Environmental and EMC Test Report

Jotron AS
PLB, Model: Tron SA20 PLB

In accordance with RTCM 11010.4

Prepared for: Jotron AS
Ringdalskogen 8
3270 Larvik
Norway

COMMERCIAL-IN-CONFIDENCE

Document 75956621-05 Issue 01

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SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Martin Hardy	Senior Engineer	Authorised Signatory	05 February 2024
Chris Bowles	Environmental Test Supervisor	Authorised Signatory	05 February 2024

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with RTCM11010.4 for the tests detailed in section 1.3.

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ANNEX A A.2

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	05-Feb-2024

Table 1

1.2 Introduction

Applicant	Jotron AS
Manufacturer	Jotron AS
Model Number(s)	Tron SA20
Serial Number(s)	101 107 115 151 157
Hardware Version(s)	R03
Software Version(s)	1.3
Number of Samples Tested	5
Test Specification/Issue/Date	RTCM 11010.4: 2022
Order Number Date	P55347 16 September 2022
Date of Receipt of EUT	08 December 2022
Start of Test	16 December 2022
Finish of Test	08 November 2023
Name of Engineer(s)	Paul Adams Christopher Bland Connor Lee Matt Sellers Stuart Mooney Colin Hedley Antony Castle Frank Van Niekerk Michael Fomison
Related Document(s)	IEC 60945: 2002 C1: 2008 ISO 694: 2000

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with RTCM 11010.4: 2022 is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: Battery Powered - Transmitter Idle				
2.1	A.3	Dry Heat tests	Satisfactory	Tested to IEC 60945
2.2	A.4	Damp Heat test	Satisfactory	Tested to IEC 60945
2.3	A.5	Low Temperature tests	Satisfactory	Tested to IEC 60945
2.4	A.6	Vibration tests	Satisfactory	Tested to IEC 60945
2.5	A.7	Bump test	Satisfactory	
2.6	A.9	Drop test	Satisfactory	Tested to IEC 60945
2.7	A.10	Thermal Shock test	Satisfactory	Tested to IEC 60945
2.8	A.11	Immersion test	Satisfactory	Tested to IEC 60945
2.9	A.12	Spurious Emissions test	-	Refer to Document 75956621-03
2.10	A.13	Operational Life and Self-tests	Satisfactory	
2.11	A.14	Limited Cospas-Sarsat type approval tests	Satisfactory	
2.12	A.15	Buoyancy test	-	Test only applicable for Class 1 PLBs
2.13	A.16	Homing Signal test	-	Refer to Document 75956621-03
2.14	A.17	Solar Radiation test	Waiver	Refer to Annex A
2.15	A.18	Oil Resistance test	Waiver	Refer to Annex A
2.16	A.8	Corrosion test	Waiver	Refer to Annex A
2.17	A.19	Compass Safe Distance	Satisfactory	ISO 694: 2000
2.18	A.20	Miscellaneous tests	Satisfactory	
2.19	A.20	Altitude tests	Satisfactory	
2.20	A.21	Internal Navigation Device tests	Satisfactory	Tested to RTCM 11010.4 + Am 1

1.4 Application Form

MAIN EUT			
MANUFACTURING DESCRIPTION	Personal Locator Beacon (PLB)		
MANUFACTURER	Jotron AS		
MODEL	Tron SA20		
PART NUMBER	103675		
HARDWARE VERSION	R03		
SOFTWARE VERSION	1.3		
PSU VOLTAGE/FREQUENCY/CURRENT	6.0 V		
HIGHEST INTERNALLY GENERATED FREQUENCY	19.200 MHz		
FCC ID (if applicable)	VRVTRONSA20		
INDUSTRY CANADA ID (if applicable)	2131A-TRONSA20		
TECHNICAL DESCRIPTION (a brief technical description of the intended use and operation)	RLS capable Personal Locator Beacon (PLB)		
COUNTRY OF ORIGIN	Norway		
RF CHARACTERISTICS (if applicable)			
TRANSMITTER FREQUENCY OPERATING RANGE (MHz)	121.5 MHz / 406.031 MHz		
RECEIVER FREQUENCY OPERATING RANGE (MHz)	N/A		
INTERMEDIATE FREQUENCIES	N/A		
EMISSION DESIGNATOR(S): https://fccid.io/Emissions-Designator/	3K20A3X (121.5) – 16K0G1D (406.031)		
MODULATION TYPES: (i.e. GMSK, QPSK)	Phase modulation 1.1 Rad (406 MHz) AM Homing (121.5 MHz)		
OUTPUT POWER (W or dBm)	36.6 dBm (406 MHz) 20.6 dBm (121.5 MHz) (see "Tron SA20 PLB 5(k) Matching network statement, description and analysis")		
SEPARATE BATTERY/POWER SUPPLY (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
PART NUMBER			
PSU VOLTAGE/FREQUENCY/CURRENT			
COUNTRY OF ORIGIN			
MODULES (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
POWER			
FCC ID			
INDUSTRY CANADA ID			
EMISSION DESIGNATOR			
DHSS/FHSS/COMBINED OR OTHER			
COUNTRY OF ORIGIN			
ANCILLARIES (if applicable)			
MANUFACTURING DESCRIPTION			
MANUFACTURER			
TYPE			
PART NUMBER			
SERIAL NUMBER			
COUNTRY OF ORIGIN			

I hereby declare that the information supplied is correct and complete.

Name: Frank Løke
Position held: Certification Manager
Date: 30.11.2023

JOTRON

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT) was a Jotron AS, Personal Locating Beacon, Model: Tron SA20 PLB with RLS. A full technical description can be found in the manufacturer's documentation.

Figure 1 - Equipment Under Test

1.5.2 Test Configuration

Where applicable, the EUT was set up on and bonded to a ground plane where required, which was located in a Shielded Enclosure or Test Laboratory as identified in each test section.

The beacon was powered from its own internal battery as a standalone device.
Where required, a GNSS simulator was used to setup a GNSS location and a RLM signal.

The major items of test equipment used that were not specific to a test are identified under General Test Equipment in Section 3.1.

1.5.3 Modes of Operation

Mode	Description
406 MHz and 121.5 MHz	The EUT was active and transmitting 406 MHz and 121 MHz signals
Idle Mode	The EUT's transmitters were not active.

Table 2

1.5.4 Monitoring of Performance

A beacon tester was used to monitor the 406 MHz, 121.5 MHz and the RLM transmission from the EUT and display the EUT's identification codes.

1.5.5 Performance Criteria

Performance Criteria A

The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The manufacturers specified performance level is detailed as:

Mode	Description
406 MHz and 121.5 MHz	The beacon should continue to transmit.
Idle Mode	The beacon should not start transmitting.

Table 3

Performance Criteria B

The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The manufacturers specified performance level is detailed as:

Mode	Description
406 MHz and 121.5 MHz	The beacon should continue to transmit after the test has been applied.
Idle Mode	The beacon should not start transmitting.

Table 4

1.6 Deviations from the Standard

The Tron SA20 PLB is designed so that the battery pack is only replaced by authorised Jotron AS service agents. The customer requested that the battery pack of test samples are not replaced during the compulsory sequence of test, therefore two radiated Tron SA20 PLB samples (S/N: 107 and 157) were tested. Test sample S/N: 107 went throughout all Performance Checks and Performance Tests requirements, while test sample S/N: 157 was non-operational during the functional test and only Performance Checks and Performance Tests were carried at the end of each test.
At the end of all environmental tests, the battery packs of all three samples were replaced and the compulsory sequence of climatic tests (Dry Heat, Damp Heat and Low Temperature) was carried and the Performance Checks and Performance Tests were carried out again (with test samples operational only during the Performance Checks and Performance Tests).
The Internal Navigation Device testing in Section 2.20 was performed to the latest RTCM standard, RTCM 11010.4 + Amendment 1.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: Tron SA20 PLB, Serial Number: 101, 107, 115, 151 and 157			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 5

Note: The Tron SA20 PLB sample, S/N: 151 was repaired by the Manufacturer to internal coaxial cables. Please refer to Manufacturer's repair report in Annex A.

1.8 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Battery Powered - 121.5 MHz Homer		
Dry Heat	Paul Adams Stuart Mooney	UKAS
Damp Heat	Paul Adams Colin Hedley	UKAS
Low Temperature	Paul Adams Colin Hedley	UKAS
Vibration	Paul Adams Christopher Bland Antony Castle	UKAS
Bump	Christopher Bland Frank Van Niekerk	UKAS
Drop	Christopher Bland Frank Van Niekerk	UKAS
Thermal Shock	Christopher Bland Michael Fomison	UKAS
Immersion	Christopher Bland Michael Fomison	UKAS
Operating Lifetime (Battery capacity) and Self-test	Paul Adams	UKAS
Limited COSPAS-SARSAT type approval test	Paul Adams Christopher Bland	
Miscellaneous Test	Matt Sellers Paul Adams	Non UKAS
Altitude	Matt Sellers Michael Fomison	
Internal Navigation Device tests	Paul Adams Matt Sellers	

Table 6

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Battery Powered - Transmitter Idle		
Compass Safe Distance	Connor Lee	UKAS

Table 7

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Dry Heat Tests

2.1.1 Specification Reference

RTCM 11010.4 Clause A.3
IEC 60945, Clause 8.2

2.1.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 151 - Modification State 0
Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.1.3 Date of Test

27 June 2023 to 28 June 2023 Dry Heat Storage
10 July 2023 to 11 July 2023 Dry Heat Functional

2.1.4 Environmental Conditions

Ambient Temperature	16.4 - 19.8 °C
Relative Humidity	30.5 - 50.5 %

2.1.5 Test Method

Storage Test

The EUTs were placed in a climatic chamber where the temperature was increased from laboratory ambient temperature to +70 °C. After 16 hours, the temperature was returned to ambient conditions. The EUTs were subjected to a performance check at the end of the test.

