source configuration at no load

R 109-4 The DISS shall control the input parameter “Primary_voltage” by reference to minimum and maximum voltage defined in the DSPF: if input is lower than minimum or higher than maximum, DISS limits voltage to this extremum value and a warning is written in the HMI of the DISS.

The DISS shall configure the primary power source before switch ON the BDR:

- voltage level: as defined above
- current limit: to be read in the DSPF

DORIS switch ON command

R 109-5 The DISS shall send the switch command “DORIS ON”.

STATUS.CHAIN verification

R 109-6 The DISS shall acquire and verify the STATUS.POWER DBL status and verify that the chain is powered ON.

In case of anomaly, the DISS shall immediately send a DORIS switch OFF command, report the anomaly and stop the execution of the TMD0.

Note: during switch ON the monitoring task is active.

Analog telemetry's edition

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R 109-7 The DISS shall record in a TMD file all the analog telemetry's defined in § 6.12 (last data acquired by the monitoring task) during the complete process of BDR start (including the STATUS UC change).

7.4.5 TMD1 requirements

7.4.5.1 Object of the TMD1

The TMD1 is used for software initialization and configuration of the addressed Chain, time synchronisation and quick verification of DORIS functions and interfaces.

In addition several input parameters of the TMD1 might be used to define common parameters applying to all TMD of a test sequence (excepted TMD0, TMD2, TMD4 and TMD8).

7.4.5.2 TMD1 actions requirements

R 110-1 The TMD1 shall execute sequentially all or several of the following actions, depending on the input parameters value:

N°	Action description	Action activation condition	Input parameter name	Parameter values
1	Selection of the active TM/TC interface	always	Channel	1553_A, 1553_B,
2	Chain initialization and verification	input parameter	EEPROM	RESTART A, RESTART B
3	1553 bus verification	always	-	-
4	Time synchronisation	always	-	-
5	Doppler packet verification	always	ut_source	UT1
			message	64 bits in hexadecimal format
6	Synchronisation verification	always		
7	Datation verification	always		

Selection of the active TM/TC interface

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The input parameter "TMTC_channel" shall be used by the DISS to determine the active channel to be used for TM/TC communication with the BDR.

- 1553_A: the nominal 1553 bus channel is used for all successive TMD execution
- 1553_B: the redundant 1553 bus channel is used for all successive TMD execution

R 110-2 The satellite name and model shall be defined with the HMI during DISS controller initialization.

The 1553 address shall be read in a parameter file according to the chosen satellite and model.

BDR initialization and verification

R 110-3 The DISS shall execute the following actions depending on the input parameter "EEPROM":

RESTART A: the DISS shall send a "RESTART A" telecommand, then, wait for the report packet during 60 seconds maxi, acquire it and verify its content in comparison with a reference report packet (application to a mask, and compare this result to a reference file).

RESTART B: same as above but with "RESTART B" telecommand.

The DISS shall wait for 1 minute.

The DISS shall send a TC NOP (See AD19, AD24 or AD25 in agreement with **Table 4-1**) and verify proper response of the BDR through the MIL bus. For it, the DISS applies a mask (defined in a parameter file) and compares this result to a reference file)

R 110-4 Deleted.

R 110-5 In case of anomaly the TMD1 shall be aborted immediately.

Time synchronisation

R 110-6 The DISS shall use the automatic time synchronisation process inside the BDR for DBS-BDR proper synchronisation.

R 110-7 The automatic time synchronisation process requires the following actions:

The DBS shall be configured to emit during N sequences of 10 seconds, a modulated beacon, at the specified velocity (beacon speed) and the reference RF levels. All parameters shall be read in the DSPF (N=" NOMBRE_SEQUENCE", RF levels =

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SBeaconLevel, UHFBeaconLevel, velocity = BeaconSpeed) and the beacon messages shall be as defined in TMD6 (see R - 117 and R - 118).

The DISS shall wait until the end of DBS emission or an operator request before to proceed (whichever comes first).

Doppler packet verification

R 110-8 The DTP shall verify the existence of at least a valid Doppler packet from the UT designated by the input parameter “ut_number” (valid Doppler packet: Val_DOP_400MHZ & Val_DOP_2GHZ valid).

R 110-9 Select the last valid Doppler packet in the TM flow and for this packet, verify the following items:

a : beacon message : equal to the emitted message,

b : frequency validity : $|\text{measured frequency} - \text{emitted frequency}| < \text{Max_freq_error_2000}$ or $\text{Max_freq_error_400}$ respectively in 2GHz and 400MHz bands,

c : RF level validity : $|\text{CAG level} - \text{emitted level}| < \text{Max_CAG_error}$.

Datation verification

R 110-10 The DISS shall analyse the datation packets by using the following algorithm :

- Check that one and only one datation packet exists between 2 PPS and check its availability
- Check if the bit service request from status word following the PPS is at ‘1’
- Check if the datation bit from vector word following PPS is at ‘1’
- Check the timing from the TOP PPS and the following datation packet is correct “Diff PPS date and datation date”

Synchronisation verification

R 110-11 This verification shall always be done by the DISS.

The DISS shall verify the proper value of the last acquired time bias (TDI - SI):
 $\text{TDI} - \text{SI} = \Delta T = -1150 \text{ ms} \pm [\text{Tolerance_TDi-Si}]$, [Tolerance_TDi-Si] is defined in DSPF as default value 0.05, min value 0 and max value 0.2

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R 110-12 In case of anomaly the TMD1 shall be failed. In any case, TDI-SI value shall be reported in an appropriate file

If one check fails, test result is KO.

7.4.5.3 DORIS telemetry processing and edition

Report packet and valid Doppler packet verification and edition as defined above.

Note about time scale correspondence:

The DISS can send at any time a TC NOP for acquisition of a report packet that gives TAI and TOUS time corresponding to the current EGSE time.

This should be done at the beginning and at the end of the DBS emission in order to determine the start and end dates of the useful telemetry to be processed by the DTP.

7.4.6 TMD2 requirements

7.4.6.1 Object of the TMD2

The standard Test Module 2 is used as a safe switch off procedure of the BDR.

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7.4.6.2 TMD2 actions requirements

R 111-1 The TMD2 shall execute sequentially the following actions:

N°	Action description	Input parameter name	Parameter values
1	DORIS switch off command	-	-
2	Temporisation 11 seconds	-	-
3	Analog telemetry's and relay status verification	-	-
4	Primary voltage setting to 0V	-	-

DORIS switch OFF command

The DISS shall send the switch command DORIS OFF.

Temporisation 11 seconds

This delay is required for analog telemetry relaxation.

Analog telemetry and STATUS.POWER verification

R 111-2 Immediately after the previous action, the DISS shall verify the following analog telemetry:

BDR primary current : < [COURANT_PRIMAIRE_OFF_DORIS],
[COURANT_PRIMAIRE_OFF_DORIS] is defined in DSPF as default value 17mA and min value 0 and max value 100

The DISS shall also acquire and verify the digital status « STATUS.POWER» (Chain OFF).

The DISS shall report any anomaly.

Primary voltage setting to 0V

R 111-3 The DISS shall configure the primary power source to 0V.

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7.4.7 TMD3 requirements

7.4.7.1 Object of the TMD3

The TMD3 is used for characterisation of the RF environment of the DORIS instrument (especially during EMC and RFC tests).

It uses the ASR test mode.

The 2 following configurations of UTi are usable for the TMD3 (with i[1;7]) :

Configuration N°	Definition	Uti measurement mode	ASR
1	Test configuration #1	Test	ON
2	Test configuration #2	Idle	ON

Two configurations of the DBS may be used for the TMD3:

1. emission of two active beacons (as in TMD6) for Spectral Analysis mode verification and calibration,
2. no emission.

The configuration #2 is the same as configuration #1 but with RF levels set to the minimum level.

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7.4.7.2 TMD3 Input parameters

R 190 The TMD3 shall accept the following configuration parameters:

Parameters name	Type	Unit	Nominal range	Definition
Mean_velocity_1 "BeaconSpeed1"	Float	m/s	± 15000	radial velocity of the beacon #1
Mean_velocity_2 "BeaconSpeed2"	Float	m/s	± 15000	radial velocity of the beacon #2
Mean_velocity_UT1	Float	m/s	± 15000	velocity of the UT1
Mean_velocity_UT2	Float	m/s	± 15000	velocity of the UT2
Mean_velocity_UT3	Float	m/s	± 15000	velocity of the UT3
Mean_velocity_UT4	Float	m/s	± 15000	velocity of the UT4
Mean_velocity_UT5	Float	m/s	± 15000	velocity of the UT5
Mean_velocity_UT6	Float	m/s	± 15000	velocity of the UT6
Mean_velocity_UT7	Float	m/s	± 15000	velocity of the UT7
N_seq "NOMBRE_SEQUENCE"	Integer	-	2 to 4000	Number of active emission 10 seconds sequence -2
RF_level_2G_1 "SbeaconLevel1"	Float	dBm	-150 to -90	beacon #1 RF level in 2GHz band at the BDR input
RF_level_400M_1 "UHFbeaconLevel1"	Float	dBm	-150 to -90	beacon #1 RF level in 400MHz band at the BDR input
RF_level_2G_2 "SbeaconLevel2"	Float	dBm	-150 to -90	beacon #2 RF level in 2GHz band at the BDR input
RF_level_400M_2 "UHFbeaconLevel2"	Float	dBm	-150 to -90	beacon #2 RF level in 400MHz band at the BDR input

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Parameters name	Type	Unit	Nominal range	Definition
UT_conf	Integer	-	1 or 2	Test configuration 1 or 2 (see §7.4.7.1)
BeaconMessageWord0	Integer		0 to 0xFFFF	Word0 of the beacon message simulated
BeaconMessageWord1	Integer		0 to 0xFFFF	Word1 of the beacon message simulated
BeaconMessageWord2	Integer		0 to 0xFFFF	Word2 of the beacon message simulated
BeaconMessageWord3	Integer		0 to 0xFFFF	Word3 of the beacon message simulated
MinLevelError400	Integer	dB	<i>Lower than Max_level_error</i> (read in DSPF)	Error by default (<0) 400Mhz on received level
MaxLevelError400	Integer	dB	<i>Lower than Max_level_error</i> (read in DSPF)	Upper limit(>0) 400MHz on received level
MinLevelError2000	Integer	dB	<i>Lower than Max_level_error</i> (read in DSPF)	Error by default (<0) 2Ghz on received level
MaxLevelError2000	Integer	dB	<i>Lower than Max_level_error</i> (read in DSPF)	Upper limit (>0) 2GHz on received level

Table 7-1 - TMD3 input parameters definition

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7.4.7.3 DBS configuration during active emission

The DBS shall be configured as follow during useful phase of the TMD3 (Spectral Analysis in progress):

R 191 The duration of the active emission phase shall allow the processing by the BDR of a number of NOMBRE_SEQUENCE DORIS sequences (ten seconds).

R 192 Two active beacons shall be simulated by the beacon #1 and #2 of the DBS.

R 193 The simulated frequency of each beacon shall be defined as follow :

$$F_{2GHz} = - Mean_velocity_i / C \times 407.25 \times F_{DBS\ USO}$$

$$F_{400MHz} = - Mean_velocity_i / C \times 80.25 \times F_{DBS\ USO}$$

Where:

- *Mean_velocity_i* are the corresponding TMD3 input parameters in m/s, with $i = 1$ or 2
- C = light speed in vacuum = 2.99792458×10^8 m/s
- $F_{DBS\ USO}$ = nominal frequency of the DBS internal USO = 5 MHz

R 194 Each beacon RF levels shall be configured by using *RF_level_2G_i* and *RF_level_400M_i* input parameters.

Note: the following restrictions are applicable to the RF level parameters (user requirement)

- No emission (conf2):
 - o all *RF_level_X_Y* set to -150 dBm
- Active emission (conf1):
 - o $RF_level_2G_1 \geq RF_level_2G_2 + 6$ dB
 - o $RF_level_400M_1 \geq RF_level_400M_2 + 6$ dB
(beacon 1 at least 6 dB above beacon 2)
 - o $RF_level_2G_1$ and $RF_level_400M_1 \geq -120$ dBm

R 195 Deleted.

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7.4.7.4 TMD3 actions requirements

R 196 The TMD3 shall execute sequentially the following actions:

N°	Action description
1	Initialization of all UT
2	Temporisation
3	BDR configuration
4	DBS configuration
5	RF emission <i>N seq</i> sequences and telemetry storage
6	Telemetry processing

Initialization of all UT

The EGSE shall send a VUT TC on all UT to initialize all UT

Temporisation

Delay required for BDR relaxation

BDR configuration

R 197 Depending on the input parameter *UT_conf*, the EGSE shall send appropriate telecommands MASR and MTUT to configure the UT_i of the BDR as defined in §7.4.7.1.

Note: see [AD4](#) for telecommands definition and format.

R 198 In case of configuration 1, the EGSE shall use the input parameters *Mean_velocity_UTi* to compute the velocity parameter of the MTUT telecommand for UT # i.

R 199 In case of configuration 1, the EGSE shall configure the parameter #2 of the telecommand MTUT as follow:

- SYN = 0
- CH = 0
- R = 1

R 200 Deleted.

DBS configuration

See § 7.4.7.3

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7.4.7.5 Telemetry processing requirements

Note about time scale correspondence:

The DISS can send at any time a TC NOP for acquisition of a report packet that gives TAI and TOUS time corresponding to the current EGSE time.

This should be done at the beginning and at the end of the DBS emission in order to determine the start and end dates of the useful telemetry to be processed by the DTP.

R 201 The EGSE shall process all jamming packets corresponding to the N_{seq} acquisitions required by the test.

R 202 The EGSE shall plot each acquired spectrum.

Note: The different spectrums may be combined in a single plot.

Note: X axis : frequency offset in Hz, Y axis : RF level in dBm

R 203 The EGSE shall determine for each spectrum the RF maximum level and associated frequency.

R 204 The EGSE shall verify for each acquired spectrum, the RF maximum level with the following algorithm:

- if DBS RF level is off (≤ -150 dBm) : the max RF level in the spectrum shall be less then $MaxNoiseFloor_{400}$ or $MaxNoiseFloor_{2000}$, respectively in 400MHz and 2GHz bands ,
- if DBS RF level is on : the max RF level in the spectrum shall be compared to the corresponding emission level of the beacon 1:
 - $MinLevelError400 < level\ error\ 400 < Max_level_error400$
 - $MinLevelError2000 < level\ error\ 2000 < Max_level_error2000$
 - $|frequency\ error| < Max_freq_error_{400}\ or\ Max_freq_error_{2000}$ respectively in 400MHz and 2GHz bands.

Processing results edition

R 205 All numeric results and plots (plots can be superposed on the same plot) from the above steps shall be record in a retrievable and displayable file.

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7.4.8 TMD4 requirements

7.4.8.1 Test objectives

The aim of this test module is:

- to functionally check the full self initialization (cold start) process including instrument self synchronisation and navigation software “ lost in space ” start,
- to functionally check the Autonomous (self programming) mode when relevant for the mission,
- to functionally check the datation process,
- to check the performances of the datation process,
- to check the performances of the on board real time ephemerides on a realistic scenario including a satellite maneuver and attitude motion as relevant
- eventually to check proper upload of the DORIS on-board software in routine mode (must be an optional function)
- eventually to check the correction time function (must be an optional function)
- to check the presence or not of TM packet types depending on the satellite mission following the table hereafter.

	Sentinel3	Jason3	SWOT	Jason-CS
TM Navigation ITRF	Yes	Yes	Yes	Yes
TM Navigation J2000	Yes	Yes	Yes	Yes
TM Navigation geodesic	Yes	Yes	Yes	Yes
TM Doppler	Yes	Yes	Yes	Yes
TM Attitude	No	Yes	Yes	Yes
TM KARIN	No	No	Yes	No

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- to check the function : insertion of the satellite broadcasted time given in the TC time in the packet time field of the header of datation packets; depending on the satellite mission following the table hereafter.

	Sentinel3	Jason3	SWOT	Jason-CS
TC Time	Yes	Yes	Yes	Yes

7.4.8.2 Test module TMD4 events

If relevant (see table here below), the TC attitude files shall have been transferred to 1553 front end before first start of TMD4

	Sentinel3	Jason3	SWOT	Jason-CS
TC attitude	No	Yes	Yes	Yes

R 257 If relevant, start and stop of TC attitude emission shall be automatically managed by DBS to DISS requests based on scenario file information (attitude column)

R 210 To perform the test TMD4, the DISS shall execute in sequence the following actions :

- start the DBS with the appropriate scenario file and broadcast file,
- wait a given delay (delay to turn on; default value = 0, maximum value = 50 seconds),
Note: by changing the delay to turn on the instrument after DBS start, various initial conditions of instrument cold start may be played.
- record last monitored parameters values in the TMD log file,
- check the instrument temperature : if temperature is below or above the turn on limits specified in the DORIS database then abort the TMD, else go on,
- turn on the DORIS instrument; save turn on time,
- wait for first status word transmitting by the instrument,
- start 1553 telemetry recording,
- wait one iteration of the background task,,
- record last monitored parameters values in the TMD log file,

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- Start TC time emission, if satellite mission accepts it,
- start spy file acquisition,

- check M1 field of routine report packet, when M1 value turns to "measurement" (value = "4") record on log file: "Doris measurement mode"; If DORIS mode has not turned to "measurement" after a given time out time then abort test and record in log file: "TimeOut on TM REPORT : doris mode didn't switch to "measurement" mode",
- If upload is selected,
 - Wait a given delay (uploading delay); default value = 0,
 - upload the DORIS on-board software as specified in TMD5 diagram, but:
 - without restarting the instrument
 - without interrupting even if TMD5 result is KO
- If correction time is selected,
 - Wait a given delay (CTDI delay); default value = 2 min,
 - Send the telecommand CTDI (with a delay of -30 ms),
 - Wait a Tm report acknowledgement of TC,
 - Wait a TM report time correction (wait 40s max),
- wait a given delay (maneuver delay); default value = 0,
- upload, by sending a 1553 TC, maneuver data predefined in a specific file if relevant (see AD11, AD15,);
- wait for the end of scenario from DBS ,
Note: the scenario may be manually stopped before the end of the scenario file; in this case the test shall not be aborted, and the following actions shall be executed:
 - Stop TC Time emission, if it has been previously activated,
 - stop 1553 telemetry recording,
 - store all telemetry files on DISS hard disk.

End of the TMD.

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7.4.8.3 Test result processing

R 274 Unless otherwise required, in this paragraph, all plots w.r.t. TAI date shall start from the first significant date i.e. > 1/1/2000

Doppler packets analysis

R 211 The DTP shall analyse the Doppler packets by using the following algorithm:

– Check availability of Doppler packets:

- If none, and Doppler TM is implemented on the satellite mission, test result is KO (“No Doppler packet”) If at least one and Doppler TM is not implemented on the satellite mission, test result is KO (“Doppler packet”)
- If Doppler packet presence test is OK:
 - record on log file “number of valid (Error Detection Code correct) Doppler packets: nnnn”,
 - read different fields of each instrument processing unit (UT) measurement data: 400MHz loop status, 2GHz loop status, 400MHz/2GHz frequency consistency status, and 2GHz measurement w.r.t. prediction consistency status, Doppler mode, bit synchro status (or measurements with/without T3 event date; i.e. T3_Datation field not equal/equal to zero), message channel indicator, T3 event date channel indicator, T3 event date correction status, and plot them w.r.t. TAI date in a readable manner,
 - from a given date TAI1 up to a second given date TAI2, for each processing unit (UT) compute the ratio between the Tdi sequences with a valid Doppler measurement (Val_DOP_400MHZ & Val_DOP_2GHZ valid) and total number of sequences when both are different from zero. Record this ratio in the log file : “realized coverage between TAI1 and TAI2 : rc%” ,
 - if relevant (significant programmed beacon field), plot both expected and received beacon numbers w.r.t. TAI date in a readable manner,

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- if relevant (significant programmed beacon field), compare both numbers when both are different from zero and compute the percentage of occurrences when they are equal; record in log file “ratio received/expected beacon: xx%”.

Datation packets analysis

R 212 The DTP shall analyse the datation packets by using the following algorithm:

– Check availability of valid Datation packets (CRC OK):

- if none test result is KO (“No datation packets”),
- else
 - plot with automatic scale TAI date of datation packets w.r.t. pulse counter,
 - plot with automatic scale, quality index w.r.t. TAI date,
 - from a given TAI date (TAI1) up to a second TAI date (TAI2), plot with a fixed scale (from 0 to 2s) the difference between TAI dates of current datation packet and previous one, report min and max values of this difference and compare it with $1s \pm T$ (T being the threshold given as test parameter); test is failed if this threshold is exceeded, as the difference shall be around 1 second,
 - If relevant (see note *), compute the difference (DIF-DATE datation error) between TAI date of datation packets and same date rounded at 1 second (DIF-DATE datation error = full TAI date – rounded TAI date):
 - for all datation packets as soon as Datation Quality Index is lower than max value (FFFFFFF), check that (DIF-DATE datation error) $\leq$ Datation Quality index, record on the log file the percentage of packets for which this relation is false (non integrity ratio), and if this percentage is over a given value, then the test result is KO.
 - from DateTAI1 to DateTAI2:
 - plot DIF-DATE datation error w.r.t. TAI date,
 - record max. value and min. value of DIF-DATE (datation error) on the log file, compare these extrema with a given

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specified value (only one absolute value for min and max) and compute the percentage of packets where the specified value is out of range. If this number is over a given percentage then the result of the test is KO. In any case, the required percentage and the found one shall be reported.

- compute the rms value of DIF-DATE datation error and record it on log file (“rms”), compare this rms value with the required value *DAT_RMS_THRESHOLD* that shall be read in the DSPF. If the calculated rms value is over the required value then the test result is KO.
- compute average value of DIF-DATE datation error and record it on log file (“Datation bias”).
- compute ratio valid packet number (CRC OK) / total packet number

Note() This test is relevant only if the PPS transmitted to DORIS is synchronized on TAI seconds. A parameter in the TMD shall indicate if it is the case or not.*

Datation availability w.r.t. pps

R 267 The DTP shall analyse the spy file by using the following algorithm:

- Plot with fixed scale (0 to 2 as the expected value is 1) the number of datation packets between 2 PPS w.r.t the computer time of PPS generation
- Compute and record the average value. Record max. value and min. value on the log file; compare these extrema with the value 1. If one of these extrema is different of 1 then the test result is KO
- Plot with automatic scale the duration between the datation packet acquisition event and the previous PPS pulse event w.r.t the PPS computer time.
- Compute and record the average value. Record max. value and min. value on the log file; compare these extrema with given values. If these extrema are over given values then the result of the test is KO.
- Record on the log file the number of status word following PPS for which the service request bit is different of 1 or the TM datation bit of the Vector Word is different of 1. Record on the log file the 10 first max anomaly values. If number of anomalies ≥ 1 then the test result is KO.

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Navigation packets analysis

R 213 The DTP shall analyse the Navigation packets by using the following algorithm:

For ITRF and J2000 packets:

- Check availability of (ITRF and J2000) Navigation packets:
 - if none (ITRF or J2000) and Navigation TM is implemented on the satellite mission, test result is KO
 - If at least one (ITRF or J2000) and navigation TM is not implemented on the satellite mission, test result is KO
 - If Navigation packet presence test is OK, as soon as Navigation Quality Index is lower than max value (0xFFFFFFFF):
 - ❖ plot with automatic scale, quality index w.r.t. TAI date,
 - ❖ compute the difference between Position in navigation packets and reference position in reference file as per AD10 at same TAI date on each component ($\Delta X, \Delta Y, \Delta Z$); compute the 3D distance ($\text{SQRT}(\Delta X^2 + \Delta Y^2 + \Delta Z^2)$); check that 3D distance $\leq$ navigation Quality index, record on the log file the percentage of packets for which this relation is false (“ Position non integrity ratio ”); if this percentage is over a given value (default value = 0), then the test result is KO
 - ❖ from a given TAI date (TAI1) up to a second TAI date (TAI2), plot with a given scale the differences between current Navigation data (P/x,y,z,V/x,y,z,) and reference file, in ITRF or in RTN referential (following parameter chosen), plot also the computed 3D distance with the same given scale.
 - ❖ For each component (X, Y, Z or R, T, N) of the Navigation error in position and in velocity and also for the computed 3D distance, between TAI1 and TAI2:
 - record max. value and min. value of these differences on the log file; compare these extrema with a given specified value (only one absolute value for min and max but one threshold for each component) and compute the percentage of packets where the specified value is out of range. If this number is over a given percentage then the result of the test is KO. In any case, the required percentage and the found one shall be reported

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- compute the rms value of these differences and report them on log file: “rms”; if they are over a given specified value (one threshold for each component) then test is KO.
- compute average value of these differences except for the distance and record them on log file (“bias”).

For Geodesic packets :

– Check availability of Geodesic packets:

- If none and Geodesic navigation TM is implemented on the satellite mission test result is KO (“No Geodesic Navigation packets”)
- If at least, one and Geodesic navigation TM is not implemented on the satellite mission, test result is KO (“Geodesic navigation packet”)
- If Geodesic packet presence test is OK as soon as Navigation Quality Index is lower than max value (0xFFFFFFFF) :
 - Plot with automatic scale, quality index w.r.t TAI date.
 - From a given TAI date (TAI1 up to a second TAI date (TAI2), plot with a given scale the differences (Navigation error) between current Geodesic data and the reference file :
 - latitude,
 - longitude,
 - orbit number,
 - orbital angular position,
 - altitude,
 - altitude variation rate.
 - For latitude, longitude, altitude, altitude variation rate, and orbital angular position:
 - Record max. value and min. value of these differences on the log file; compare these extrema with a given specified value and compute the percentage of packets where the specified value is exceeded. If this number is over a given percentage then the result of the test is KO. In any case, the required percentage and the found one shall be reported
 - Compute the rms value of these differences and record them on a log file: “rms noise: value”; if they are over a given specified value then test is KO: “rms value out of requirement spec”

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- Compute average value of these differences and record them on log file (“bias”).
- For orbit number (note that it is an integer):
 - record max. value and min. value of the differences on the log file; compute the percentage of packets where the difference is not 0. If this number is over 0% then the result of the test is KO. In any case, the required percentage and the found one shall be reported.

Attitude packets analysis when relevant (see table in “Test module TMD4 events” paragraph, above)

R 258 The DTP shall analyse the attitude packets by using the following algorithm:

- Check availability of attitude packets:
 - If none, and Attitude TM is implemented on the satellite mission, test result is KO (“No Attitude packet”)
 - If at least, one and Attitude TM is not implemented on the satellite mission, test result is KO (“Attitude packet”)
 - If Attitude packet presence test is OK:
 - Check that for all TC attitude sent, a TM attitude with the same contents that TC is received.
 - If none test result is KO.
 - If an anomaly is detected, record on the log file the 10 first TC which the TM is not found and the 10 first TM which not corresponding at a TC.

CTA function checking

R 259 If CTA checking is selected, the DTP shall check the CTA function by using the following algorithm:

- Check the reception of a TM report acknowledgement of TC CTDI.

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- Check that less than 40 s after the TM report acknowledgement, a Time correction report is received with a correction of date TOUS of 30ms (date TOUS of TM report “time correction” modulo 10s – date TOUS of the last TM report modulo 10s) ≤ 30 ms.
- Check that from the TM report TC acknowledgement up to the end, at least one TM report Time correction is received with a correction of time in TOUS date of -10 ms. If none, test result is KO.
- Record on test report file the acknowledgement of TC CTDI and the 3 first Time correction report TM which follow the acknowledgement. For all this TM report, record the TOUS date and the TAI date.

Satellite On board Time function checking

R 260 if the satellite mission implements the TC Time, the DTP shall check the correspondence between the “packet time” date in the Datation header packets and the date in TC Time by using the following algorithm:

- From a given TAI date (TaiDateMin) up to a second date (TaiDateMax), compare the “packet time “ date of datation packets received between PPS(n) and PPS(n+1) with the date of the TC Time received between PPS(n-1) and PPS(n). The comparison shall be compliant with the description of the satellite onboard time management as per AD11, AD11 and AD19. If the dates are not compliant, the test result is KO.
- Record on the log file the five first differences.

Report packets analysis

R 219 The DISS shall analyse the Report packets by using the same algorithm as TMD5 to verify proper software upload if chosen.

R 270 Deleted.

KARIN bulletin check

R 276 If relevant, the DTP shall analyze the KARIN bulletin by using the steps described in Annex 7.

General Test result

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R 277 If at least one KO has been raised during test then general result test is KO else general test result is OK.

7.4.8.4 TMD4 general requirements and assumptions

Assumptions

- a) It is assumed that the monitoring task is running all along the test,
- b) Before to start this test module it is assumed that the DORIS chain is OFF,
- c) The duration of this test is between 4 and 13 hours,
- d) TAI dates specified in the processing requirements are the dates associated to and included in Doris data field and not the date of Packet time field.

General requirements

- R 214** All KO messages shall be recorded in the log file.
- R 215** All plots shall be stored in printable file.
- R 216** Standard TM screen shall be displayed in real time all along the test module.
- R 217** The above given parameters shall be stored in the file DSPF.
- R 218** The test parameter file shall be an ASCII file easy to modify by an elegant supplied tool or standard editor.

7.4.9 TMD6 requirements

7.4.9.1 Object of the TMD6

This TMD is used to assess and control the critical DORIS performances using constant frequency beacons (static configuration).

DBS unit can emit 2 beacons simultaneously and BDR chain can process up to 7 simultaneous beacons : nominally, several UT are affected on the first beacon, the others are affected on the second.

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The following performances are assessed in S band and 400MHz band:

- frequency measurement bias
- frequency measurement short term error
- beacon acquisition probability
- bit error rate
- message time tagging short term error (T3 measurement)
- Chain group delay measurement
- RF level measurement error

Moreover, it shall be possible to configure the ASR mode in parallel.

7.4.9.2 General description of the TMD6

The DISS is configured to emit for N 10s sequences, two static beacon signals at a velocity (i.e. a frequency) defined by input parameters of the TMD.

All Uts are programmed in TUT mode at a designated velocity equal to the velocity defined by input parameters plus a velocity bias defined by an input parameter of the TMD.

This bias is used to test the BDR acquisition range.

Note for a correct acquisition probability characterisation, the relative bias of the powered chain USO and the EGSE USO frequencies shall be less than $1 \cdot 10^{-8}$ for proper execution of the TMD6.

It is not foreseen to take into account the true USO bias as input parameter of the TMD6.

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7.4.9.3 TMD6 Input parameters

R 112-1 The TMD6 shall accept the following configuration parameters:

Parameters name	Type	Unit	Nominal range	Definition
Jamming Mode			NO/YES	Defines if the Jamming mode must be activated
Mean_velocity_1 “BeaconSpeed1”	Float	m/s	± 15000	radial velocity of the beacon #1
Mean_velocity_2 “BeaconSpeed2”	Float	m/s	± 15000	radial velocity of the beacon #2
Mean_velocity_UT1	Float	m/s	± 15000	velocity of the UT1
Mean_velocity_UT2	Float	m/s	± 15000	velocity of the UT2
Mean_velocity_UT3	Float	m/s	± 15000	velocity of the UT3
Mean_velocity_UT4	Float	m/s	± 15000	velocity of the UT4
Mean_velocity_UT5	Float	m/s	± 15000	velocity of the UT5
Mean_velocity_UT6	Float	m/s	± 15000	velocity of the UT6
Mean_velocity_UT7	Float	m/s	± 15000	velocity of the UT7
N_seq	Integer	-	2 to 4000	number of active emission 10 seconds sequences
RF_level_2G_1 “2GbeaconLevel1”	Float	dBm	-150 to -90	beacon #1 RF level in 2GHz band at the BDR input
RF_level_400M_1 “400MbeaconLevel1”	Float	dBm	-150 to -80	beacon #1 RF level in 400MHz band at the BDR input
RF_level_2G_2 “2GbeaconLevel2”	Float	dBm	-150 to -90	beacon #2 RF level in 2GHz band at the BDR input
RF_level_400M_2	Float	dBm	-150 to -80	beacon #2 RF level in 400

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Parameters name	Type	Unit	Nominal range	Definition
“400MbeaconLevel2”				MHz band at the BDR input
Message	64 bits hexa-decimal format	-	-	message in 400MHz and 2GHz band
VELOCITY_BIAS_Uti (i = 1 to 7)	Float	m/s	± 30	Velocity Bias taking into account USOs frequency biases.
<i>Max_sigma_dop_2G</i>	Integer	mHz	1 to 100	Picinbono variance limit
<i>Max_sigma_dop_400M</i>	Integer	mHz	1 to 100	Picinbono variance limit
<i>Min_meas_proba</i>	Integer	%	0 to 100	Probability
<i>Min_dop_proba_2G</i>	Integer	%	0 to 100	Probability
<i>Min_dop_proba_400M</i>	Integer	%	0 to 100	Probability
<i>Max_CAG_error_2G</i>	Integer	dB	0 to 100	Max BDR CAG Error 2G
<i>Max_CAG_error_400M</i>	Integer	dB	0 to 100	Max BDR CAG Error 400M
<i>Max_sigma_T3_2G</i>	Integer	μ s	0 to 1000	Max T3 Datation Picinbono variance
<i>Max_sigma_T3_400M</i>	Integer	μ s	0 to 1000	Max T3 Datation Picinbono variance
<i>Min_delta_T3_2G</i>	Integer	μ s	0 to 2000	Min average delta T3
<i>Min_delta_T3_400M</i>	Integer	μ s	0 to 2000	Min average delta T3
<i>Max_delta_T3_2G</i>	Integer	μ s	0 to 2000	Max average delta T3
<i>Max_delta_T3_400M</i>	Integer	μ s	0 to 2000	Max average delta T3
<i>BitErrorNumber</i>	Integer	-	0 to 100	Max number of false bits for each channel

Table 7-2 - TMD6 input parameters definition

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R 112-2 The DISS shall add a Velocity bias (VELOCITY_BIAS_Uti defined in the DSPF) to the MEAN_VELOCITY_Uti specified to compute the MTUT parameter.