Functional Test

The EUTs were switched on, and placed in a climatic chamber where the temperature was increased from ambient temperature to +55.0 °C. The conditions remained for a period of 16 hours. After 13 hours at +55°C the EUTs were subjected to a performance check and performance test. At the end of the test, the temperature was returned to laboratory ambient conditions.

At the conclusion of all testing, a satisfactory Performance Check was carried on all three EUTs.

Figure 2 - Dry Heat Functional test setup – EUTs close-up and installed in climatic chamber

2.1.6 Test Results

Storage Test

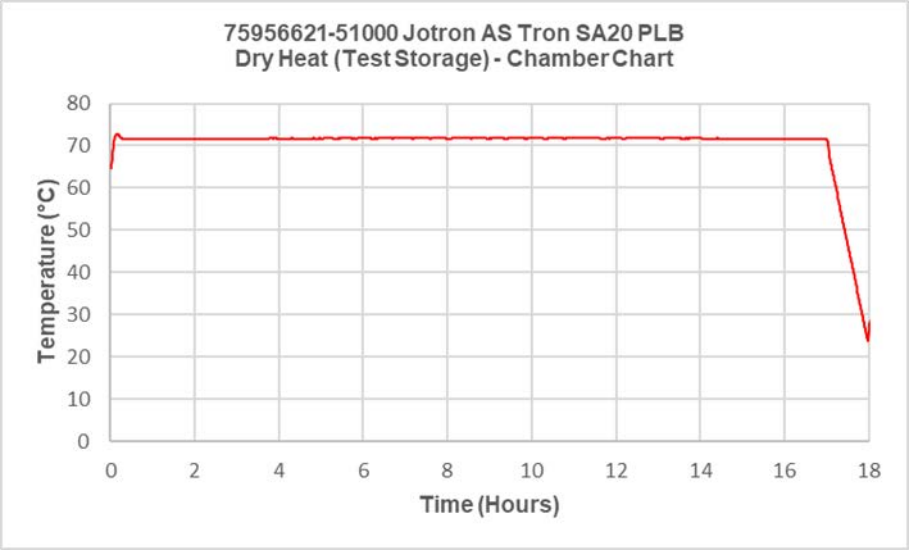


Figure 3 – Temperature Plot

Performance Check

Tron SA20 PLB, S/N: 151

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031073718
121 MHz Presence	Presence Confirmed

Table 8

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031040064
121 MHz Presence	Presence Confirmed

Table 9

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031057692
121 MHz Presence	Presence Confirmed

Table 10

Functional Test

Figure 4 – Temperature Plot

*NOTE: The fluctuation around the 16-hour mark is due to the chamber door being opened to activate the EUT and perform the performance test.

Performance Test

Tron SA20 PLB, S/N: 151

Parameter	Result (Max / Min)
Output Power	36.88 / 36.87
Digital Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
Bit Rate	400.02 / 399.96
Modulation: Rise Time (us)	137.6 / 130.9
Modulation: Fall Time (us)	135.8 / 129.2
Positive Deviation (rad)	1.139 / 1.048
Negative Deviation (rad)	-1.153 / -1.057
Nominal Frequency (MHz)	406.0311 / 406.0311
Short-term Stability (/100 ms)	5.74E-10 / 4.64E-10
Medium-term Stability – Slope (/minute)	9.85E-11 / 2.59E-11
Medium-term Stability – Residual	3.09E-10 / 1.94E-10
Spurious Emissions	(see Plot)

Table 11

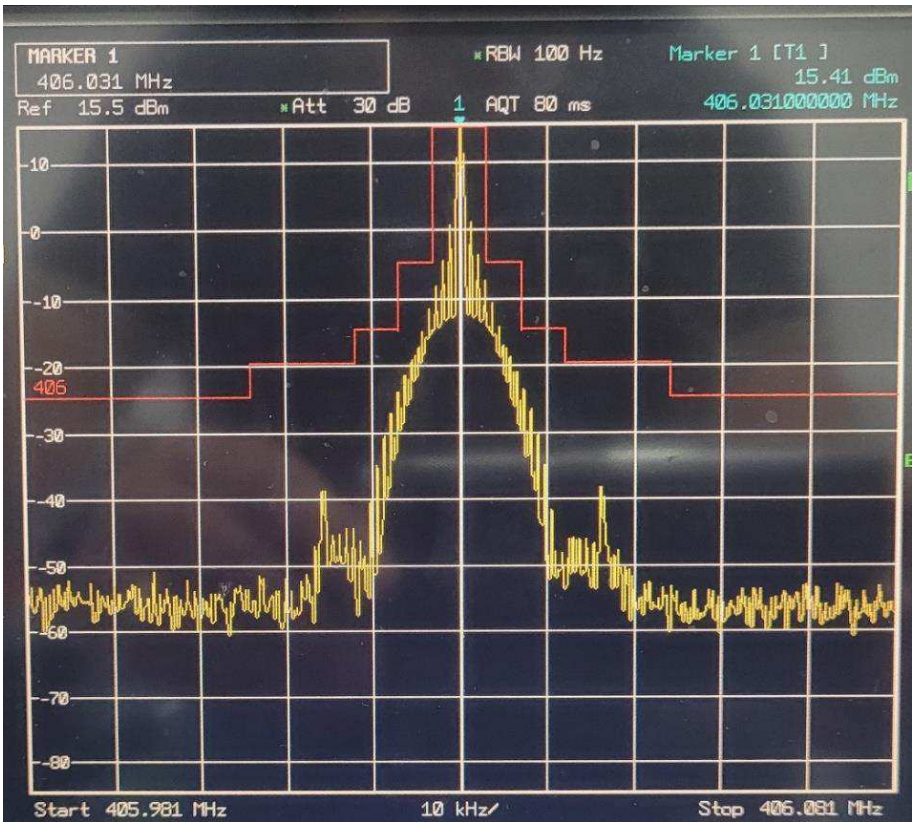


Figure 5 - Spurious Emissions

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031049359
121 MHz Presence	Presence Confirmed

Table 12

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031073718
121 MHz Presence	Presence Confirmed

Table 13

2.1.7 Test Location and Test Equipment Used

This test was carried out in the RF Laboratory 4.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Spectrum Analyser	Hewlett Packard	8542E	18	-	TU
Termination (50ohm)	Diamond Antenna	DL-30N	337	12	05-Jan-2024
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	15-Mar-2024
Termination (50ohm, 6W)	Micronde	R404613	3074	12	02-Dec-2023
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3160	12	13-Oct-2023
Power Meter	Rohde & Schwarz	NRP	3491	12	13-Jan-2024
1 MHz / 10 MHz reference	Quartzlock	E10-X	4973	12	23-Feb-2024
Cable (18 GHz)	Rosenberger	LU7-036-1000	5025	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-036-1000	5034	12	21-May-2024
Cable (18 GHz)	Rosenberger	LU7-036-2000	5035	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-036-2000	5037	-	O/P Mon
USB Power Sensor	Boonton	RTP5318	5185	12	10-Feb-2024
Tester (Beacon)	WS Technologies	BT200-1100Y	5395	-	TU
Environmental Chamber	ACS	DY110TC	5589	-	O/P Mon
Thermocouple Data Logger	Pico Technology Ltd	TC-08 + Type T Thermocouple	5740	12	09-Mar-2024
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024

Table 14

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.2 Damp Heat Test

2.2.1 Specification Reference

RTCM 11010.4 Clause A.4
IEC 60945, Clause 8.3

2.2.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 151 - Modification State 0
Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.2.3 Date of Test

20 December 2022 to 21 December 2022

2.2.4 Environmental Conditions

Ambient Temperature	20.3 - 21.2 °C
Relative Humidity	43.0 - 43.5 %

2.2.5 Test Method

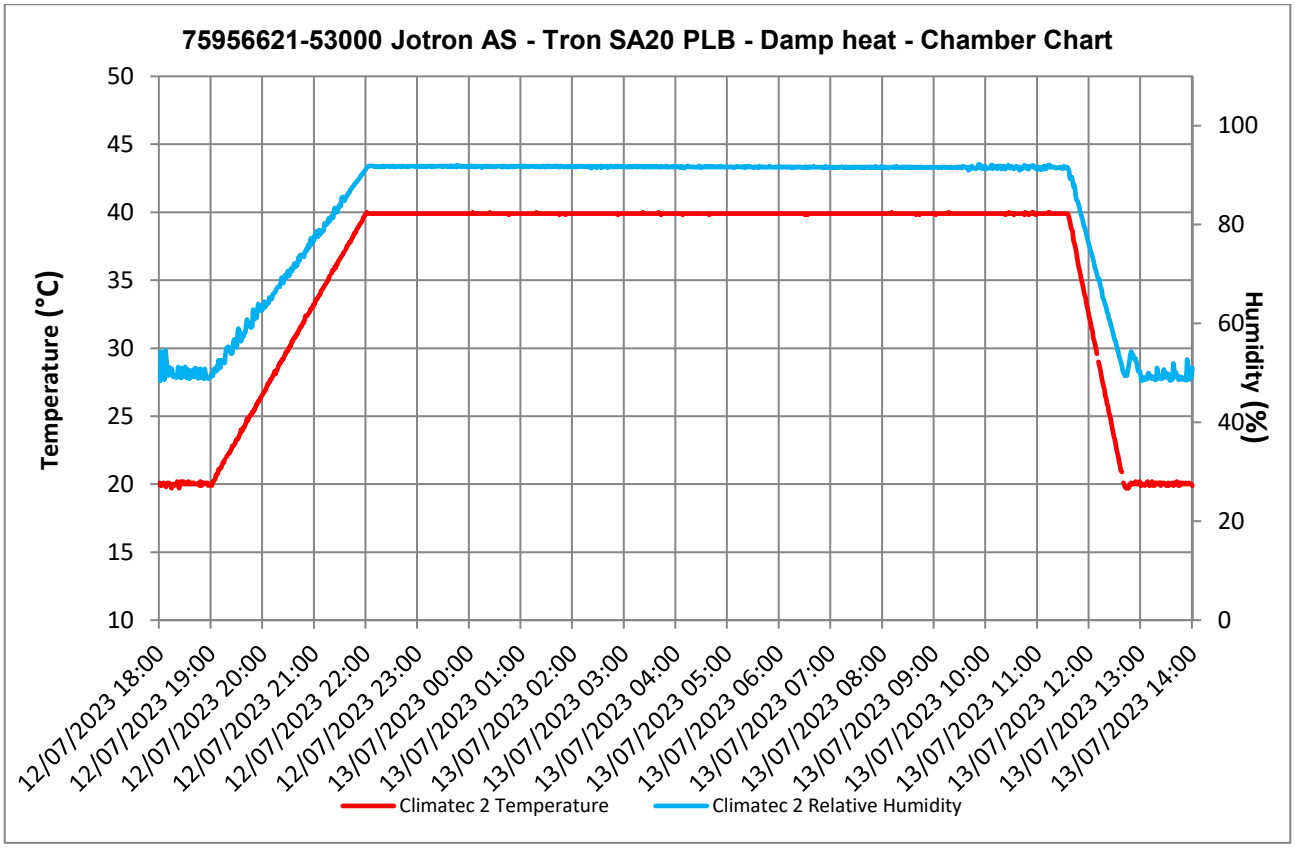
The EUTs were placed in a climatic chamber where the temperature was increased from laboratory ambient to +40°C and the relative humidity increased to 95%. After 10 hours, the EUTs were activated for at least 2 hours. During this period the EUT's were subjected to a performance check.

At the conclusion of all testing, a satisfactory Performance Check was carried on both EUTs.

Figure 6 - Damp Heat test setup – EUTs close-up and installed in climatic chamber

2.2.6 Test Results

Temperature Plot



Performance Checks

Tron SA20 PLB, S/N: 151

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018CCD0156FA3B84F9EBB49
406 MHz Frequency	406.03108990
121 MHz Presence	Presence Confirmed

Table 15

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018CCD0156FA3B84F9EBB49
406 MHz Frequency	406.03110490
121 MHz Presence	Presence Confirmed

Table 16

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.03108990
121 MHz Presence	Presence Confirmed

Table 17

2.2.7 Test Location and Test Equipment Used

This test was carried out in the Climatic Area.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period Months	Calibration Due
Load (50ohm/30W)	Weinschel	50T-054	285	12	28-Jul-2023
Termination (50ohm)	Diamond Antenna	DL-30N	337	12	05-Jan-2024
Climatic Chamber	Climatec	Climatec 2	2845	12	19-Dec-2023
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3159	12	21-May-2024
1 MHz / 10 MHz reference	Quartzlock	E10-X	4973	12	23-Feb-2024
Cable (18 GHz)	Rosenberger	LU7-036-1000	5034	12	21-May-2024
Cable (18 GHz)	Rosenberger	LU7-036-2000	5035	-	O/P Mon
Analyser (Spectrum)	Rohde & Schwarz	FPL1003	5349	12	02-Jan-2024
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5742	12	08-Feb-2024
Cable (N to N 2m)	Amphenol RF	N/A	5951	12	21-May-2024
Cable (N to N 2m)	Amphenol RF	N/A	5952	12	21-May-2024

Table 18

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.3 Low Temperature Tests

2.3.1 Specification Reference

RTCM 11010.4 Clause A.5
IEC 60945, Clause 8.4

2.3.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 151 - Modification State 0
Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.3.3 Date of Test

21 December 2022 to 22 December 2022 - Low Temperature Storage Test
28 July 2023 to 29 July 2023 – Low Temperature Functional Test

2.3.4 Environmental Conditions

Ambient Temperature	19.3 – 20.8 °C
Relative Humidity	37.1 – 51.3 %

2.3.5 Test Method

Storage Test

The EUTs were placed in a climatic chamber where the temperature was decreased from laboratory ambient temperature to -30 °C. After 12 hours, the temperature was returned to ambient conditions. The EUTs were subjected to a performance check at the end of the test.

Functional Test

The EUTs whilst switched off, were placed in a climatic chamber where the temperature was decreased from ambient temperature to -20°C. After 13 hours (see temperature plot below), the EUTs were powered on and kept operational for a further 2 hour period. During this time, they were subjected to a performance test and check. At the conclusion of the tests, the chamber conditions were returned to laboratory ambient.

At the conclusion of all testing, a satisfactory Performance Check was carried on all three EUTs.

Figure 7 – Low Temperature Storage test setup – EUTs close-up and installed in climatic chamber

2.3.6 Test Results

Storage Test

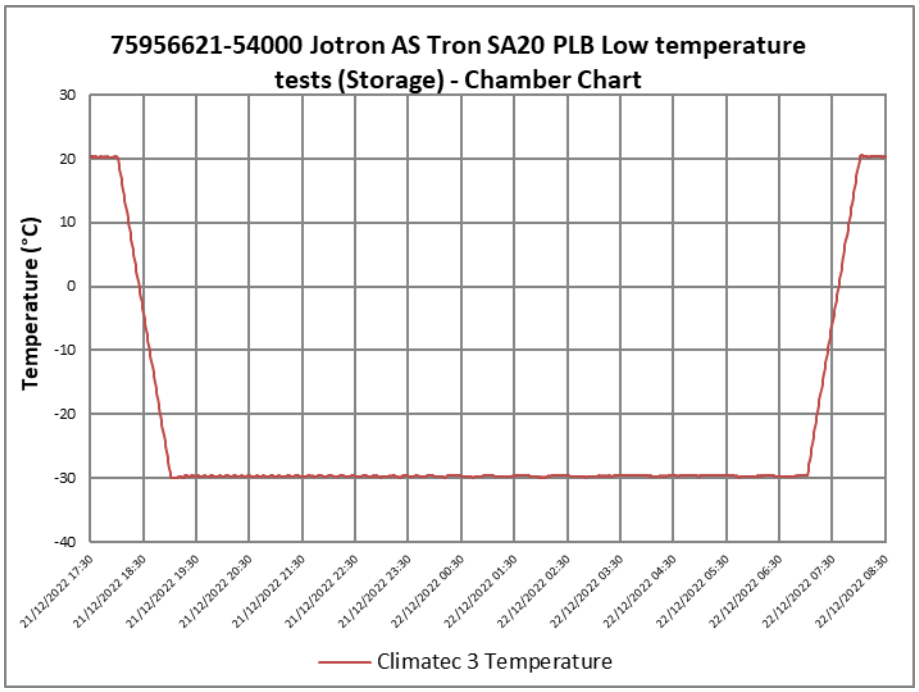


Figure 8 – Temperature Plot

Performance Check

Tron SA20 PLB, S/N: 151

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031075
121 MHz Presence	Presence Confirmed

Table 19

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031075
121 MHz Presence	Presence Confirmed

Table 20

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031065
121 MHz Presence	Presence Confirmed