7.4.9.4 DBS configuration during active emission

The DBS shall be configured as follow during useful active emission phase of the TMD6 :

R 113 The duration of the active emission phase shall allow the processing by the BDR of a number of N_seq DORIS sequences (ten seconds).

R 114 Two active fully modulated beacons shall be simulated by the beacon #1 and #2 of the DBS.

Note : the BDR is able to process a static message. This avoids the complexity of a changing 3.0 message as per AD3.

R 115 The simulated frequency of each beacon shall be defined as follow :

$$F_{2GHz} = - Mean_velocity_i / C \times 407.25 \times F_{DBS\ USO}$$

$$F_{400MHz} = - Mean_velocity_i / C \times 80.25 \times F_{DBS\ USO}$$

Where :

- *Mean_velocity_i* are the corresponding TMD6 input parameters in m/s, with *i* = 1 or 2
- *C* = light speed in vacuum = 2.99792458 10⁸ m/s
- *F_{DBS USO}* = nominal frequency of the DBS internal USO = 5 MHz

R 116 Each beacon RF levels shall be configured by using *RF_level_2G_i* and *RF_level_400M_i* input parameters.

R 117 The modulation message in 400MHz band shall be defined as follow :

- 120 bits "1",
- synchronisation word "0A6F" in hexadecimal,
- message (64 bits) defined by the input parameter *Message* excepted the bit VM which is forced to 0 (400MHz channel).

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R 118 The modulation message in 2GHz band shall be defined as follow :

- 120 bits "1",
- synchronisation word "0A6F" in hexadecimal,
- 2 words in reserve (32 bits),
- message (64 bits) defined by the input parameter *Message* (same content as 400MHz band) excepted the bit VM which is forced to 1 (2GHz channel).
- error detection code as defined in AD3.

R 119 Deleted.

R 120 Deleted.

R 121 Deleted.

R 122 Deleted.

7.4.9.5 TMD6 actions requirements

R 123-1 The TMD6 shall execute sequentially the following actions :

N°	Action description
1	BDR configuration
2	DBS configuration
3	RF emission NOMBRE_SEQUENCE sequences and telemetry storage
4	Initialization of all UT
5	Temporisation 30 s
6	Telemetry processing

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BDR configuration

R 123-2 Deleted

R 124 The EGSE shall send a MTUT test telecommand to configure each UT_i of the BDR in TEST mode.

R 227 The EGSE shall send a MASR test telecommand to configure the addressed chain of the BDR in ASR mode with parameter 'start-stop' = 1 if (Jamming_mode=YES), and 'start-stop' = 0 if (Jamming_mode=NO).

Note : see AD19, AD19, AD19 for MTUT and MASR telecommands definition and format.

R 125 The EGSE shall use the input parameters *Mean_velocity_UTi* and the parameter VELOCITY_BIAS_Uti from the DSPF file to compute the velocity parameter (Velocity = *Mean_velocity_UTi* + VELOCITY_BIAS_Uti) of each MTUT telecommand, for UT_i with i = 1 to 7.

R 126 The EGSE shall configure the parameter #2 of the telecommands MTUT as follows :

- SYN=0
- CH=0
- R=1

R 127 Deleted.

R 128 Deleted.

DBS configuration

See § 7.4.9.4

RF emission and telemetry processing

See § 7.4.9.6

Initialization of all UT

R 269 The EGSE shall send a VUT TC on all UT to initialize all UT

Temporization 30s

Delay required to for BDR relaxation

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7.4.9.6 Telemetry processing requirements

Note about time scale correspondence:

The DISS can send at any time a TC NOP for acquisition of a report packet that gives TAI and TOUS time corresponding to the current EGSE time.

This should be done at the beginning and at the end of the DBS emission in order to determine the start and end dates of the useful telemetry to be processed by the DTP.

General requirement

R 129 The telemetry processing shall be applied to all useful sequences from 1 to N_seq for each UT in TEST mode.

R 130 The EGSE shall use the following validity criteria for subsequent processing:

- Doppler validity in 400MHz band : Val_DOP_400MHZ is set to 0
- Doppler validity in S band : Val_DOP_2GHZ is set to 0
- T3_Datation date validity : T3_Datation $\neq$ 0
- message validity : message $\neq$ 0000...
- Measurement full validity : all above criteria are valid

Note: Meas_coherence_OK parameter is not retained as validity criteria for TMD6 processing.

Doppler measurements performance assessment

R 245 In order to assess the Doppler measurements performance, the EGSE shall process the scientific telemetry as follow for each band and each UT in TEST mode :

- computing and plotting of Doppler variances for each packet of 30 successive valid Doppler measurements,
- computing of the average, min, max and quadratic average of the above variances,
- checking quadratic mean variance against required values *Max_sigma_dop_2G* and *Max_sigma_dop_400M*,
- plotting of the Doppler frequency from all valid Doppler measurements,
- computing of the mean Doppler frequency from all valid Doppler measurements.

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Computing of Doppler variances for 30 measurements :

The Picinbono variance shall be used. The equation of this variance is defined in Annex 3.

The computing applies only to a packet of 30 successive valid Doppler measurements. When non-valid measurements are encountered, the algorithm shall skip these measurements and look for the next packet of successive valid measurements, if any.

The last valid measurements shall be discarded if their number is less than 30.

The algorithm shall process the measurements in their chronological order.

Computing of the quadratic mean variance :

The following mean shall be computed:

$$qm = \sqrt{\frac{1}{m} \sum_{i=1}^m PV_i^2}$$

where PV_i are the m Picinbono Variances determined at the precedent step.

Computing of the UT processing probability

R 246 The 3 following processing probabilities shall be determined for each UT in TEST mode:

- measurement probability : ratio of the number of fully valid measurements over the total number of measurements processed by the EGSE
- Doppler processing probability on 400 MHz band : ratio of the number of valid 400MHz band Doppler measurements over the total number of measurements processed by the EGSE
- Doppler processing probability on 2 GHz band : ratio of the number of valid S band Doppler measurements over the total number of measurements processed by the EGSE
- The EGSE shall check these probabilities against the required values *Min_meas_proba*, *Min_dop_proba_2G*, *Min_dop_proba_400M*

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Processing of CAG level

R 247 The EGSE shall process the CAG levels from the scientific telemetry, as follow for each band and each UT in TEST mode:

- plotting the CAG level of all Doppler valid measurements,
- computing of the mean, max and min CAG level from all Doppler valid measurements,
- computing of the mean, max and min CAG error,
CAG error = (CAG level - DBS emitted level)
- checking max and min errors against required values $\pm Max_CAG_error_X$. ($X= 400M$ or $2G$) .

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Processing of T3 Datation measurements

R 248 The EGSE shall process the T3_Datation measurements from the scientific telemetry, as follow for each UT in TEST mode:

T3_Datation variance processing

- computing and plotting of the Picinbono variances of T3_Datation for each packet of 30 successive valid T3_Datation measurements (same algorithm as for Doppler processing),
- computing of the quadratic mean of the above variances (same algorithm as for Doppler processing),
- checking of the quadratic mean against the required value *Max_sigma_T3* .

Nota : for the T3_Datation variance processing it is not necessary to take into account the TDI – SI bias file.

ΔT3 mean value processing

ΔT3 shall be computed from T3_Datation and (TDI-SI) measurements as described in Annex 4.

- computing and plotting of the mean ΔT3 values for each packet of 30 valid measurements,
- computing of the mean ΔT3 value from all the valid measurements,
- checking of the mean ΔT3 value against the required values *Min_delta_T3_400M* and *Max_delta_T3_400M* (for 400MHz channel) and *Min_delta_T3_2G* and *Max_delta_T3_2G* (for 2GHz channel) (read in DSPF).

Group delay computing

The EGSE shall compute group delay on both channels as per Annex 4

Bit error rate computing

R 249 The EGSE shall process for each UT in TEST mode, every received message as follow :

- compare the received message to the sent message (as defined by the input parameter *Message*),
- record the TOUS date and the content of the failed messages in hexadecimal string format for easy false bit identification (limited to the first 10 failed messages only),
- accumulate the number of false bits if any.

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- Then a Bit Error Rate shall be computed for each UT in TEST mode as the ratio of the number of false bits over the whole number of bits processed (i.e. number of valid messages x number of bits of the message).
- The EGSE shall check that the number of false bits is less than the specified value (parameter: “BitErrorNumber”).
- The BER shall be computed separately on each channel 400MHz and 2GHz.

Note 1 : Bit VM of the message is managed by the DBS depending of the channel.

Note 2 : As an EDAC is used on the 2GHz channel, the BER test result on this channel will lead in:

- “0” (no error bit) within the efficient operating range of the EDAC
- a BER value depending of the number of bits set to “1” in the original message as soon as the inefficiency threshold of the EDAC will be reached. In this case, the message given in the Doppler packet is forced to “0” so that, while comparing it with original, only bits set to “1” in the original message will be counted as false. In fact, the true number of erroneous bits by received message is included in the range: [EDAC threshold, total number of bits of the message]

Processing results edition

R 250 All numeric results and plots from the above steps shall be stored in three printable files. The formats required are :

- html file
- pdf file
- plain text file

ASR processing

When instrument is configured in ASR mode, the processing of the ASR telemetry will be performed manually in off line mode. No automatic processing is requested to the DTP.

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7.4.10 TMD7 requirements

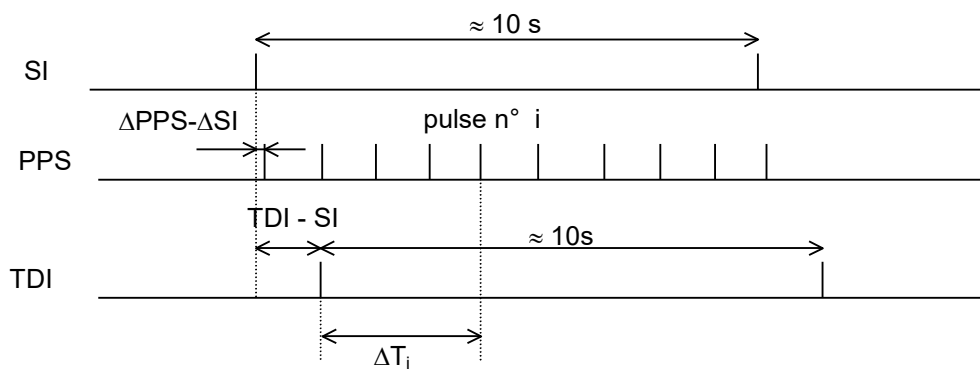
7.4.10.1 Object of the TMD7

The TMD7 is used during admittance test for verification and calibration of the hardware functions involved in the time tagging of the PPS signal.

The test uses the knowledge of the TDI-SI bias and the PPS-SI biases (30 constant values) for the verification process.

- ΔPPS is an internal bias of the EGSE, it is assumed constant and shall be characterised by DACTEM,
- ΔT_i is the measured delay between the BDR internal TDI pulse and received PPS pulse modulo 1 second.

Note: the BDR Measurement Bias is nominally 300 ns $\pm$ 100 ns (input propagation time + measurement noise).



In addition, the test processing shall take into account the EGSE measurement biases due to the following propagation times:

- from the BDR J2 connector to the time counter input: ΔTDI
- from the DBS internal SI signal to the time counter input: ΔSI
- from the DBS internal PPS signal to the BDR J5 connector: ΔPPS

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7.4.10.2 TMD7 Input parameters

No input parameters for this test.

7.4.10.3 DBS configuration

The DBS is used only for stable PPS and SI generation for this test.

Thus no specific configuration of the DBS is required for this test.

7.4.10.4 Assumptions

- DORIS instrument is ON,
- Auto Initialization process is not going on (completed or aborted),
- PPS is transmitted by DBS via DISS.

7.4.10.5 TMD7 actions requirements

R 220 The TMD7 shall execute sequentially the following actions:

N°	Action description
1	BDR configuration
2	Acquisition of one Report Packet
3	Verify BDR configuration
4	Record initial time synchronisation information
5	Acquire at least 30 successive datation packets
6	Record final time synchronisation information
7	Telemetry processing (datation packets and time synchronisation information)

BDR configuration and verification

R 221 The EGSE shall send the VUT telecommand for all UT (step 1) then shall check the acknowledgment (step 3).

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Record initial time synchronisation information

R 251 The EGSE shall record the TAI date of the report packet and report it in the test log file as *RPTD*.

R 252 The EGSE shall acquire the TDI-SI bias, store it in the .bia file..

Record final time synchronisation information

R 253 Immediately following the acquisition of 30 datation packets, the EGSE shall acquire the TDI-SI bias, store it and report it in the test log file.

7.4.10.6 Telemetry processing requirements

R 222 The EGSE shall transmit telemetry (30 datation packets) acquired during the test and the parameters RPTD, TSD and TSF to DTP for processing.

R 223 The EGSE shall check availability of valid (error control code OK) datation packets.

- If none then test is KO : “no valid datation packets available”,
- else
 - If number of valid datation packets < 30 then test is KO: “number of available datation packets: [number of datation packet(s)] < 30”,
 - Else go on through processing

R 224 The EGSE shall plot TAI date data as follow:

- Plot TAI date w.r.t. packet time of datation packets,
- Plot TAI date modulo 1 second w.r.t. packet number (it is assumed that packet number 1 is the older one).

R 254 The EGSE shall apply the following algorithm to datation data:

- Set I_0 = Integer (packet time of first datation packet modulo 10 seconds) assuming packet time is expressed in seconds,
- For $I = 1$ to 30 do

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- $TS(I) = TSD + (I_0 + (I-1)) \cdot (TSF - TSD) / 30$, (compensation of USO's frequency biases)
- $\Delta T(I) = (TS(I) + TDDP(I) - RPTD - \Delta PPS - \Delta TDI + \Delta SI) \text{ modulo } 1 \text{ second}$,

With:

$TDDP(I)$ = TAI date of datation packet

ΔPPS , ΔTDI , ΔSI = EGSE internal time delays characterized by the EGSE manufacturer.

– Plot $\Delta T(I)$ w.r.t. I

R 255 The EGSE shall compute the following datation statistical data:

- mean datation delay: $\Delta T_m = \Sigma \Delta T(I) / 30$,
- datation delay standard deviation : $\sigma \Delta T = ([\Sigma (\Delta T(I) - \Delta T_m)^2] / 30)^{1/2}$
- max datation delay : $Tm_max = \max (\Delta T(I))$
- min datation delay : $Tm_min = \min (\Delta T(I))$

R 225 The EGSE shall control the following datation statistical data:

- “Standard deviation” : $\sigma \Delta T < \max_PPS_SD$
- “Max value” : $\max \Delta T(I) < \max_PPS_bias$
- “Min value” : $\min \Delta T(I) > \min_PPS_bias$

Note: test limits for data control shall be read in the DSPF.

Processing results edition

R 226 All plots, recorded and computed values and parameters, control results shall be reported in the log file and reported in a retrievable file.

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7.4.11 TMD5 requirements

7.4.11.1 Object of the TMD5

The standard Test Module TMD5 is used for easy and automatic uploading into the BDR of a new resident software in EEPROM bank A or B.