Table 21

Functional Test

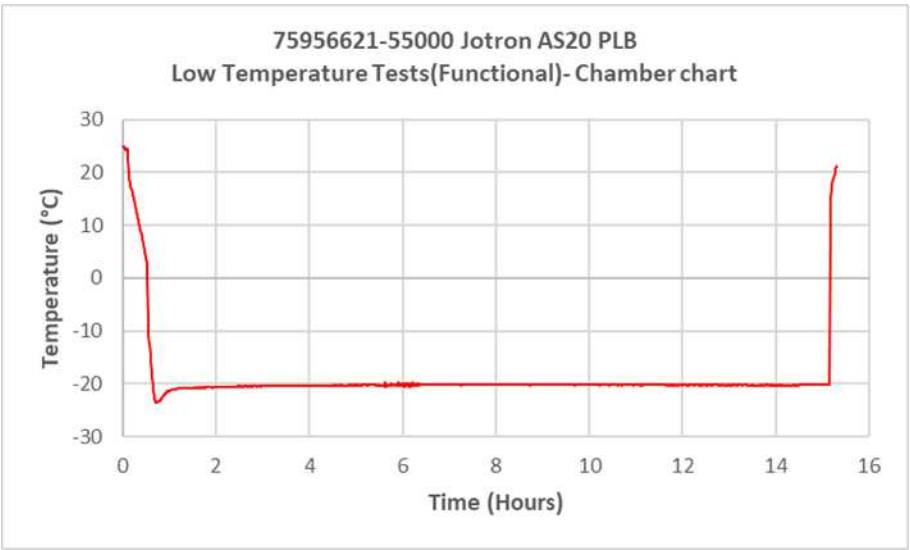


Figure 9 – Temperature Plot

Performance Test
Tron SA20 PLB, S/N: 151

Parameter	Result (Max / Min)
Output Power	36.58 / 36.54
Digital Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
Bit Rate	400.00 / 399.91
Modulation: Rise Time (us)	139.1 / 129.2
Modulation: Fall Time (us)	136.9 / 128.9
Positive Deviation (rad)	1.128 / 1.050
Negative Deviation (rad)	-1.148 / -1.070
Nominal Frequency (MHz)	406.03108283 / 406.031082594
Short-term Stability (/100 ms)	1.88E-10 / 1.52E-10
Medium-term Stability – Slope (/minute)	2.11E-11 / -7.71E-11
Medium-term Stability – Residual	3.36E-10 / 1.47E-10
Spurious Emissions	(see Plot)

Table 22

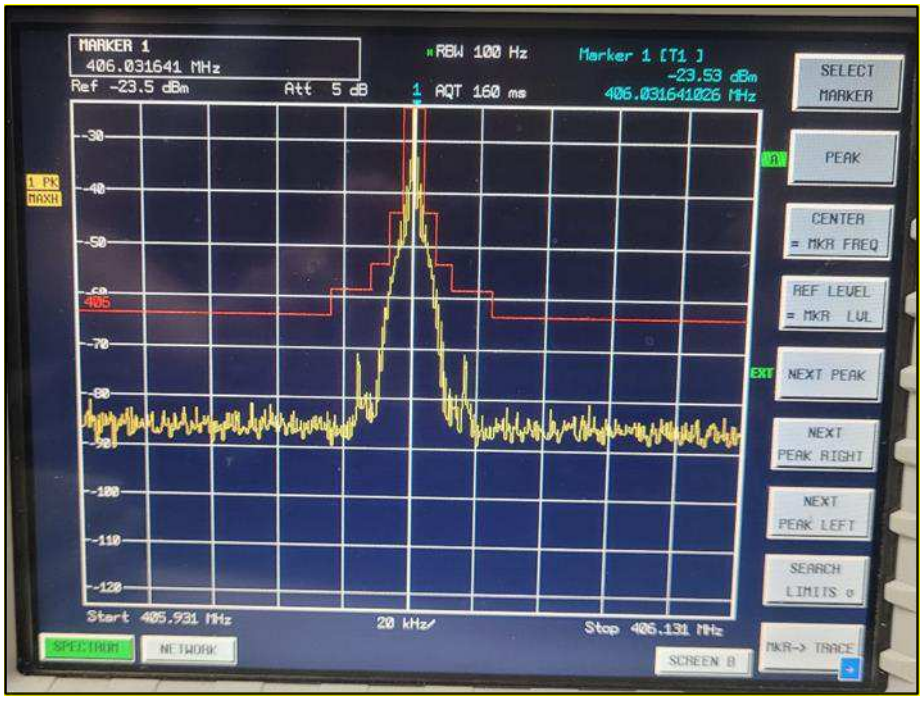


Figure 10 - Spurious Emissions

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031059295
121 MHz Presence	Presence Confirmed

Table 23

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031160256
121 MHz Presence	Presence Confirmed

Table 24

2.3.7 Test Location and Test Equipment Used

This test was carried out in the RF Laboratory 4.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Spectrum Analyser	Hewlett Packard	8542E	18	-	TU
Termination (50ohm)	Diamond Antenna	DL-30N	337	12	05-Jan-2024
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	15-Mar-2024
Termination (50ohm, 6W)	Micronde	R404613	3074	12	02-Dec-2023
Attenuator (20dB, 10W)	Aeroflex / Weinschel	23-20-34	3160	12	13-Oct-2023
Power Meter	Rohde & Schwarz	NRP	3491	12	13-Jan-2024
1 MHz / 10 MHz reference	Quartzlock	E10-X	4973	12	23-Feb-2024
Cable (18 GHz)	Rosenberger	LU7-036-1000	5025	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-036-1000	5034	12	21-May-2024
Cable (18 GHz)	Rosenberger	LU7-036-2000	5035	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-036-2000	5037	-	O/P Mon
USB Power Sensor	Boonton	RTP5318	5185	12	10-Feb-2024
Tester (Beacon)	WS Technologies	BT200-1100Y	5395	-	TU
Environmental Chamber	Climatec	Climatec 3	2846	12	07-Oct- 2023
Environmental Chamber	ACS	DY110TC	5589	-	O/P Mon
Thermocouple Data Logger	Pico Technology Ltd	TC-08 + Type T Thermocouple	5740	12	09-Mar-2024
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024

Table 25

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.4 Vibration Test

2.4.1 Specification Reference

RTCM 11010.4 Clause A.6
IEC 60945, Clause 8.7

2.4.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.4.3 Date of Test

06 January 2023 to 09 January 2023

2.4.4 Environmental Conditions

Ambient Temperature	19.0 - 19.3 °C
Relative Humidity	38.3 - 49.1 %

2.4.5 Test Method

The EUTs were fixed to the vibration table and were subject to the following vibration profiles:

Resonance Sweep

Taking at least 15 min to cover each octave of frequency, the equipment was subjected to sinusoidal vibration at all frequencies between:

- 5 Hz and 12,5 Hz with an excursion of ±1,6 mm ± 10 %;
- 12,5 Hz and 25 Hz with an excursion of ±0,38 mm ± 10 %;
- 25 Hz and 50 Hz with an excursion of ±0,10 mm ± 10 %.

The frequency sweep rate was slow enough to allow the detection of resonance in any part of the EUTs.

A resonance search was carried out during the vibration test. No resonance of any part of any of the components was observed, therefore the EUTs were only subject to sinusoidal vibration at 30 Hz frequencies in each of the mutual perpendicular direction in the horizontal plane.

Axis	Resonant Frequency (Hz)
Up and Down (Vertical)	No resonant frequency found
Side to side	No resonant frequency found
Forward and Aft (Front/Back)	No resonant frequency found

Table 26

Note: There were no resonance frequencies detected and therefore the endurance run in each axis, was carried out at 30 Hz.

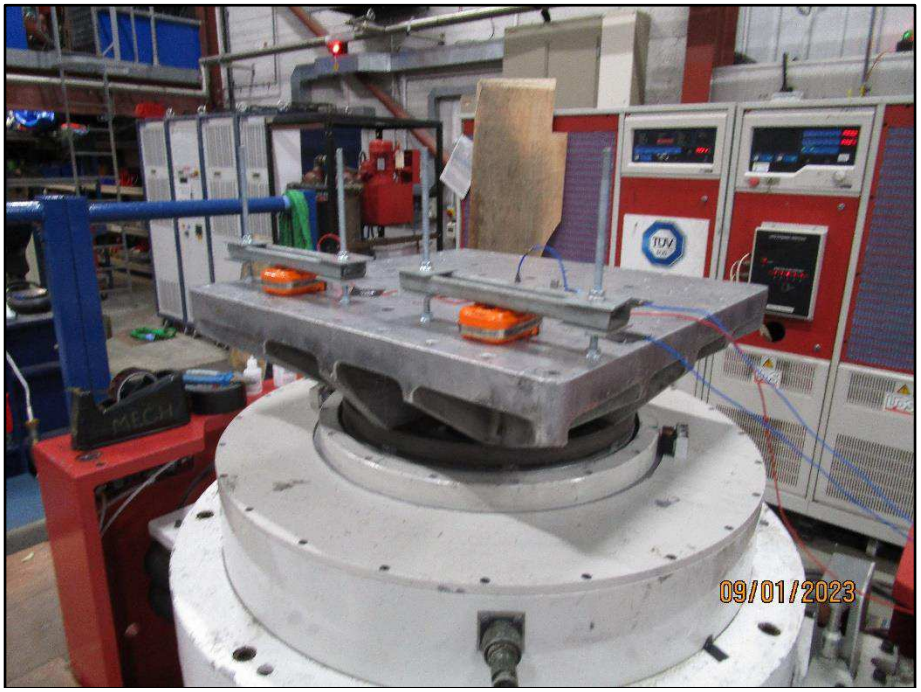


Figure 11 - Test Setup – Forward and Aft (Front/Back)