7.4.11.2 TMD5 input parameters

R 131 The TMD5 shall accept the following configuration parameters

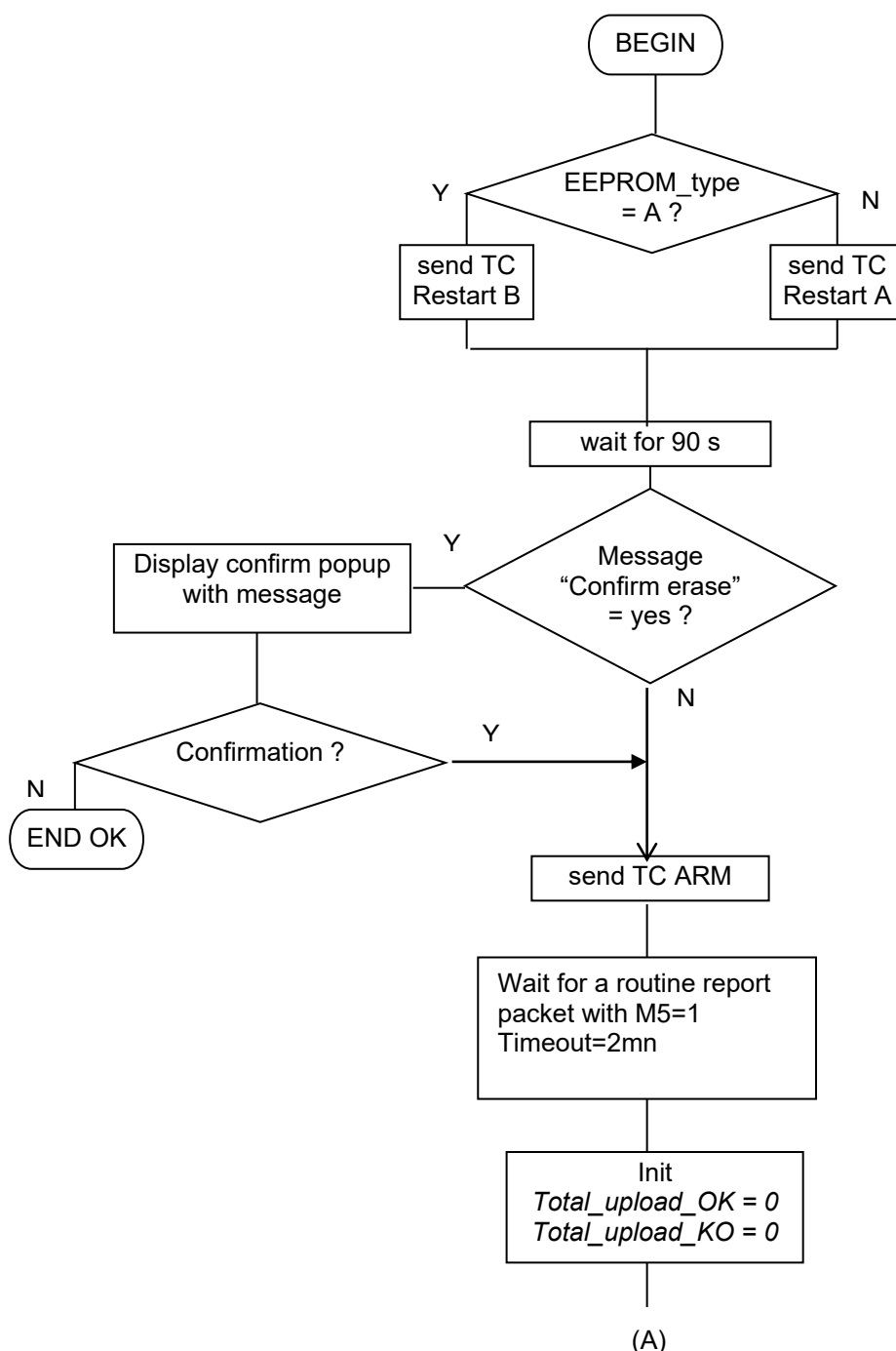
Parameters name	Type	Unit	Nominal range	Definition
File_identifier	string	-	-	Name of the file to be uploaded, the file format shall be compliant to or AD11 or AD19 see Table 4-1
EEPROM_type	string	-	A or B	Defines the target EEPROM bank for the upload
Zone identifier (only for DGXX-S EGSE version)	4 bits integer	-	8 4 2 1	For DGXX-S Code For DGXX-S ZQS DORIS For DGXX-S ZQS DIODE For DGXX-S ZQS System

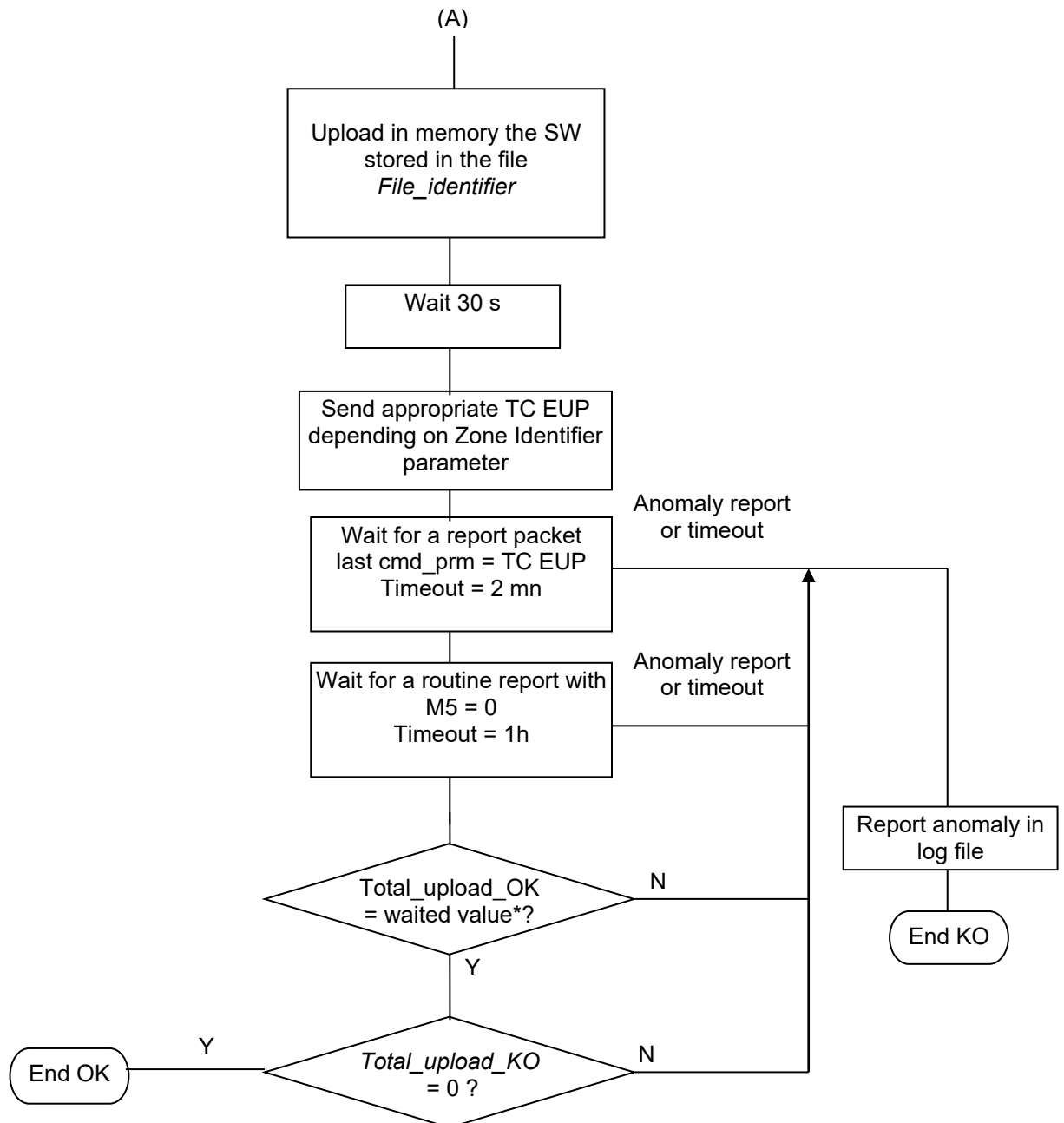
7.4.11.3 TMD5 actions requirements

R 132-1 Deleted

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R 132-2 The TMD5 shall implement the actions described by the following diagram for DGXX-S:





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* Waited value : total number of uploaded Upload_Memory_TCs

7.4.11.4 Telemetry processing requirements

R 133 Deleted.

7.4.11.5 TMD5 miscellaneous requirements

R 134 Deleted.

7.4.12 TMD8 requirements

7.4.12.1 Object of the TMD8

The standard Test Module 8 is used to implement a temporisation between two active TMD.

The TMD8 is useful for example during a temperature transition while keeping the benefit of the monitoring task.

7.4.12.2 TMD8 actions requirements

R 135 The DISS shall wait for T minutes before ending the TMD8.

T is an input parameter of the TMD8 defined as an integer value in minutes

R 187 The DISS shall record in a retrievable file every 15 minutes during execution of the TMD8, the last acquired analog telemetries.

7.5 TEST SEQUENCES REQUIREMENTS

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7.5.1 Test Sequences definition

A Test Sequence is a file that defines a list of standard TMD that the DISS will execute in sequence automatically.

THALES will build a basic set of Test Sequences, which will be used in the different stages of BDR level tests.

7.5.2 Test Sequence management requirements

R 136 The DISS shall be able to manage at least 100 Test Sequences composed of up to 50 Test Modules and/or primitives.

R 137 The DISS shall provide to the user, tools for building, archiving, editing and printing of the Test Sequences.

R 229 Before execution of TMD3, TMD5, TMD6 or TMD7, the DISS shall verify that the last acquired DBLs are as expected. In case of anomaly the Test Sequence shall be immediately aborted.

R 230 An optional comment entered by the user, shall be attached to each TMD in the Test Sequence file.

Note: this comment shall be recorded in the TMD log file and in the TMD standard acceptance data log.

R 235 The DISS shall be able to run tests sequences composed of automatic and semi-automatic TMD.

R 261 Archiving of a TMD telemetry file in the EGSE including the following data:

- reference of the log file,
- information about the TMD (type and parameters),
- local date and time of the TMD execution,
- raw DORIS telemetry recorded during the TMD,
- for each TSQ played, all TMA and temperature acquisition must be stored in a file,
- TMD and semi-automatic test can be programmed in the same TSQ,
- The file name shall include the date and time of the TMD,

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- time bias acquisitions if required depending on TMD.

R 266 During TMD execution, the survey of the BDR is executed each minutes (with possibility to change time acquisition).

7.5.3 Test Sequences execution requirements

R 138 The DISS shall allow the automatic execution of any Test Sequence selected by the user, for up to 24 hours of continuous operation.

R 139 The DISS shall provide to the user a mean to stop the processing of the test sequence at the end of the current TMD under execution. If this mean is used, the DISS shall record in the log file and display immediately this action.

Note: This requirement is a complement of R-104.

R 140 In case of abnormal exit of the TMD execution (See § 7.4), the DISS shall resume with the execution of the next TMD in the test sequence.

7.5.4 Common parameters of the test sequence processing

One parameter is applicable to TMD1 and all TMD following this TMD1:

- selection of the active MIL-STD 1553 bus interface use for TM/TC communication: nominal or redundant

This parameter is one of the input parameters of the TMD1 (See § 7.4.5).

7.6 PRIMITIVES REQUIREMENTS

R 231 Deleted.

7.7 MANUAL TOOLS REQUIREMENTS

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R 141 The EGSE shall offer to the user the possibility to quickly prepare and execute all sole standard Primitives (via menu bar for instance).

R 142 The EGSE shall offer to the user the possibility to build non-standard Test Modules based on standard Primitives.

R 143 The EGSE shall provide a "record" mode allowing the automatic creation of a Test Module based on the successive Primitives executed by the user.

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8. DTP SPECIFIC REQUIREMENTS

8.1 RS422 REQUIRMENT

R 170 The DTP shall implement a RS422 interface for communication with the TM/TC test interface #1 (from BDR-J7).

R 171 The RS422 electrical interface of the DTP shall be insulated from RJ-45 interface through optocouplers.

R 172 The DTP shall comply with the following protocol over the RS422 interface:

Hardware protocol

- 19200 bauds
- 8 bits of data
- 1 start bit
- 1 stop bit
- no parity bit

Software protocol

- no software handshaking: TM and TC packet are sent at any time when available with no verification of the receiver status before or after the emission, it is the responsibility of the receiver to handled the flow of TM or TC packets

TM and TC formats

- TM and TC data are formatted in packets using the same formats as for the nominal MIL-STD 1553 interface (as defined in or AD11 or AD15 or AD19 see **Table 4-1**)
- all data shall be sent in binary code as for the MIL-STD 1553 interface
- a 32 bits synchronisation header 0A 6F CD 04 (hexadecimal) shall be sent before and after each packet only for TC

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Note: the BDR has the ability to send TM packet formatted in ASCII code for troubleshooting purpose with a low level terminal. This feature can be activated through a test TC packet but will not be used in association with the DTP.

R 256 The DTP shall be able to send over the RS422 interface "universal" TC entered by the user:

- Function code "WWWW" H
- Parameter # 1 "XXXX" H
- Parameter # 2 "YYYY" H
- Parameter # 3 "ZZZZ" H
- Parameter # 4 "AAAA" H

WWWW, XXXX, YYYY , ZZZZ and AAAA are 16 bits binary values entered by the user in hexadecimal format.

8.2 MISCEALLENOUS

R 273 DTP curve scale values must be stored in a configuration file for enhanced graphic results

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9. EGSE CONNECTORS REQUIREMENTS

R 144 The DORIS EGSE shall use robust and easy to lock connectors for non-RF harness connection on the EGSE side. The connector types shall be submitted to THALES for acceptance.

R 145 The harness towards BDR connectors J1 to J7 shall be connected to the EGSE on its rear side.

R 146 The DORIS EGSE shall use N female type connectors for 400MHz and 2GHz bands links.

R 265 All connectors of any harness shall be equipped with all pin, even if some of them are not used inside the harness (not connected to a wire in the harness).

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10. TEST HARNESS REQUIREMENTS

10.1 INTRODUCTION

DACTEM has to provide test harnesses used to connect the BDR to the EGSE, including RF cables.

This chapter defines the requirements applicable to these harnesses.

Table 10-1 defines the test harnesses required from DACTEM for BDR level tests.

Harness ID	From	Towards	Characteristics	Observation
TH1	DISS	BDR : J1 through J7 Test base plate : JTH	Shielded wires	used in all test phases including EMC and thermal vacuum
TH2	DBS	BDR : J30 & J31	RF cables	used in all test phases including EMC and thermal vacuum, but DACTEM cable will not be exposed to vacuum.
TH3	DTP	BDR : J7	RS422 test cable	not used for EMC and thermal vacuum tests

Table 10-1 - test harnesses definition

The harnesses TH1 and TH3 are connected to the sub D connectors of the BDR unit through savers provided by THALES.

The harness TH2 is connected to the BDR through a connector bracket fitted with N type connectors.

THALES will provide the RF cable from the RF connector bracket to the BDR unit.

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10.2 HARNESS TH1 REQUIREMENTS

In thermal vacuum conditions tests, BDR chain1 unit and BDR chain2 unit must be tested without stopping vacuum conditions (BDR connectors inside vacuum room must be changed at each BDR CHAIN unit test and after ambient pressure return).

DACTEM shall provide a test harness TH1 which interconnect the DISS to the following connectors (see figure 1 and 2 for more information):

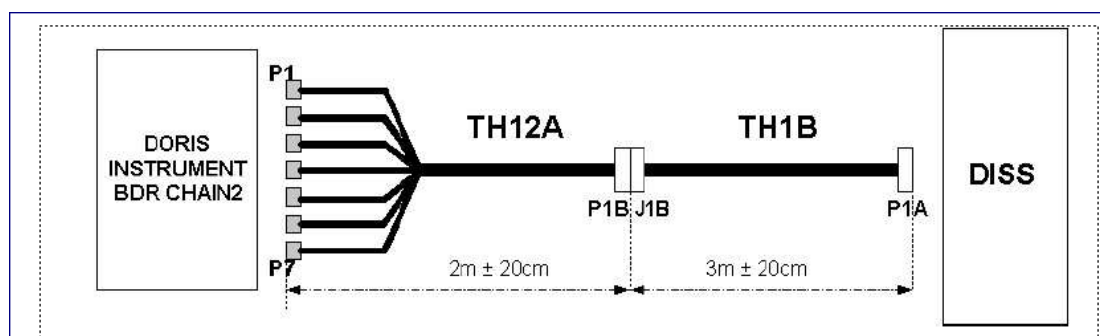
BDR Chain1 unit: J1, J2, J3, J4, J5, J7 or BDR Chain2 unit: J1, J2, J3, J4, J5, J7

The test harness TH1 is divided in two sections TH1A / TH1B. TH1A is supplied in two strictly identical harness named TH11A and TH12A. The two sections TH1A (TH11A and TH12A) and the single section TH1B are supplied with the EGSE.

1 harness TH11A for BDR chain1 unit (DORIS side).

1 harness TH12A for BDR chain2 unit (DORIS side)

1 harness TH1B for DISS side.



P1B, J1B, P1A are 128 pins connectors.

Note: the 2m requirement for the internal harness is applicable to the length between connector P1B and BDR J1 connector.

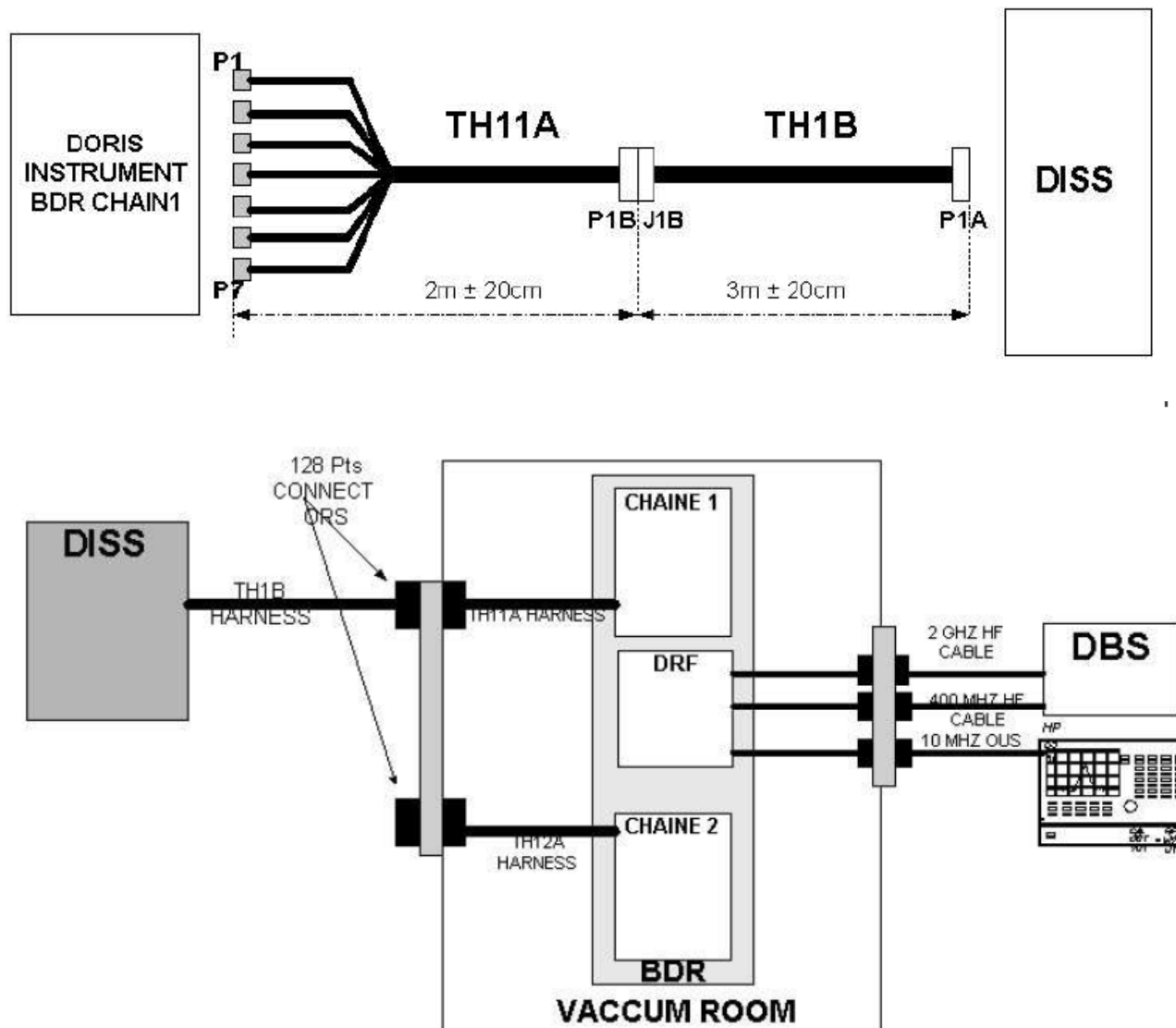


Figure 1 BDR CHAIN 1 unit – DISS unit Vacuum Connections

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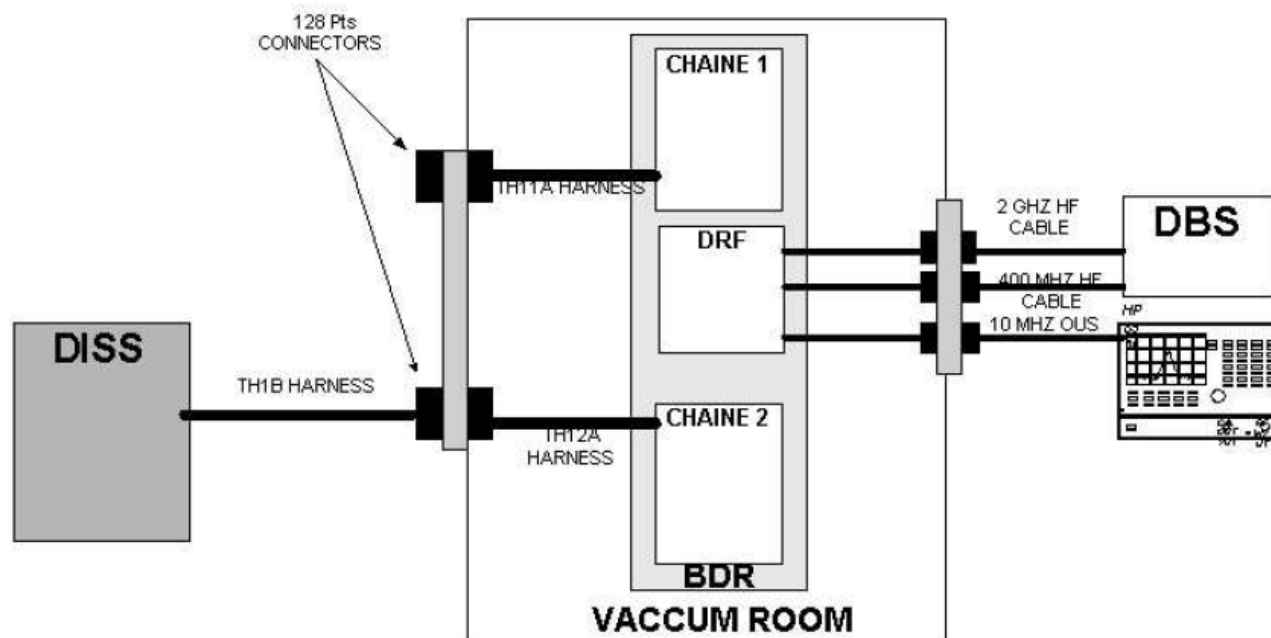


Figure 2 BDR CHAIN 2 unit – DISS unit Vacuum Connections

DACTEM shall provide these following connectors:

TH1B connector P1A Male 128 pins :	FRB LM/PJV 15-12 PMR
TH1B connector J1B Female 128 pins:	SOCAPEX LJT 06 RT 25-35 SN 014
TH11A and TH12A connector P1B Male 128 pins:	SOCAPEX LJT 01 RT 25-35 PN 014

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R 147 Deleted

R 148 The sub D connector on the BDR side shall provide good EMC shielding.

Note: connectors type and bonding provision to be proposed by DACTEM for approval by THALES,

R 149 The different branches of the harness, departing from the DORIS instrument, shall be grouped in a sole strand at a distance of 45 cm $\pm$ 5cm from the BDR

Note: this will allow easy attachment of the harness to the test plate, for safety reason.

R 150 The test harness section on the BDR side shall be compatible with vacuum conditions (outgasing).

R 151 The test harness section on the BDR side shall withstand the following temperature range: -40°C to +70°C.

THALES imposes no other specific requirements for the design of the harness. However DACTEM shall use the best practices for this kind of design.

R 271 The harness design shall be submitted to THALES for acceptance.

10.3 RF HARNESS TH2 REQUIREMENTS

R 152 DACTEM shall provide two RF cables of 6 meters long fitted with N type connectors.

R 153 Deleted

R 154 The RF cables type shall be KX13.

Note: THALES will provide the RF cables used for thermal environment tests.

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10.4 TEST HARNESS TH3 REQUIREMENTS

R 155 DACTEM shall provide a test harness of 6 meters long, interconnecting the BDR connector J7 to the DTP.

R 156 Deleted.

R 157 The harness or the DISS shall be able to configure the configuration pins (short circuit or open circuit) from the J5 TH11A on PCONF TH11A connector and from the J5 TH12A on PCONF TH12A connector.

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11. EGSE MISCELLANEOUS REQUIREMENTS

R 158 All DORIS EGSE units shall be movable without special handling devices (low size and mass or use of rollers).

R 159 All DORIS EGSE units shall be delivered within containers (DISS, DBS) or housing (DTP) providing adequate protection against shocks, vibration and moisture in normal transport conditions by road, sea or air.

Note: the containers will be provided by CNES.

R 160 All DORIS EGSE individual units shall be less than 2.0 meters high and 0.8 meters wide.

R 161 All DORIS EGSE units shall be compliant with the EMC norm NF EN 50950 (DBT 73/23/CEE modified 93/68/CEE).

R 162 The main power connection of the EGSE units shall be of the following type: 220 volts, single phase, 10/16A outlet.

R 163 The DISS shall be fitted with an emergency switch off command.

R 164 The DORIS EGSE shall provide a mass storage device allowing archiving of useful test results from the DTP and the DISS. Useful information is the test TM results, all used test parameter files only and test result files. Duplicated storage of any files not used during the test has to be avoided.

R 165 The DORIS EGSE shall include a virtual printer.

R 166 The DISS shall include a drawer for the storage of accessories.

R 167 The computers used in the DTP shall include Libre Office package.

R 168 The EGSE hardware and test software shall be designed to be adaptable (hardware and software) to any DORIS equipment (SENTINEL3, JASON3, SWOT and Jason-CS).

R 275 The EGSE shall be compliant with CE standards

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Design rules:

R 272 The EGSE test software's, shall be designed to be robust to anomalies and to give all possible information related to the origin of a critical anomaly that cause abnormal termination of the execution.

Note : For example: in case of no response of an EGSE unit to a command, print the name of the unit, the local time and the content of the command.

12.SELF TEST AND INITIALIZATION REQUIREMENTS

R 240 The DISS unit shall provide a self-test function, which can be activated by the user:

- activation of self-test of standard equipment (power supply, multimeter, acquisition boards, 1553 board,...)
- test of primary power supply securities (semi manual test accepted)
- activation of self-test of specific units when available (synthesizer of the DBS, interface boards, ...)
- global unit and EGSE test

R 241 At DBS and DISS electrical switch on and after a self-test, the DBS and DISS interfaces shall be placed in a safe and inactive configuration:

- RF levels off
- primary power supply set to 0 V
- 1553 bus inactive
- PPS and DBL inactive (high impedance recommended)

R 242 The self-test results shall be stored in a file for later access and printing under user control.

R 243 Any anomaly encountered during self-test shall be reported to the user.

R 244 All hardware functions of the DBS and the DISS shall be properly initialised in a known state at start-up of the application software:

- primary voltage and current limits configured to nominal values
- initial setting of DBS RF signals : No emission

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- initial configuration of interfaces boards and standard equipments

R 268 Whenever the DBS software is switched off, the RF unit emission shall be stopped. Exception: when RF unit is in local mode, emission cannot be supervised.

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13.DELIVERY REQUIREMENT ITEM LIST

All items described below are made available by CNES to Thalès.

13.1 HARDWARE DELIVERY

R 232 The hardware delivery shall include the following item:

- 1 DBS unit (including screen, keyboard, mouse and associated cables)
- 1 container for the DBS
- 1 DISS unit (including screen, keyboard, mouse and associated cables)
- 1 container for the DISS
- 1 DTP unit (including interface box)

13.2 SOFTWARE DELIVERY

R 233 The software delivery shall include the following item:

- DBS, DISS and DTP application software on relevant hard disk + 1 copy on DVDROM or USB Key (all executable code files and source code files of standard TMD). Electronic delivery is allowed.
- Linux Red-Hat in Dactem configuration on each unit hard disk + original installation DVDROMs or USB Keys. Electronic delivery is allowed.
- Libre Office (contained in Red-Hat package)

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13.3 ANY SOFTWARE UTILITY AS NEEDED, PREVIOUSLY DISCUSSED WITH CNES (FOR EXAMPLE, ALLOW EASY COMPARISON OF HEXADECIMAL DATA).DOCUMENTATION DELIVERY

R 234 The documentation delivery shall include the following item:

- documentation of the standard equipments of the EGSE (PC, power supply, multimeter, ...)
- documentation of the standard software of the EGSE (if any)
- configuration item list for all hardware and software item
- user manual of the EGSE (1 single document or 1 for each unit) including
 - installation procedure,
 - calibration procedure,
 - software user manual,
 - anomaly / limitation / known problems (if any)

This document shall use English language for the DTP and the DBS.

- EGSE electrical definition document (at least external and internal harness definition, functions definition and interfaces)
- acceptance test reports and/or certificates of conformity of the EGSE (including CE certificate).
- EGSE documentation list



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ANNEX 1: DELETED



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ANNEX 2: REQUIREMENTS SORTED LIST

R 1 The DBS shall be able to provide RF signals coming from up to two simultaneous DORIS beacons from 3.0 version. <Page 20>

R 2 The DBS shall be able to be configured under manual control, in order to deliver permanent CW beacon signals with constant frequency and level. <Page 20>

R 3 The DBS shall be able to be configured under DISS control in order to deliver permanent modulated beacon signals with constant frequency and level (static mode). <Page 20>

R 4 The DBS shall be able to be configured in order to deliver simulated RF signals received by a DORIS BDR in orbit (dynamic mode with simulation of Doppler shift and level variation). <Page 20>

R 5 Deleted. <Page 21>

R 6 In dynamic mode, the DBS shall be able to process an input file defining every 10 s the ephemerides of the satellite and an input file defining the position of the DORIS beacons (ephemerid mode). <Page 21>

R 7 In static mode, the DBS shall be able to maintain a continuous emission for at least 3 hours. <Page 21>

R 8 In dynamic mode, the DBS shall be able to maintain a continuous emission for at least 24 hours. <Page 21>

R 9 The DBS shall be able to shut off its RF emission (off mode). <Page 21>

R 10 In dynamic mode, the start of the DBS emission shall be driven by the DISS. <Page 21>

R 11 The DBS shall provide a test output of one of its internal USO references. <Page 21>

R 12 The SI time reference of the beacons shall be accessible for test purpose. <Page 21>

R 13 The reference impedance of the RF outputs shall be 50 ohm. <Page 22>

R 14 The VSWR of the RF outputs shall be less than 1.2 in static and dynamic modes. <Page 22>

R 15 Each RF signal level shall be programmable by step of 1 dB within an instantaneous range of 50 dB for the 2GHz band and 400MHz band output port. <Page 22>

R 16 The maximum level of the instantaneous range shall be adjustable by step of 10 dB in the range [-90 dBm, -40 dBm]. <Page 22>

R 17 By design, the RF level shall be limited in any circumstances to -24 dBm. <Page 22>

R 18 Within a delay of 30 days after calibration, the absolute precision of the RF levels delivered by the EGSE in static mode shall be better than: <Page 22>

R 19 In dynamic modes, the EGSE shall modify the RF levels only during the time window [SI - 700 ms, SI - 500 ms] where SI is the time reference of the 10s sequence of the beacons. <Page 22>

R 20 In all modes, the noise spectral density of the RF output ports shall be less than -170 dBm/Hz inside the DORIS bands. <Page 22>

R 21 In Off mode, the RF output level shall be less than -150 dBm on 2GHz band and 400MHz band ports. <Page 22>