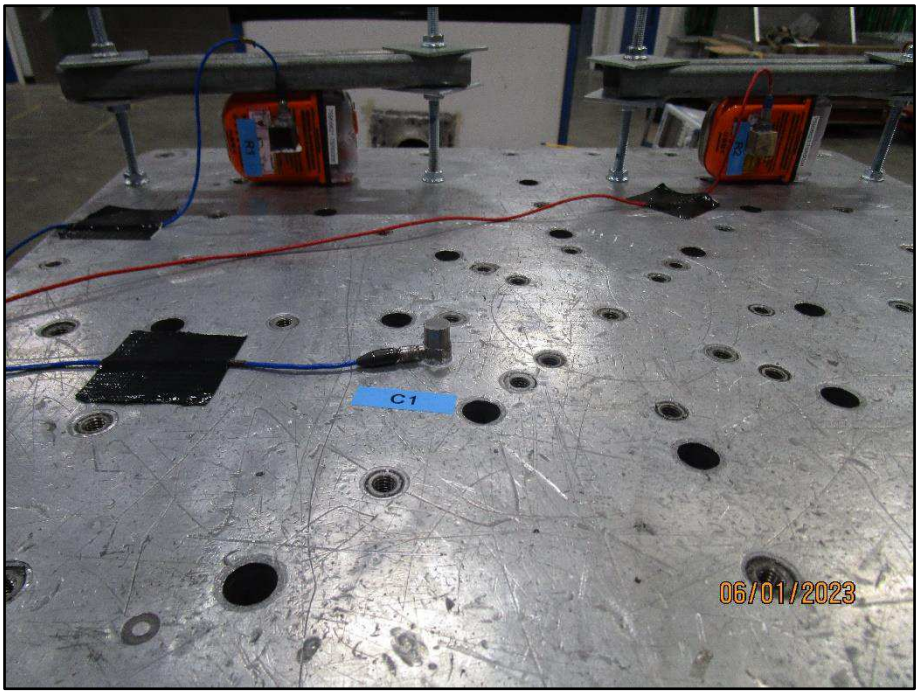


Figure 12 - Test Setup – Side to Side

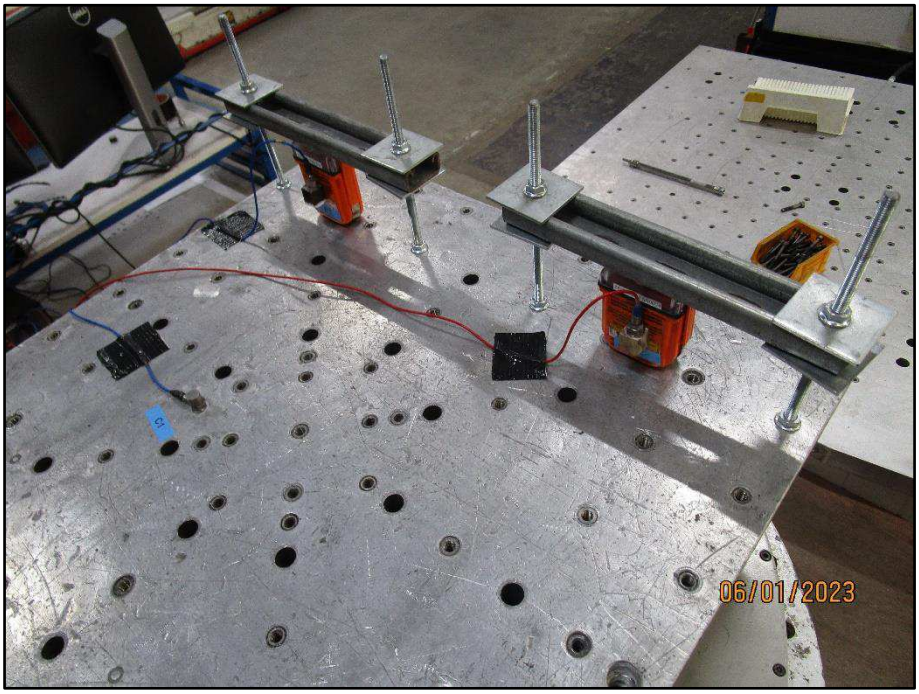


Figure 13 - Test Setup – Up and Down (Vertical)

2.4.6 Test Results

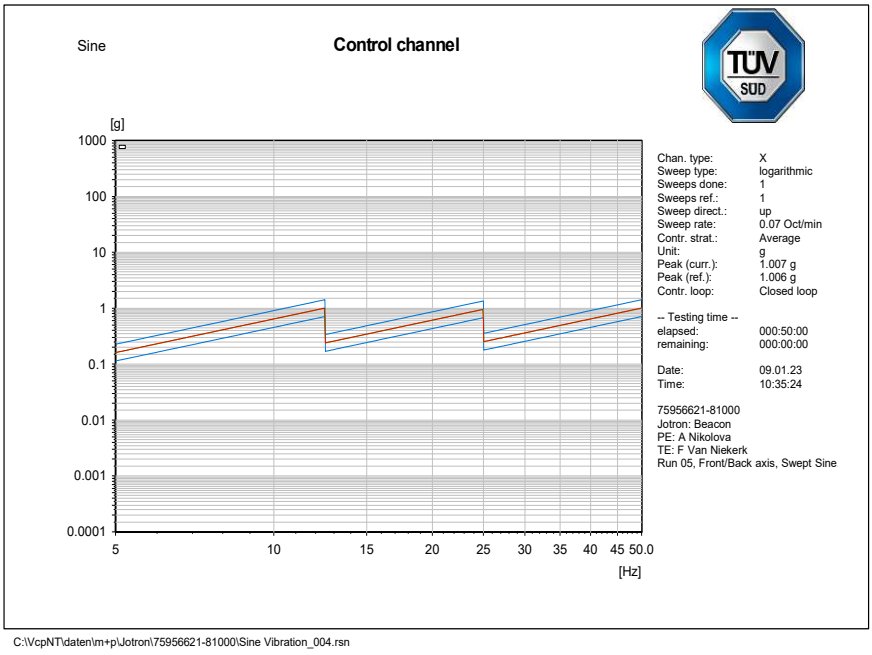


Figure 14 - Forward and Aft (Front/Back) Axis – Resonance Search – Control

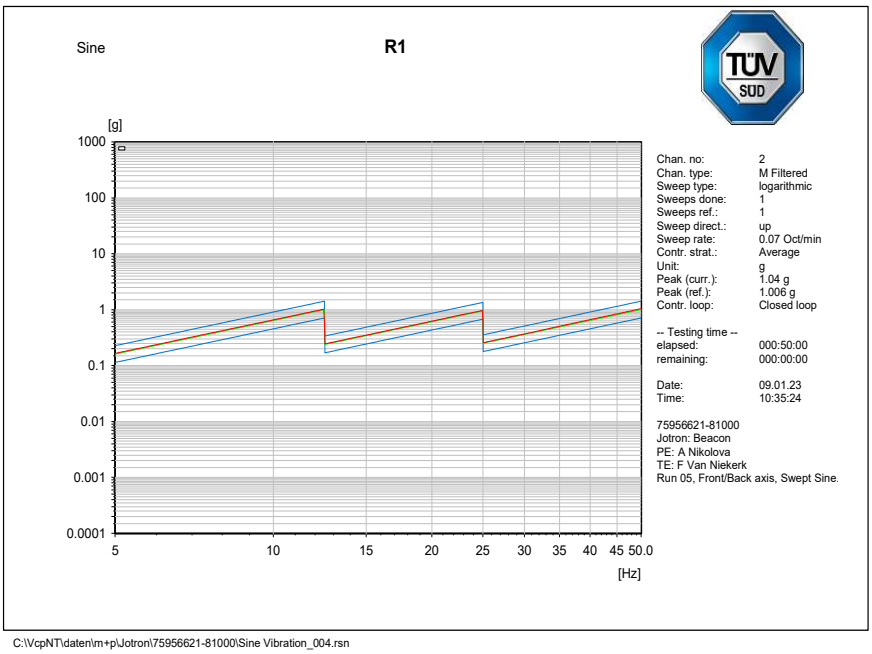


Figure 15 - Forward and Aft (Front/Back) Axis Resonance Search - Tron SA20 PLB, S/N: 107 Response

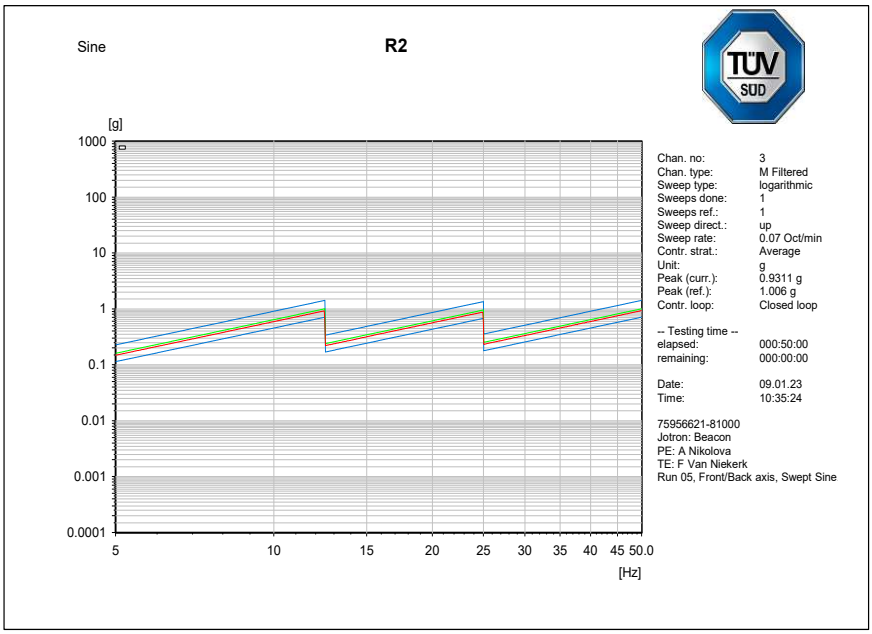


Figure 16 - Forward and Aft (Front/Back) Axis Resonance Search - Tron SA20 PLB, S/N: 157 Response

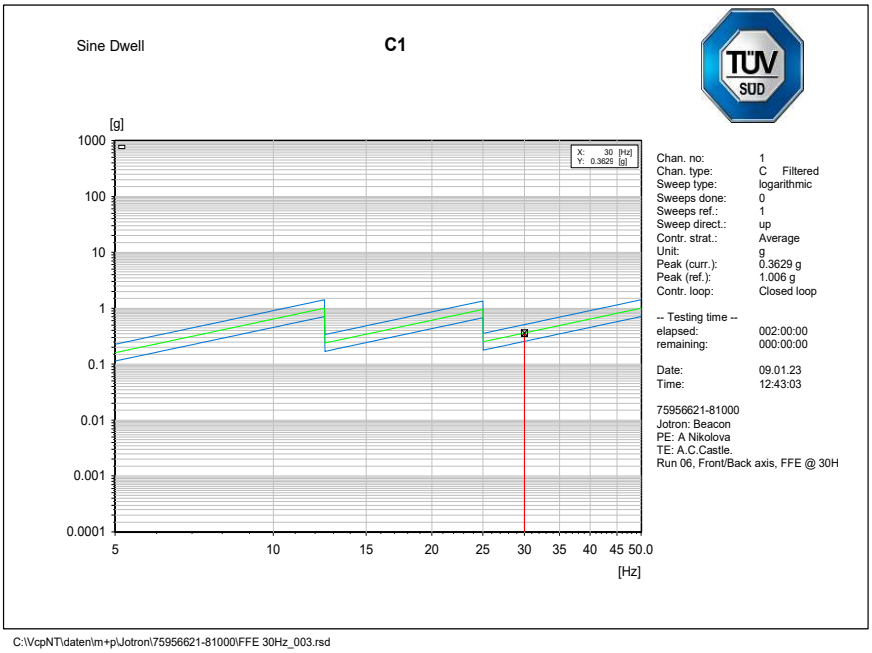


Figure 17 - Forward and Aft (Front/Back) Axis – Endurance Run (30 Hz) - Control

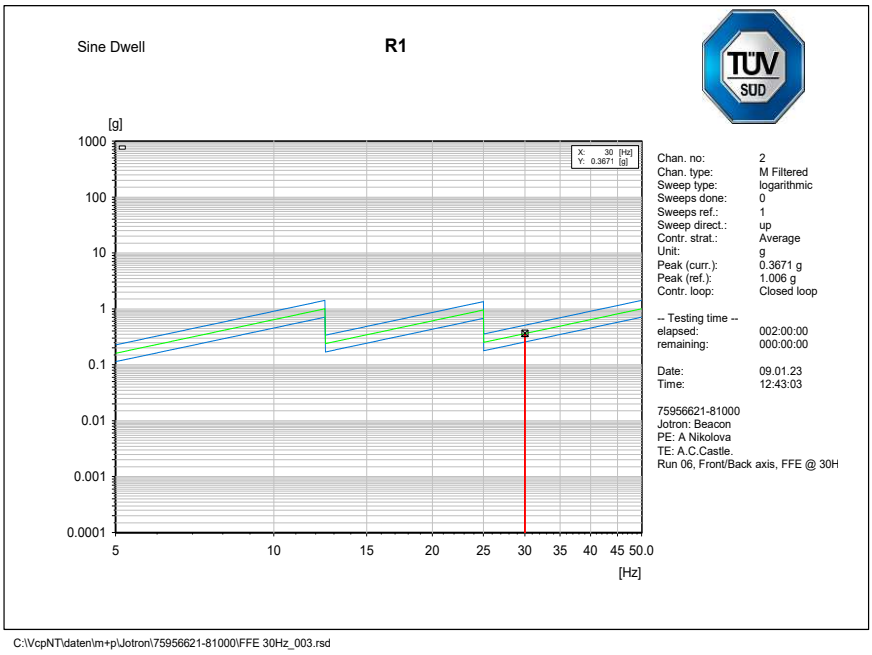


Figure 18 - Forward and Aft (Front/Back) – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 107 Response

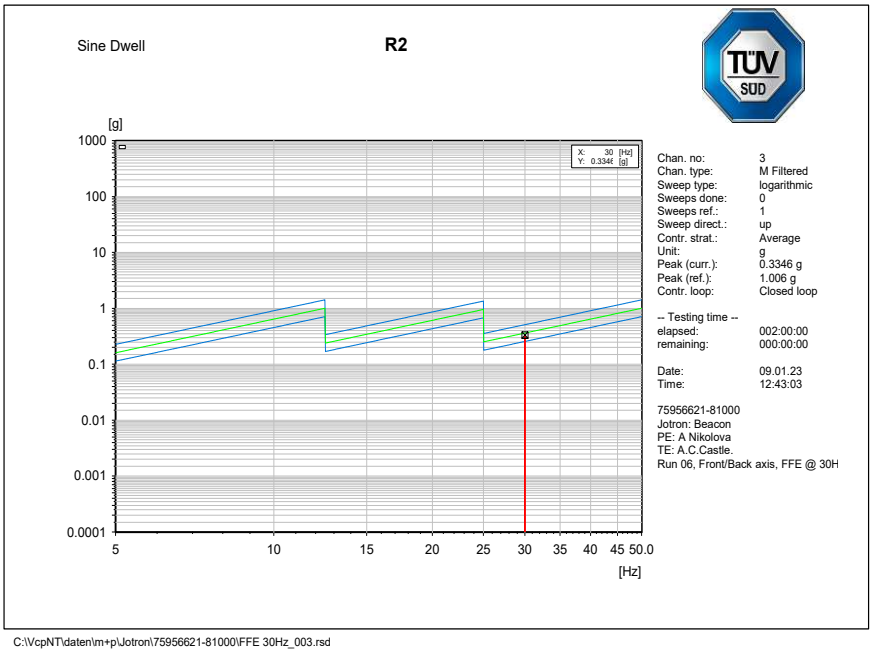


Figure 19 - Forward and Aft (Front/Back) – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 157 Response