R 22 The EGSE shall be able to drive the BDR inputs with no alteration of the RF output signals, excepted RF level modification due to the VSWR of the BDR inputs. <Page 22>

R 23 Deleted. <Page 23>

R 24 In static mode, the RF 2GHz band frequencies shall be programmable in the range [407,25 FUSO $\pm$ 100 kHz] with a resolution better than 1 Hz. <Page 23>

R 25 In static mode, the RF 400MHz band frequencies of a spurious shall be programmable in the range [80,25 FUSO $\pm$ 20 kHz] with a resolution better than 1 Hz. <Page 23>

R 26 In static mode, the RF 2GHz band and 400MHz band frequencies (resp. F2 and F1) of a same beacon shall be programmable independently. <Page 23>

R 27 In static mode, the short-term relative stability of the RF signals must be better than 5.10⁻¹³ for an integration time of 10 s (Picinbono variance computed over 30 measurements). <Page 23>

R 28 In dynamic modes, the bias between the target frequency and the delivered RF frequency every 10 seconds, must be less than: <Page 23>

R 29 Deleted. <Page 23>

R 30 Deleted. <Page 24>

- R 31** The USO output used as a test output shall be routed directly to a BNC connector. <Page 24>
- R 32** The jitter of the SI test output shall be less than 100 ns (3 sigma). <Page 24>
- R 33** The requirements applicable to the SI test output interface are the following: <Page 24>
- R 34** The DBS shall provide a calibration process of the RF signal levels. <Page 24>
- R 35** The calibration process shall use EGSE internal measurement means or standard external means provided by the user (spectrum analyser or power meter). <Page 24>
- R 36** The full calibration process shall take less than 15 minutes to complete. <Page 24>
- R 37** After calibration, a printable calibration report shall be stored on the hard disk of the DBS for archiving. <Page 25>
- R 38** The DBS shall use the compensation parameters determined during the last calibration. <Page 25>
- R 39** The DBS shall be able to take into account two different (main or additional) attenuation or gain values defined by the user. <Page 25>
- R 40** Deleted. <Page 25>
- R 41** The DBS shall display permanently on a LCD or CRT monitor the following information: <Page 25>
- R 42** The required information displayed by the DBS shall be refreshed every 10 seconds. <Page 25>
- R 43** The DISS shall implement an emulation of all Sentinel3, Jason3, SWOT or Jason-CS electrical interfaces as defined in the table 5.2-1 below : <Page 26>
- R 44** The DISS shall implement the additional electrical interfaces defined in the table 5.2-2 below. <Page 28>
- R 45** In case of EGSE failure or main power loss or printer malfunction, the EGSE shall be able to retrieve and process in batch mode all the acquired telemetry up to the last successful test module. <Page 29>

R 46 The DISS shall provide a measurement of the time bias between the active edge of the SI synchronisation signal (from the DBS) and the active edge of the TDI.TEST signal (from BDR-J2) with a precision equal or better than 100 ns. <Page 29>

R 47 The rate of measurement of TDI-SI shall be 0.1 Hz. <Page 29>

R 48 The DISS shall implement electrical interfaces compliant with AD5, and AD7 filtered by AD8, AD9, AD13, AD21 and AD23 according to Table 4-1. If there are differences between the interfaces of the 3 satellites, the DISS shall implement the interface depending of the satellite interface simulated for the unit under test. <Page 32>

R 49 The DISS shall implement to all possible extent the same interface circuits as the S/C. <Page 32>

R 50 The DISS shall be compliant with AD5 and AD7 filtered by AD8, AD9, AD13, AD21, and AD23 according to Table 4-1 (fault emission) in case of an EGSE single failure and when the EGSE is off. <Page 32>

R 51 The grounding concept of the EGSE shall be compliant with AD5, and AD7 filtered by AD8, AD9, AD13, AD21 and AD23 in agreement with Table 4-1. <Page 32>

R 52 Deleted <Page 33>

R 53 The DISS shall display permanently the last acquired STATUS.POWER and STATUS.UC statuses through two LEDs on the DISS display. <Page 33>

R 54 The DISS shall make available through BNC connectors the following test signals from BDR-J2: <Page 33>

R 55 Deleted. <Page 34>

R 56 Deleted <Page 34>

R 57 Deleted. <Page 34>

R 58 The DISS shall implement MIL-STD 1553 redundant bus interface compliant with AD17. <Page 34>

R 59 deleted <Page 34>

R 60 The DISS shall be able to select EEPROM A or B by a test directive. <Page 34>

R 61 The bus management shall be maintained permanently as long as the DISS is in nominal operating mode. <Page 34>

R 62 The DISS shall be able to communicate with the instrument for every possible value of the mission configuration pins interface as defined in Table 4-1) <Page 35>

R 63 Deleted. <Page 35>

R 64 Deleted (reported in R – 174). <Page 35>

R 65 Deleted (reported in R – 174). <Page 35>

R 66 Deleted <Page 35>

R 67 Deleted (reported in R – 179). <Page 35>

R 68 The DISS shall provide a programmable voltage source in the range [0V, 40V]. <Page 36>

R 69 The programming step shall be less or equal to 100 mV. <Page 36>

R 70 The precision of the programmed voltage at the BDR CHAIN1 unit or CHAIN2 unit input shall be better than 100 mV. <Page 36>

R 71 The power supply shall provide an over voltage limiter adjustable to 39 V (non programmable for safety reasons). <Page 36>

R 72 The current capability of the source shall be 3A or above. <Page 36>

R 73 The power supply shall provide a programmable current limitation programmable in the range [0, 3A] by step of 100 mA. <Page 36>

R 74 The source impedance shall be less than 100 mOhm from 0 to 100 Hz. <Page 36>

R 75 The noise at the voltage source output shall be less than 50 mV RMS in the 30 Hz-50 MHz band, when connected to the BDR. <Page 36>

R 76 The spurious lines at main frequency (50 Hz and harmonics) at the voltage source output shall be less than 10 mV. <Page 36>

R 77 At the DISS rack switch ON, the voltage source shall be off by default ($|V_{out}| < 1V$). <Page 36>

R 78 Deleted. <Page 37>

R 79 The DISS shall provide software drivers for execution of the Power Command telecommands (HMI for manual control, low level primitives). <Page 37>

R 80 After execution of a Power Command, the DISS shall control proper execution by monitoring of the related status line and record and report on the DISS standard display and in a retrievable file in case of non-acknowledgement by the status power. <Page 37>

R 81 The design of the Power Command interface shall allow easy modification of the voltage and pulse length for trouble shooting facility and for different satellite accommodations <Page 37>

R 82 Deleted. <Page 37>

R 83 The DISS shall provide software drivers for execution of the RESTART A&B telecommands (HMI for manual control, low level primitive). <Page 37>

R 84 Deleted. <Page 38>

R 85 The PPS signal shall be synchronous of MIL-STD 1553 bus activity. <Page 38>

R 86 Deleted. <Page 38>

R 87 Deleted. <Page 38>

R 88 Deleted (reported in R – 174). <Page 38>

R 89 The DISS shall implement an input interface for at least the above current telemetries on J3 connector (i.e. +5V current and +20 V USO current). <Page 38>

R 90 Deleted. <Page 39>

R 91 The DISS shall implement an interface for the acquisition of the test plate temperature provided by a thermistor. The temperature is computed by interpolation verify two thermistance values in the table defined in Annex5 . <Page 39>

R 92 The DISS shall be able to measure the BDR CHAIN1 unit or CHAIN2 unit primary current with a precision of ± 20 mA. <Page 39>

R 93 The DISS shall provide adequate measurement means and software drivers for acquisition and decoding of the analog telemetries defined in R 89, R 91, R 92 above (HMI for manual control, low level primitive). <Page 39>

R 94 The DORIS EGSE shall manage one or several parameter files gathered in the same directory which provide whenever needed standard parameters values to

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hardware and software modules of the EGSE. In the remainder of this document, a generic name is used for these files: DORIS Standard Parameters Files (or DSPF).
<Page 41>

R 95 The DSPF shall be ASCII files which can be easily modified by standard editing tools. All the modifiable parameters will be changed through specific HMI software either for specific mission adaptation purpose or for test purpose. <Page 41>

R 96 The EGSE shall implement the following standard Test Modules: <Page 54>

R 97 Before any TMD processing, the EGSE shall record in a log file: <Page 54>

R 98 During processing of any TMD, the EGSE shall record in a log file the current local time, the name, the parameter values (if any) in decoded format before every Primitive execution and its overall execution status. <Page 55>

R 99 At the beginning of any TMD processing, the EGSE shall conduct the following actions: <Page 55>

R 100 During processing of any TMD, the following action/primitive shall be executed: <Page 55>

R 101 After processing any TMD, the TMD log file shall be archived in the EGSE and then printed if required by the test configuration (test parameter set by the user). <Page 56>

R 102 The DTP (and the DISS) shall provide a way for retrieving old log files and telemetry files. Useful files will be stored in a specific test folder for archiving purpose. <Page 56>

R 103 The DTP shall be able to execute in batch time the actions 12, 14 and 15 of the requirement R by retrieving the archived telemetry file. <Page 56>

R 104 The EGSE shall provide to the user a mean to stop immediately the execution of a TMD. <Page 56>

R 105 In case of abnormal termination of a TMD (due to DORIS or EGSE anomaly or user action), the EGSE shall archive the current log file and a partial telemetry file in order to facilitate the analysis of the anomaly. <Page 56>

R 106 The duration of the configuration phase of a TMD shall be minimised and not exceed 5 mn. <Page 56>

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R 107 The duration of the exploitation phase (telemetry processing) of TMD1, TMD3, TMD6 and TMD7 shall be minimised and not exceed 10 mn (printing time not included). <Page 56>

R 108 Source code of the standard TMDs and executable code of development tools (lab windows CVI) shall be provided to allow customisation of the TMDs by the user. <Page 56>

R 109-1 The TMD0 shall execute sequentially the following actions, depending on the input parameters value: <Page 58>

R 109-2 In case of anomaly, the DISS shall immediately stop the TMD0 execution and report the anomaly. <Page 59>

R 109-3 The DISS shall wait for 30 seconds before execution of the switch ON procedure after switch OFF in order to allow for proper relaxation of the DC/DC converter inside the BDR CHAIN1 unit or CHAIN2 unit. <Page 59>

R 109-4 The DISS shall control the input parameter “Primary_voltage” by reference to minimum and maximum voltage defined in the DSPF: if input is lower than minimum or higher than maximum, DISS limits voltage to this extremum value and a warning is written in the HMI of the DISS. <Page 59>

R 109-5 The DISS shall send the switch command “DORIS ON”. <Page 59>

R 109-6 The DISS shall acquire and verify the STATUS.POWER DBL status and verify that the chain is powered ON. <Page 59>

R 109-7 The DISS shall record in a TMD file all the analog telemetry’s defined in § 6.12 (last data acquired by the monitoring task). <Page 59>

R 110-1 The TMD1 shall execute sequentially all or several of the following actions, depending on the input parameters value: <Page 60>

R 110-2 The satellite name and model shall be defined with the HMI during DISS controller initialization. <Page 61>

R 110-3 The DISS shall execute the following actions depending on the input parameter “EEPROM”: <Page 61>

R 110-4 Deleted <Page 61>

R 110-5 In case of anomaly the TMD1 shall be aborted immediately. <Page 61>

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R 110-6 The DISS shall use the automatic time synchronisation process inside the BDR for DBS-BDR proper synchronisation. <Page 61>

R 110-7 The automatic time synchronisation process requires the following actions: <Page 62>

R 110-8 the DTP shall verify the existence of at least a valid Doppler packet from the UT designated by the input parameter “ut_number”. Select the last valid Doppler packet in the TM flow and for this packet, verify the following items: <Page 62>

R 110-9 beacon message: equal to the emitted message. <Page 62>

R 110-10 The DISS shall analyse the datation packets by using the following algorithm: <Page 62>

R 110-11 This verification shall always be done by the DISS. <Page 62>

R 110-12 In case of anomaly the TMD1 shall be failed. <Page 63>

R 111-1 The TMD2 shall execute sequentially the following actions: <Page 64>

R 111-2 Immediately after the previous action, the DISS shall verify the following analog telemetry: <Page 64>

R 111-3 The DISS shall configure the primary power source to 0V. <Page 64>

R 112-1 The TMD6 shall accept the following configuration parameters: <Page 83>

R 112-2 The DISS shall add a Velocity bias (defined in the DSPF) to the MEAN_VELOCITY_Uti specified to compute the MTUT parameter. <Page 84>

R 113 The duration of the active emission phase shall allow the processing by the BDR of a number of N_seq DORIS sequences (ten seconds). <Page 84>

R 114 Two active fully modulated beacons shall be simulated by the beacon #1 and #2 of the DBS. <Page 84>

R 115 The simulated frequency of each beacon shall be defined as follow : <Page 84>

R 116 Each beacon RF levels shall be configured by using RF_level_2G_i and RF_level_400M_i input parameters. <Page 85>

R 117 The modulation message in 400MHz band shall be defined as follow : <Page 85>

R 118 The modulation message in S band shall be defined as follow : <Page 85>

R 119 Deleted. <Page 86>

R 120 Deleted. <Page 86>

R 121 Deleted. <Page 86>

R 122 Deleted. <Page 86>

R 123-1 The TMD6 shall execute sequentially the following actions : <Page 86>

R 123-2 Deleted. <Page 86>

R 124 The EGSE shall send a MTUT test telecommand to configure each UTi of the BDR in TEST mode. <Page 87>

R 125 The EGSE shall use the input parameters Mean_velocity_UTi and the parameter velocity_bias from the DSPF file to compute the velocity parameter (Velocity = Mean_velocity_UTi + Velocity_bias) of each MTUT telecommand, for UTi with i = 1 to 7. <Page 87>

R 126 The EGSE shall configure the parameter #2 of the telecommands MTUT as follows : <Page 87>

R 127 Deleted. <Page 87>

R 128 Deleted. <Page 87>

R 129 The telemetry processing shall be applied to all useful sequences from 1 to N_seq for each UT in TEST mode. <Page 88>

R 130 The EGSE shall use the following validity criteria for subsequent processing: <Page 88>

R 131 The TMD5 shall accept the following configuration parameters <Page 98>

R 132-1 Deleted. <Page 98>

R 132-2 The TMD5 shall implement the actions described by the following diagram for DGXX-S: <Page 101>

R 133 In addition to the telemetry processing defined in § 7.4.11.3, the TMD5 shall implement the following telemetry processing: <Page 103>

R 134 Deleted.**135** The DISS shall wait for T minutes before ending the TMD8.
<Page 103>

R 136 The DISS shall be able to manage at least 100 Test Sequences composed of up to 50 Test Modules and/or primitives. <Page 104>

R 137 The DISS shall provide to the user, tools for building, archiving, editing and printing of the Test Sequences. <Page 104>

R 138 The DISS shall allow the automatic execution of any Test Sequence selected by the user, for up to 24 hours of continuous operation. <Page 105>

R 139 The DISS shall provide to the user a mean to stop the processing of the test sequence at the end of the current TMD under execution. <Page 105>

R 140 In case of abnormal exit of the TMD execution (See § 7.4), the DISS shall resume with the execution of the next TMD in the test sequence. <Page 105>

R 141 The EGSE shall offer to the user the possibility to quickly prepare and execute all sole standard Primitives (via menu bar for instance). <Page 106>

R 142 The EGSE shall offer to the user the possibility to build non-standard Test Modules based on standard Primitives. <Page 106>

R 143 The EGSE shall provide a "record" mode allowing the automatic creation of a Test Module based on the successive Primitives executed by the user. <Page 106>

R 144 The DORIS EGSE shall use robust and easy to lock connectors for non-RF harness connection on the EGSE side. The connector types shall be submitted to THALES for acceptance. <Page 109>

R 145 The harness towards BDR connectors J1 to J7 shall be connected to the EGSE on its rear side. <Page 109>

R 146 The DORIS EGSE shall use N female type connectors for 400MHz and 2GHz bands links. <Page 109>

R 147 Deleted <Page 114>

R 148 The sub D connector on the BDR side shall provide good EMC shielding. <Page 114>

R 149 The different branches of the harness, departing from the DORIS instrument, shall be grouped in a sole strand at a distance of 45 cm $\pm$ 5cm from the BDR <Page 114>

R 150 The test harness section on the BDR side shall be compatible with vacuum conditions (outgasing). *<Page 114>*

R 151 The test harness section on the BDR side shall withstand the following temperature range: -40°C to +70°C. *<Page 114>*