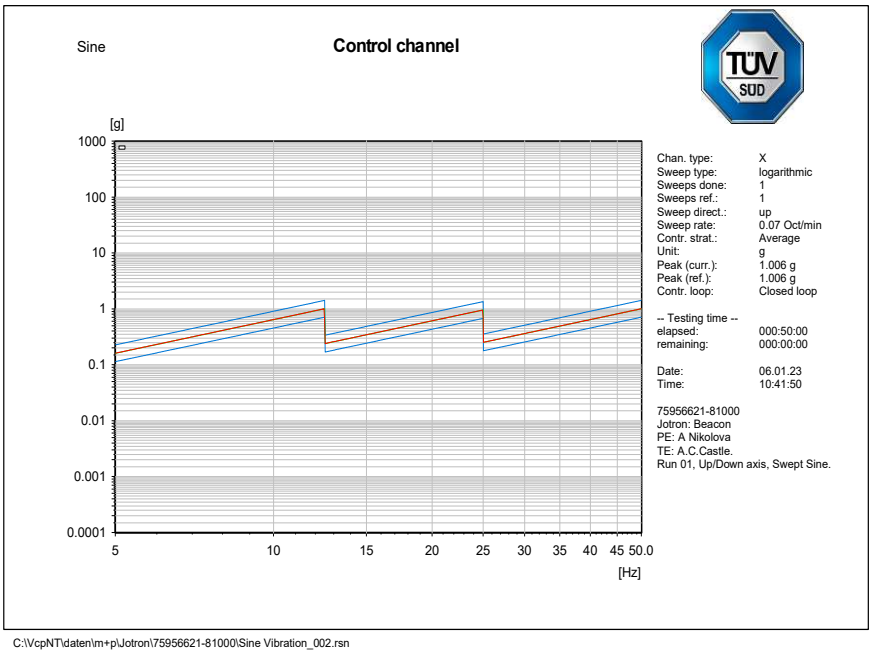


Figure 20 - Up and Down (Vertical) Axis – Resonance Search – Control

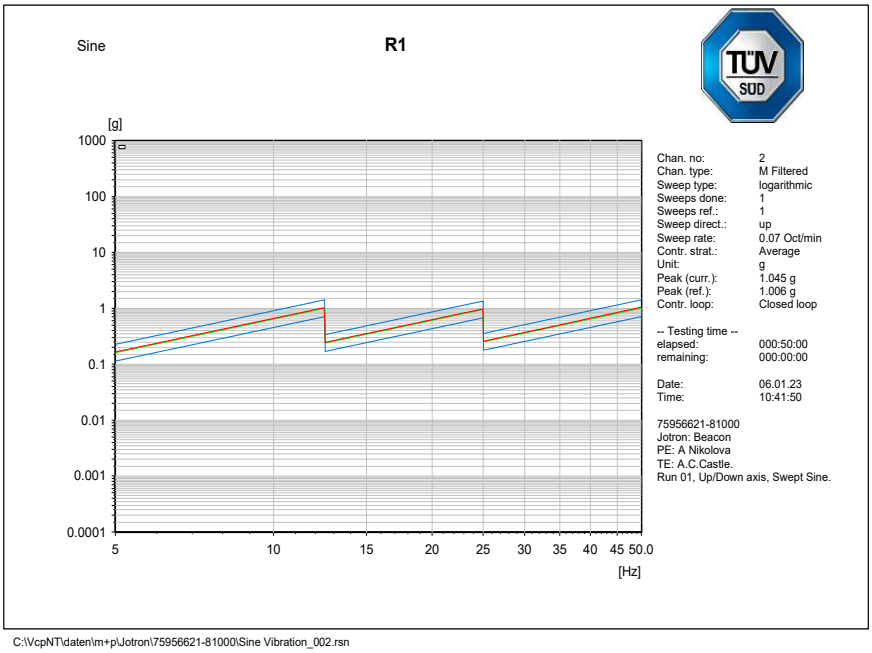


Figure 21 - Up and Down (Vertical) Axis Resonance Search - Tron SA20 PLB, S/N: 107 Response

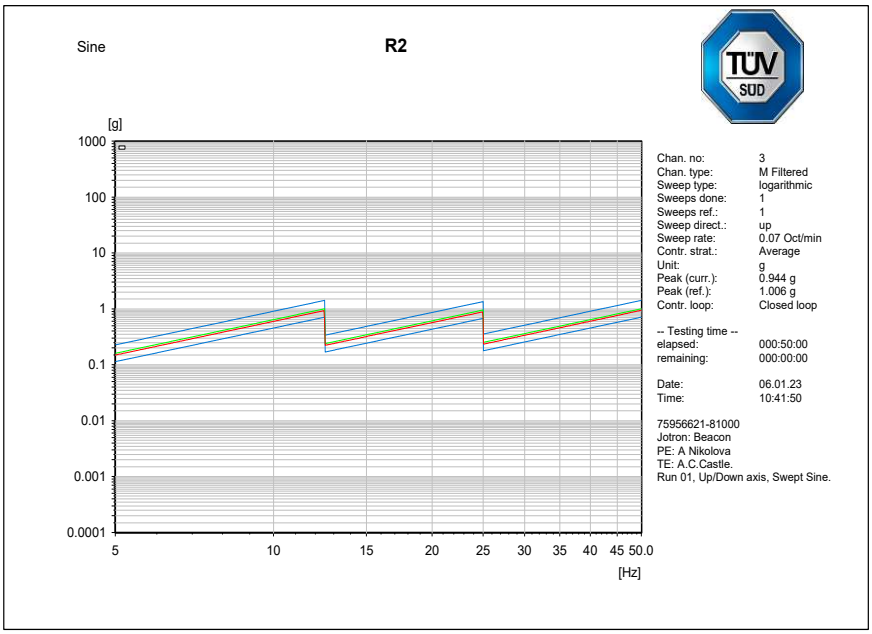


Figure 22 - Up and Down (Vertical) Axis Resonance Search -Tron SA20 PLB, S/N: 157 Response

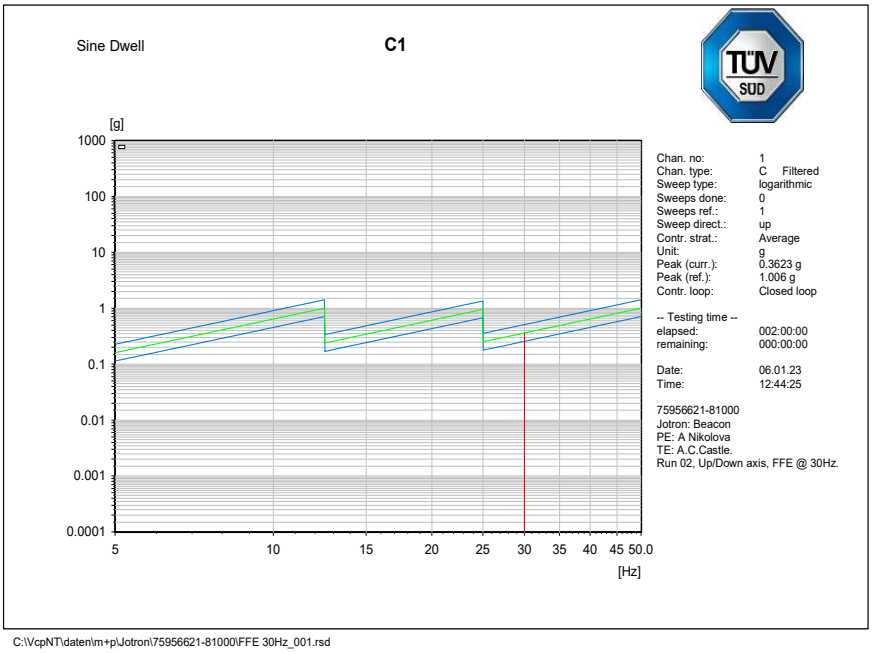


Figure 23 - Up and Down (Vertical) – Endurance Run (30 Hz) – Control

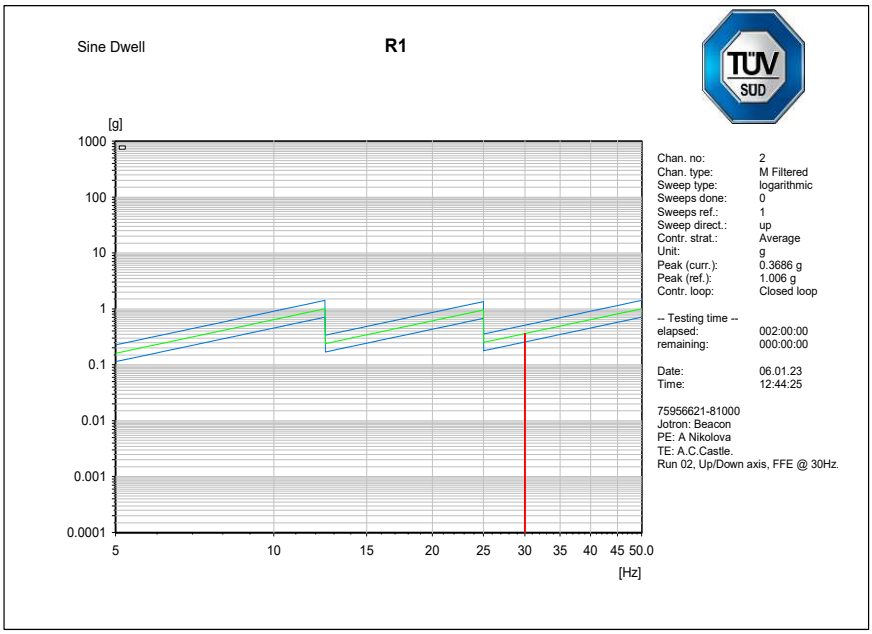


Figure 24 - Up and Down (Vertical) – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 107 Response