R 152 DACTEM shall provide two RF cables of 6 meters long fitted with N type connectors. *<Page 114>*

R 153 Deleted *<Page 114>*

R 154 The RF cables type shall be KX13. *<Page 114>*

R 155 DACTEM shall provide a test harness of 6 meters long, interconnecting the BDR connector J7 to the DTP. *<Page 115>*

R 156 Deleted. *<Page 115>*

R 157 The harness or the DISS shall be able to configure the configuration pins (short circuit or open circuit) from the J5 TH11A on PCONF TH11A connector and from the J5 TH12A on PCONF TH12A connector. *<Page 115>*

R 158 All DORIS EGSE units shall be movable without special handling devices (low size and mass or use of rollers). *<Page 116>*

R 159 All DORIS EGSE units shall be delivered within containers (DISS, DBS) or housing (DTP) providing adequate protection against shocks, vibration and moisture in normal transport conditions by road, sea or air. *<Page 116>*

R 160 All DORIS EGSE individual units shall be less than 2.0 meters high and 0.8 meters wide. *<Page 116>*

R 161 All DORIS EGSE units shall be compliant with the EMC norm NF EN 50950 (DBT 73/23/CEE modified 93/68/CEE). *<Page 116>*

R 162 The main power connection of the EGSE units shall be of the following type: 220 volts, single phase, 10/16A outlet. *<Page 116>*

R 163 The DISS shall be fitted with an emergency switch off command. *<Page 116>*

R 164 The DORIS EGSE shall provide a mass storage device allowing archiving of test results from the DTP and the DISS. *<Page 116>*

R 165 The DORIS EGSE shall include a laser printer allowing printing of information from the DBS, the DTP and the DISS. *<Page 116>*

R 166 The DISS shall include a drawer for the storage of accessories. <Page 116>

R 167 The computers used in the DTP and the DISS shall include Microsoft WORD and EXCEL software. <Page 116>

R 168 The EGSE hardware and test software shall be designed to be adaptable (hardware and software) to any DORIS equipments (SENTINEL3, JASON3, SWOT, and Jason-CS). <Page 116>

R 170 The DTP shall implement a RS422 interface for communication with the TM/TC test interface #1 (from BDR-J7). <Page 107>

R 171 The RS422 electrical interface of the DTP shall be insulated through optocouplers. <Page 107>

R 172 The DTP shall comply with the following protocol over the RS422 interface: <Page 107>

R 173 The DISS shall implement a low level monitoring task whenever the nominal application software of the DISS is running, excepted during the configuration mode. <Page 29>

R 174 The monitoring task shall include the following actions: <Page 29>

R 175 When BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall acquire every Xseconds the time bias TDI-SI. <Page 30>

R 176 During any monitoring session, the DISS shall record any anomalies concerning the monitoring task in the general log file or in the TMD log file if a TMD is running. <Page 30>

R 177-1 When BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall test the following analog telemetries: <Page 30>

R 177-2 Primary current shall be read in the DSPF file, and +5V current limitation, +20V current limitation, temperature Min limitation and temperature Max limitation are read on the database. <Page 31>

R 178 The DISS shall report anomalies from the above test on its standard display and record in the log file all useful information (date, time, anomalous parameter and value). <Page 31>

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R 179-1 The DISS shall record in the log file any change of the DBL value between two successive acquisitions, and the date and time of occurrence. <Page 31>

R 179-2 Note: the DISS shall not send any RESTART or OFF/ON command to the BDR in case the DBL reports an anomaly except when TMD0 is running see R-109. <Page 31>

R 180 Deleted. <Page 31>

R 181 When the BDR CHAIN1 or BDR CHAIN2 is ON (i.e. when the status STATUS.POWER from J5-CHAIN is set), the DISS shall monitor the following 1553 bus anomalies: <Page 31>

R 182 The DISS shall report on its standard display and record in the log file, the first occurrence of the above anomalies (date, time and type). <Page 32>

R 183 The DISS shall display permanently the last acquired analog telemetries after conversion (primary current, +5V current, OUS current in mA, temperature of the test base plate). <Page 33>

R 184 The DISS shall display permanently the last acquired TDI – SI bias in seconds with 10 ms resolution when BDR is ON. <Page 33>

R 185 The DISS shall display permanently information about current activity running and EGSE status (for instance, equipment under test, phase of test, Test Sequence and Test Module running if any, current calculator date and time, LAN status). <Page 33>

R 186 The DISS shall display permanently the status of the 1553 bus <Page 33>

R 187 The DISS shall record in a retrievable file every 15 minutes during execution of the TMD8, the last acquired analog telemetries. <Page 103>

R 190 The TMD3 shall accept the following configuration parameters: <Page 66>

R 191 The duration of the active emission phase shall allow the processing by the BDR of a number of NOMBRE_SEQUENCE DORIS sequences (ten seconds). <Page 68>

R 192 Two active beacons shall be simulated by the beacon #1 and #2 of the DBS. <Page 68>

R 193 The simulated frequency of each beacon shall be defined as follow : <Page 68>

R 194 Each beacon RF levels shall be configured by using RF_level_2G_i and RF_level_400M_i input parameters. <Page 68>

R 195 Deleted. <Page 68>

R 196 The TMD3 shall execute sequentially the following actions: <Page 69>

R 197 Depending on the input parameter UT_conf, the EGSE shall send appropriate telecommands MASR and MTUT to configure the UTi of the BDR as defined in §7.4.7.1. <Page 69>

R 198 The EGSE shall use the input parameters Mean_velocity_UTi to compute the velocity parameter of the MTUT telecommand for UT # i, in case of configuration 1. <Page 69>

R 199 The EGSE shall configure the parameter #2 of the telecommand MTUT as follow: <Page 69>

R 200 Deleted. <Page 69>

R 201 The EGSE shall process all jamming packets corresponding to the N_seq acquisitions required by the test. <Page 70>

R 202 The EGSE shall plot each acquired spectrum. <Page 70>

R 203 The EGSE shall determine for each spectrum the RF maximum level and associated frequency. <Page 70>

R 204 The EGSE shall verify for each acquired spectrum, the RF maximum level with the following algorithm: <Page 70>

R 205 All numeric results and plots (plots can be superposed on the same plot) from the above steps shall be record in a retrievable and displayable file. <Page 70>

R 206 The EGSE shall record in files and print when required an abstract of the performance and functional tests results (TMD1, TMD3, TMD4, TMD6, and TMD7). <Page 57>

R 207 The test telemetry results shall also be exportable in an Excel file for further analysis. <Page 57>

R 210 To perform the test TMD4, the DISS shall execute in sequence the following actions: <Page 72>

R 211 The DTP shall analyse the Doppler packets by using the following algorithm: <Page 74>

R 212 The DTP shall analyse the datation packets by using the following algorithm: <Page 75>

R 213 The DTP shall analyse the Navigation packets by using the following algorithm: <Page 77>

R 214 All KO messages shall be recorded in the log file. <Page 81>

R 215 All plots shall be stored in printable file. <Page 81>

R 216 Standard TM screen shall be displayed in real time all along the test module. <Page 81>

R 217 The above given parameters shall be stored in the file DSPF. <Page 81>

R 218 The test parameter file shall be an ASCII file easy to modify by an elegant supplied tool or standard editor. <Page 81>

R 219 The DISS shall analyse the Report packets by using the same algorithm as TMD5 to verify proper software upload if chosen. <Page 80>

R 220 The TMD7 shall execute sequentially the following actions: <Page 94>

R 221 The EGSE shall send the VUT telecommand for all UT (step 1) then shall check the acknowledgment (step 3). <Page 94>

R 222 The EGSE shall transmit telemetry (30 datation packets) acquired during the test and the parameters RPTD, TSD and TSF to DTP for processing. <Page 95>

R 223 The EGSE shall check availability of valid (error control code OK) datation packets. <Page 95>

R 224 The EGSE shall plot TAI date data as follow: <Page 95>

R 225 The EGSE shall control the following datation statistical data: <Page 96>

R 226 All plots, recorded and computed values and parameters, control results shall be reported in the log file and reported in a retrievable file. <Page 96>

R 227 The EGSE shall send a MASR test telecommand to configure the addressed chain of the BDR in ASR mode with parameter 'start-stop' = 1 if (Jamming_mode=YES), and 'start-stop' = 0 if (Jamming_mode=NO). <Page 87>

R 229 Before execution of TMD3, TMD5, TMD6 or TMD7, the DISS shall verify that the last acquired DBLs are as expected. In case of anomaly the Test Sequence shall be immediately aborted. <Page 104>

R 230 An optional comment entered by the user, shall be attached to each TMD in the Test Sequence file. <Page 104>

R 231 Deleted. <Page 106>

R 232 The hardware delivery shall include the following item: <Page 119>

R 233 The software delivery shall include the following item: <Page 119>

R 234 The documentation delivery shall include the following item: <Page 120>

R 235 The DISS shall be able to run tests sequences composed of automatic and semi-automatic TMD. <Page 104>

R 240 The DISS unit shall provide a self-test function, which can be activated by the user: <Page 117>

R 241 At DISS electrical switch on and after a self test, the DISS interfaces shall be placed in a safe and inactive configuration. <Page 117>

R 242 Deleted.

R 243 Any anomaly encountered during self-test shall be reported to the user. <Page 117>

R 244 All hardware functions of the DBS and the DISS shall be properly initialised in a known state at start-up of the application software: <Page 117>

R 245 In order to assess the Doppler measurements performance, the EGSE shall process the scientific telemetry as follow for each band and each UT in TEST mode : <Page 88>

R 246 The 3 following processing probabilities shall be determined for each UT in TEST mode: <Page 89>

R 247 The EGSE shall process the CAG levels from the scientific telemetry, as follow for each band and each UT in TEST mode: <Page 90>

R 248 The EGSE shall process the IT3 measurements from the scientific telemetry, as follow for each UT in TEST mode: <Page 91>

R 249 The EGSE shall process for each UT in TEST mode, every received message as follow : <Page 91>

R 250 All numeric results and plots from the above steps shall be stored in a printable file. <Page 92>

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R 251 The EGSE shall record the TAI date of the report packet and report it in the test log file as RPTD. <Page 95>

R 252 The EGSE shall acquire the TDI-SI bias, store it in the .bia file.. <Page 95>

R 253 Immediately following the acquisition of 30 datation packets, the EGSE shall acquire the TDI-SI bias, store it and report it in the test log file. <Page 95>

R 254 The EGSE shall apply the following algorithm to datation data: <Page 95>

R 255 The EGSE shall compute the following datation statistical data: <Page 96>

R 256 The DTP shall be able to send over the RS422 interface "universal" TC entered by the user: <Page 108>

R 257 If relevant, start and stop of TC attitude emission shall be automatically managed by DBS to DISS requests based on scenario file information (attitude column) <Page 72>

R 258 The DTP shall analyse the attitude packets by using the following algorithm: <Page 79>

R 259 If CTA checking is selected, the DTP shall check the CTA function by using the following algorithm: <Page 79>

R 260 if the satellite mission implements the TC Time, the DTP shall check the correspondence between the "packet time" date in the Datation header packets and the date in TC Time by using the following algorithm: <Page 80>

R 261 Archiving of a TMD telemetry file in the EGSE including the following data: <Page 104>

R 262 Random lockout shall not appeared when DBS unit is manually programmed by DISS unit <Page 21>

R 263 deleted <Page 34>

R 264 The DISS shall use the adequate 1553 bus protocol depending on the satellite to be simulated for the unit under test in agreement with table Table 4-1. <Page 34>

R 265 All connectors of any harness shall be equiped with all pin, even if some of them are not used inside the harness (not connected to a wire in the harness). <Page 109>

R 266 During TMD execution, the survey of the BDR is executed each minutes (with possibility to change time acquisition). <Page 105>

R 267 The DTP shall analyse the spy file by using the following algorithm: <Page 76>

R 268 Whenever the DBS software is switched off, the RF unit emission shall be stopped. Exception: when RF unit is in local mode, emission cannot be supervised. <Page 118>

R 269 The EGSE shall send a VUT TC on all UT to initialize all UT <Page 87>

R 270 Deleted

R 271 The harness design shall be submitted to THALES for acceptance. <Page 114>

R 272 The EGSE test software's, shall be designed to be robust to anomalies and to give all possible information related to the origin of a critical anomaly that cause abnormal termination of the execution. <Page 117>

R 273 DTP curve scale values must be stored in a configuration file for enhanced graphic results <Page 108>

R 274 Unless otherwise required, in this paragraph, all plots w.r.t. TAI date shall start from the first significant date i.e. > 1/1/2000 <Page 74>

R 275 The EGSE shall be compliant with CE standards

R 276 If relevant, the DTP shall analyze the KARIN bulletin by using the steps described in Annex 7 <Page 83>

R 277 If at least one KO has been raised during test then general result Test is KO else general test result is OK <Page 84>.



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ANNEX3 PICINBONO VARIANCE DEFINITION

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The Picinbono variance shall be used to assess the short term performances of the DORIS instrument this variance is defined below :

$$\sigma^2 p = \frac{1}{2N} \sum_{i=1}^N \left[\frac{1}{2} (\varepsilon_{i+2} + \varepsilon_i) - \varepsilon_{i+1} \right]^2$$

where ε_i is the short term error at sequence i, defined by :

$$\varepsilon_i = (fm_i - fr_i)$$

with fm_i : measured Doppler frequency or datation

and fr_i : true Doppler frequency or datation at sequence i.

For the TMD6 application, fr_i is considered as a constant, leading to the following simplified formula :

$$\sigma^2 p = \frac{1}{2N} \sum_{i=1}^N \left[\frac{1}{2} (fm_{i+2} + fm_i) - fm_{i+1} \right]^2$$



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ANNEX 4

$\Delta T3$ DETERMINATION

$\Delta T3$ determination:

$\Delta T3$ is an estimation of the beacon message transit time within the BDR.

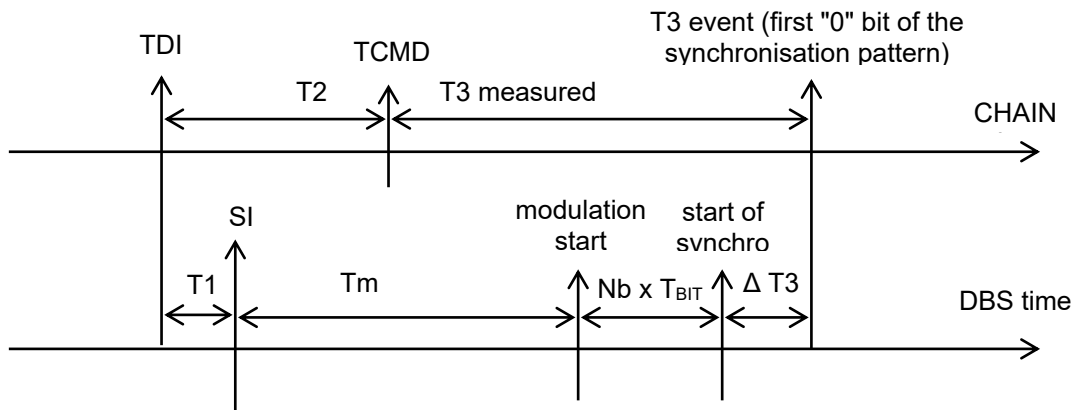


Figure A4.1 : $\Delta T3$ determination

T1	:	TDI - SI bias = $N1 / \text{FOUS}_{\text{DBS}}$ (> 0 if TDI later than SI)
T2	:	TCMD delay = $3 \cdot 10^7 / \text{FOUS}_{\text{BDR}}$
T3	:	measurement from Doppler packet = $T3_{\text{datation}} \times 2.5 / \text{FOUS}_{\text{BDR}}$
Tm	:	delay time between modulation start and SI (beacon 0,1 Hz) (2,1 s for BM, 4,9 s for other cases) = $N_m / \text{FOUS}_{\text{DBS}}$
Nb	:	number of "1" bits in the message header = 120 bits "1" for master beacons and all beacon 3.0. = 80 for standard beacons 1.0 and 2.0.
T _{BIT}	:	message bit period at emission = constant = $2.5 \cdot 10^4 / \text{FOUS}_{\text{DBS}} \approx 5 \text{ ms}$
FOUS _{DBS}	:	= $F1 + \Delta F1$ with $F1 = 5 \cdot 10^6 \text{ Hz}$
FOUS _{BDR}	:	= $F2 + \Delta F2$ with $F2 = 10 \cdot 10^6 \text{ Hz}$
$\Delta F / F$	:	relative USO bias = $\Delta F1 / F1 - \Delta F2 / F2$

Hypothesis:

- the TDI-SI counter is driven by the DBS USO #1 which is used by the beacon #1, if the modulation is coming from the beacon #2, an error of $(\text{TDI-SI}) \times (F_{1\#1} - F_{1\#2}) / F_1$ shall be considered, but this error is very low in nominal conditions ($\ll 500$ ns)
- nominally, $T_1 \approx -1.15$ s

Then:

$$\Delta T_3 = T_1 + T_2 + T_3 - N_b \times T_{\text{BIT}} - T_m$$

$$\Delta T_3 = \frac{N_1}{FOUS_{DBS}} + \frac{3.10^7}{FOUS_{MVR}} + \frac{T_3 - \text{datation} \times 2.5}{FOUS_{MVR}} - \frac{N_b \times 2.510^4}{FOUS_{DBS}} - \frac{N_m}{FOUS_{DBS}}$$

As ΔT_3 and $\Delta F/F$ are nominally small (respectively ≈ 1 ms and $< 2 \cdot 10^{-7}$), ΔT_3 shall be computed as follow:

$$\Delta T_3 \approx 3 \text{ s} + \langle T_3 \text{ (s)} \rangle - [\langle T_m \text{ (s)} \rangle + N_b \times 5 \cdot 10^{-3} - \langle T_1 \text{ (s)} \rangle] \times (1 - \Delta F/F)$$

with $\langle x \text{ (s)} \rangle$ designating a time estimation in seconds, of the parameter x calculated with the nominal values F_1 and F_2 of the USO frequencies.

$\Delta F/F$ can be estimated by monitoring the TDI – SI bias drift:

$$\Delta F/F \approx [T_1(t=t_2) - T_1(t=t_1)] / [t_1 - t_2]$$

With t_1 and t_2 being two distinct instants of measurement of the TDI – SI bias.

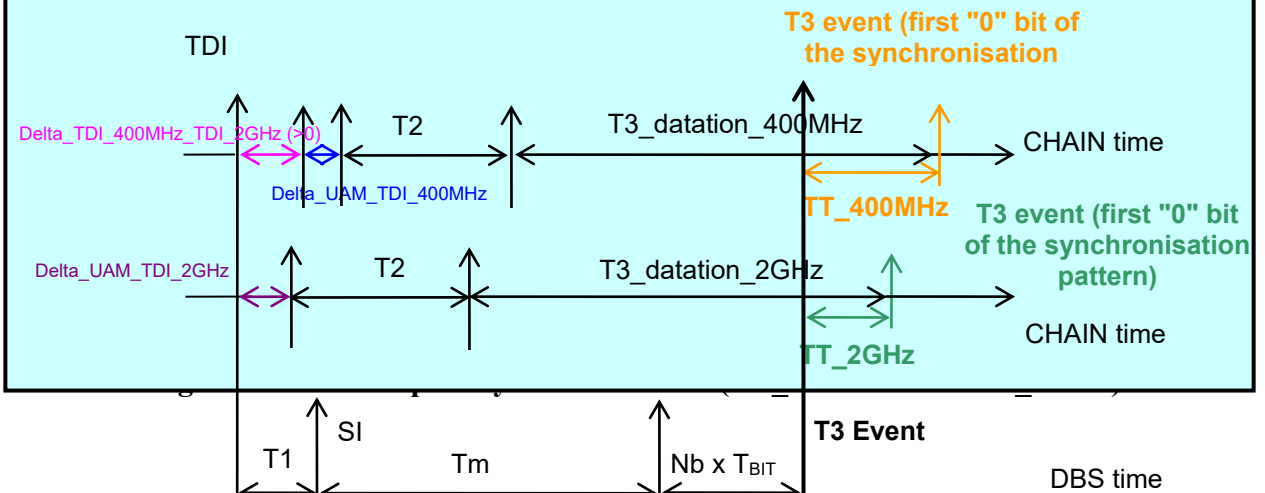
It is recommended to choose $(t_2 - t_1) \geq 1000$ s in order to obtain a resolution of 10^{-9} , assuming the TDI - SI measurement resolution is 100 ns.

Group Delay computing

In fact, the value “T3_Datation” does not include neither the delay of the samples time base “Delta_UAM_TDI” nor the delay of the 400MHz channel with respect to the 2GHz channel, see fig A4.2.

So to compute the real group delay of each channel, these time base delays gathered from Doppler packets shall be added.

DORIS INSTRUMENT



$$TT_2GHz = \Delta T3_2GHz + \Delta UAM_TDI_2GHz$$

$$TT_400MHz = \Delta T3_400MHz + \Delta UAM_TDI_400MHz + \Delta TDI_400MHz_TDI_2GHz$$

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ANNEX 5 **DORIS TEST BASE PLATE** **CHARACTERISTICS OF THE THERMISTOR**

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Furnisher :

Reference : **B57164K102J**

Nominal resistance : 1000 ohm @ +25°C

Resistance value : $R(\theta) = 1000 \times \text{Coeff}(\theta)$

with : θ = temperature in °C

Coeff(θ) is a value given by the table next page

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Temperature parameter for thermistance 1Kohms B57164K102J–serie

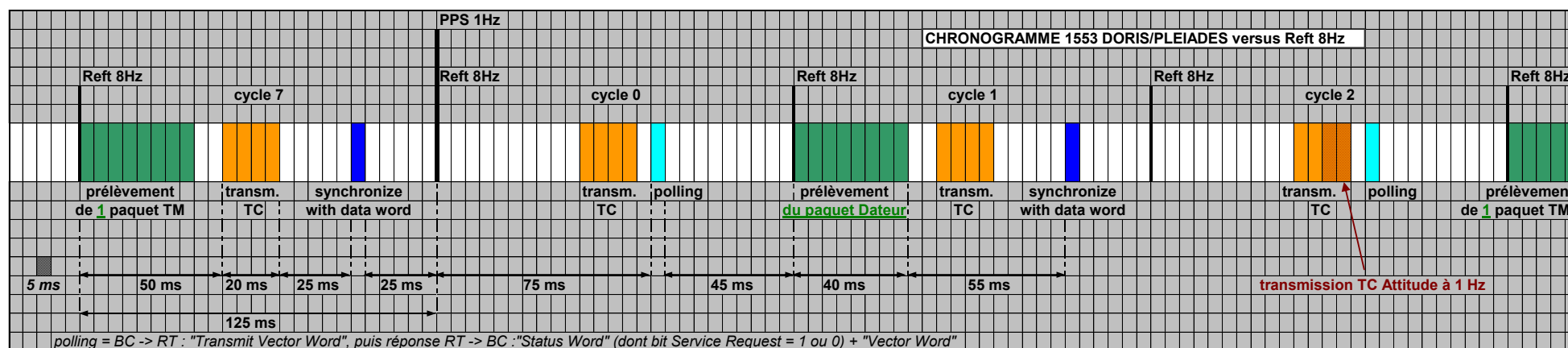
Temp.	Coeff.	Temp.	Coeff.	Temp.	Coeff.	Temp.	Coeff.	Temp. (°C)	Coeff.
-55	69.5	-13	5.6	28	0.864	69	0.202	110	0.0616
-54	66.8	-12	5.43	29	0.84	70	0.192	111	
-53	62.9	-11	5.24	30	0.814	71	0.186	112	
-52	59.2	-10	4.93	31	0.796	72	0.181	113	
-51	55.3	-9	4.7	32	0.783	73	0.18	114	
-50	52.2	-8	4.43	33	0.718	74	0.172	115	
-49	49.2	-7	4.18	34	0.694	75	0.169	116	
-48	45.9	-6	3.97	35	0.671	76	0.163	117	
-47	43.3	-5	3.82	36	0.644	77	0.154	118	
-46	40.2	-4	3.66	37	0.622	78	0.151	119	
-45	37.3	-3	3.44	38	0.608	79	0.147	120	
-44	35.4	-2	3.3	39	0.566	80	0.142	121	
-43	33.4	-1	3.14	40	0.55	81	0.14	122	
-42	31.4	0	3.07	41	0.524	82	0.136	123	
-41	29.5	1	2.907	42	0.514	83	0.131	124	
-40	28.1	2	2.78	43	0.492	84	0.126	125	
-39	25.7	3	2.63	44	0.474	85	0.123	126	
-38	24.3	4	2.49	45	0.458	86	0.119	127	
-37	22.8	5	2.4	46	0.433	87	0.117	128	
-36	21.1	6	2.31	47	0.42	88	0.112	129	
-35	19.8	7	2.21	48	0.408	89	0.108	130	
-34	18.8	8	2.1	49	0.396	90	0.105	131	
-33	17.6	9	1.99	50	0.383	91	0.103	132	
-32	16.7	10	1.93	51	0.369	92	0.1	133	
-31	15.9	11	1.84	52	0.353	93	0.098	134	
-30	15	12	1.76	53	0.344	94	0.0956	135	
-29	13.9	13	1.68	54	0.332	95	0.0932	136	
-28	13.2	14	1.6	55	0.322	96	0.091	137	
-27	12.4	15	1.54	56	0.312	97	0.0872	138	
-26	11.8	16	1.46	57	0.299	98	0.085	139	
-25	11.2	17	1.41	58	0.29	99	0.0832	140	
-24	10.5	18	1.34	59	0.282	100	0.0805	141	
-23	9.76	19	1.29	60	0.273	101	0.0783	142	
-22	9.23	20	1.22	61	0.262	102	0.0765	143	
-21	8.78	21	1.15	62	0.253	103	0.0741	144	
-20	8.41	22	1.12	63	0.246	104	0.0725	145	
-19	7.8	23	1.09	64	0.239	105	0.0703	146	
-18	7.53	24	1.04	65	0.231	106	0.0688	147	
-17	7.12	25	1.005	66	0.222	107	0.0682	148	
-16	6.8	26	0.956	67	0.215	108	0.0666	149	
-15	6.46	27	0.94	68	0.208	109	0.065	150	
-14	6.1								

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ANNEX 6

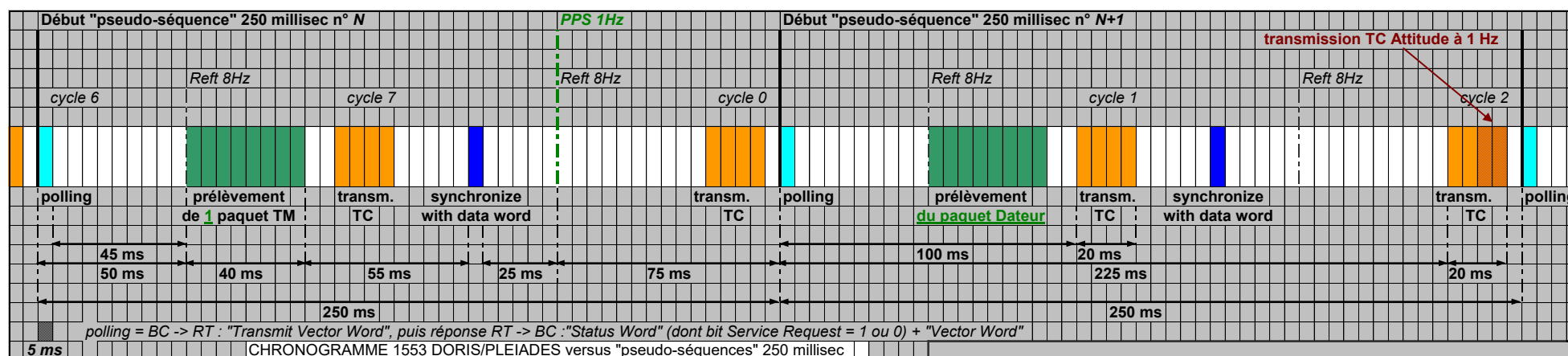
1553 Chronogram (Proteus type only)

1553 DORIS chronogram versus 8 Hz



- Colored areas show scheduled actions in this slot
- Each action length has to be lower to the allocated slot duration.
- TC attitude has to be transmitted in a TC slot TBD : if in the slot, a ground 1553 TC has to be transmitted, the TC attitude has to be transmitted after the ground TC with a TBD milliseconds delay to separate them.

1553 DORIS chronogram versus « pseudo séquences » of 250 milliseconds



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ANNEX 7

KARIN Bulletin validation

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Step 1 : Validation of the altitude prediction :

1. Formula:

$$\text{Altitude_Estimated (t-Tref)} = a + b * (t - \text{Tref} + 20\text{sec}) + c * (t - \text{Tref} + 20\text{sec})^2 / 2 + d * (t - \text{Tref} + 20\text{sec})^3 / 6 + e * (t - \text{Tref} + 20\text{sec})^4 / 24$$

2. calculate the formula above with t = Tref (contained in the Karin bulletin) and the coefficients issued from the DORIS / KARIN packet

3. compare this value with the altitude given in the orbit reference file at Tref date (column 84)

4. compare this deviation against a given threshold in the Karin EGSE validation setup

5. plot of the deviation thus obtained (configurable operator plot, max/min default value is +/-1m) and horizontal limits for the threshold value (max and min value).

Nota : LSB for axis display is at least 0,1mm

Step2 : Validation of the longitude and latitude prediction :

1. Formula :

There isn't extrapolation formula on these parameters. The goal is to compare these values (contained in the Karin bulletin) to the longitude & latitude given in the orbit reference file (columns 68 and 69) at Tref date.

2. Difference in Latitude : The conversion in meters of the difference in latitude is made by using the following formula :

$$\text{Deviation (meters)} = \text{Latitude deviation (real figure in } ^\circ) * R$$

Where R is equal to the sum of the Earth's radius (6378km) and the altitude contained in the orbit reference file, column 70. LSB for axis display is 1 meter.

3. Difference in Longitude : The difference in meters from the difference in longitude is made using the following formula :

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Distance in meters = Distance in longitude (real figure in °) * R*cos (lat)

Where lat is latitude (real figure in °) and where R is equal to the sum of the terrestrial radius (6378km) and the altitude contained in the orbit reference file, column 70. LSB for axis display is 1 meter.

4. Check deviations from the thresholds given in the Karin EGSE validation setup
5. Plots of the deviations obtained at steps 2 & 3 (configurable operator plots, max default value is 1mm) and horizontal limits for the threshold value (max and min value). Max/min default value of the threshold is +/-10m.

Step 3 : Verification of continuity between two bulletins :

1. Formulas : We have to form the difference between :

$$\text{Alt_new} = a + b * (10\text{sec}) + c * (10\text{sec})^2/2 + d * (10\text{sec})^3/6 + e * (10\text{sec})^4/24$$

And

$$\text{Alt_Old} = a_{\text{previous}} + b_{\text{previous}} * (20\text{sec}) + c_{\text{previous}} * (20\text{sec})^2/2 + d_{\text{previous}} * (20\text{sec})^3/6 + e_{\text{previous}} * (20\text{sec})^4/24$$

Where Alt_new is the estimated altitude at Tref-10sec using the coefficients of the current Karin bulletin and Alt_Old is the estimated altitude at the same date using the coefficients of the previous Karin bulletin.

2. Verification : check the deviation from a given threshold in the Karin EGSE validation setup
3. Graphic : make a plot of the difference Alt_new - Alt_Old (configurable operator plot, max/min default value is set to +/-1 mm). LSB for axis display is 0,1mm

Step 4 : Doris Karin packet production delay checking:

The Vector Word indicating the provision of Karin packet by the BDR for the satellite shall be scrutinized (Karin bit testing in the DORIS 1553 Vector Word) and the Time difference between this event and the preceding 10s TAI event shall be studied.

From DateTAI1 to DateTAI2 :

1. A general statistic table shall be produced for this delay in the general TMD4 test report with :

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- a. Delay maximum value and minimum value
- b. Delay bias
- c. Comparison of the max delay value with a given specified max value (default is 4s) and compute the percentage of packets where the specified value is exceeded. If this number is over a given percentage then the result of the test is KO otherwise OK. In any case, the specified required percentage and the found one shall be reported.

2. Graphic: make a plot of the delay (configurable axis max/min default value is respectively 6s and 0s) with a configurable horizontal threshold max line set to specified max value (4s by default the same as the max value specified in step 1.c). Axis step by default is 1s.

Notas :

- ✓ In the spy file, the TAI information provided in the datation packets can be extracted and provide the TAI event information.
- ✓ The recorded computer time of the specified Vector Word and of the datation packet can give the delay between those two events on another time scale. Modulo or rounding methods can then be applied to assess the overall delay between 10s TAI event and Karin Vector Word occurrence.

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