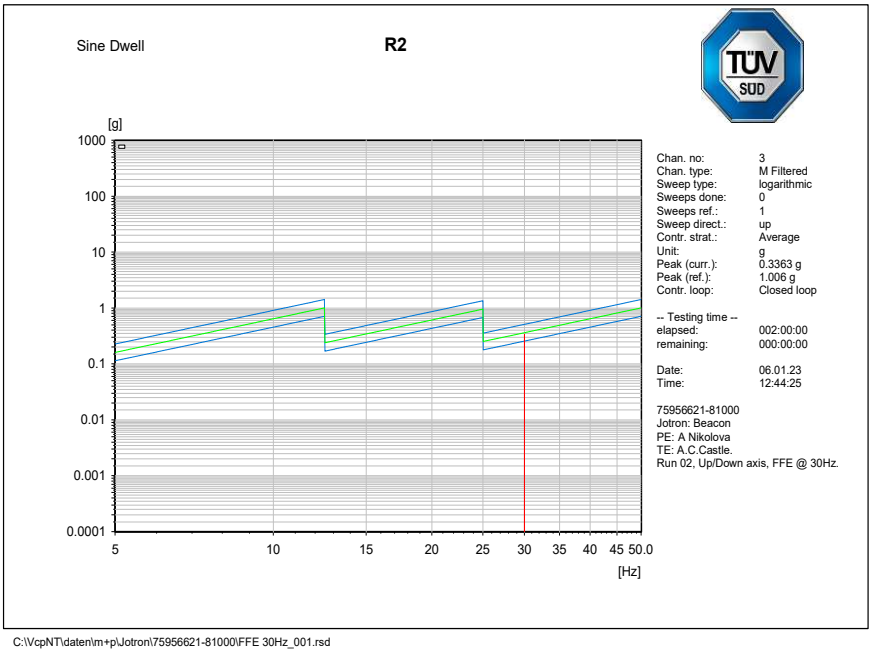


Figure 25 - Up and Down (vertical) – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 157 Response

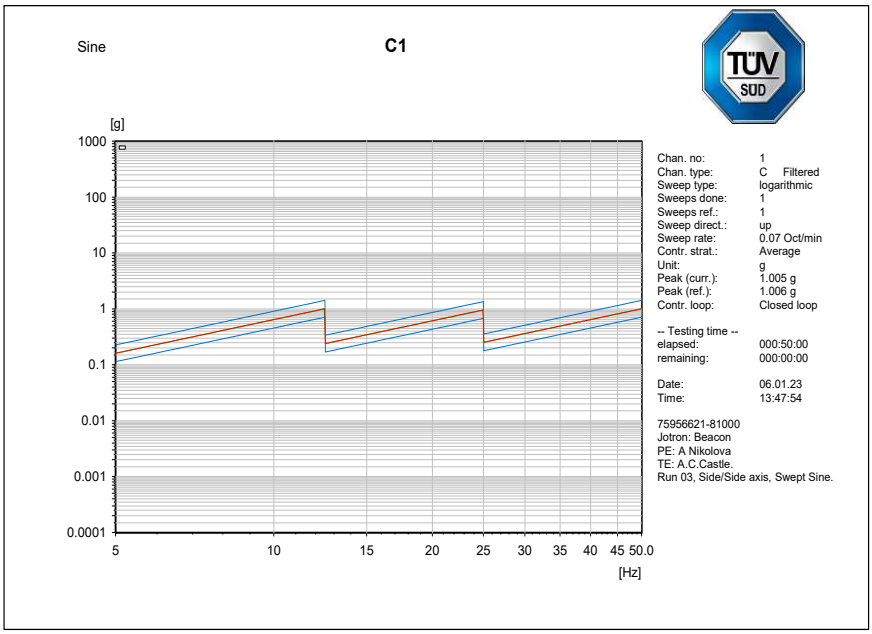


Figure 26 - Side to Side Axis – Resonance Search – Control

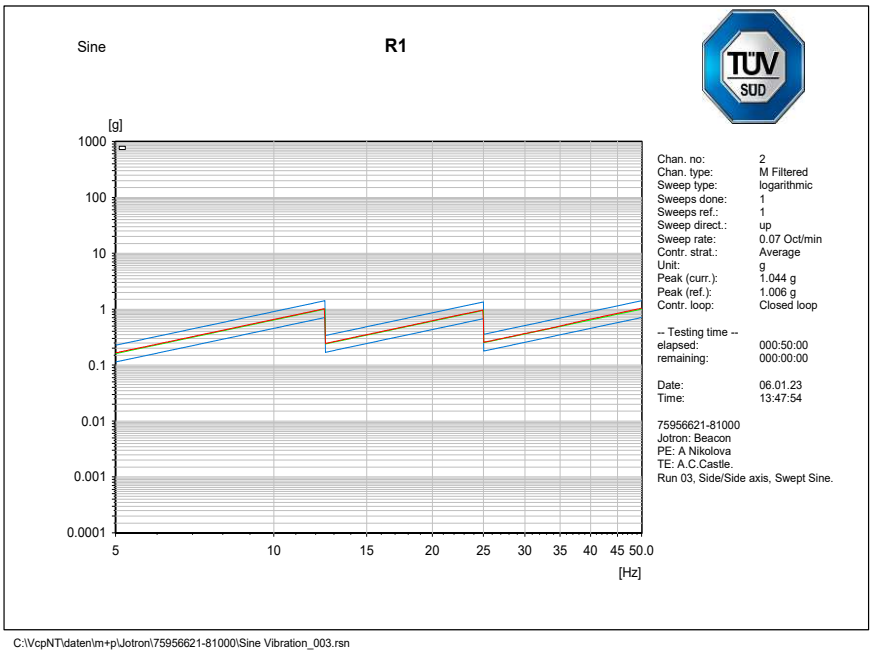


Figure 27 - Side to Side Axis Resonance Search - Tron SA20 PLB, S/N: 107 Response

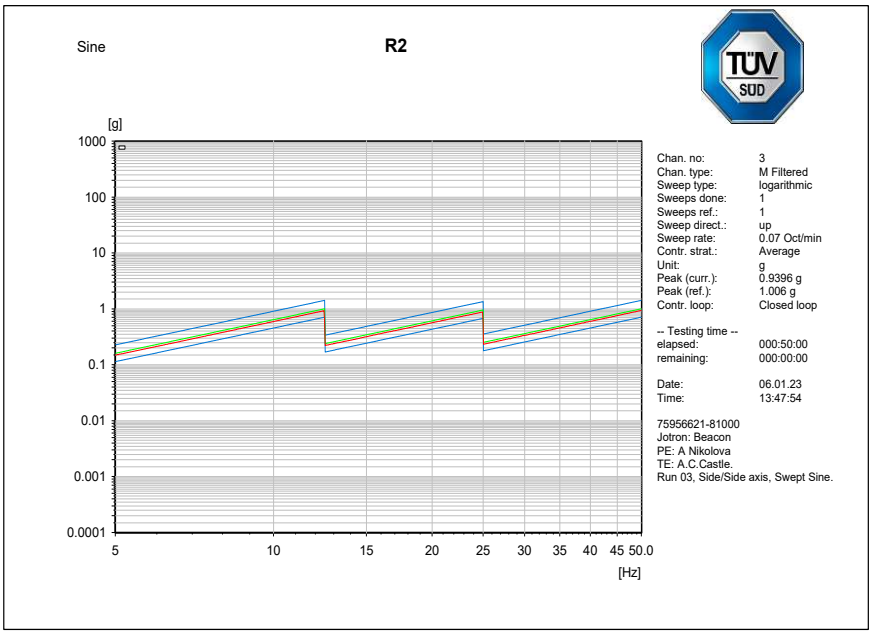


Figure 28 - Side to Side Axis Resonance Search - Tron SA20 PLB, S/N: 157 Response

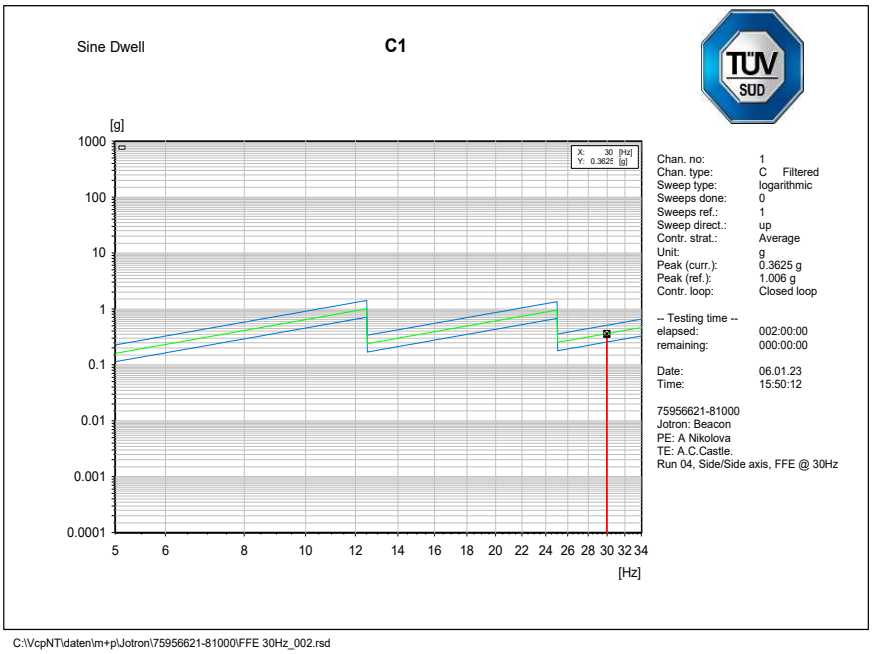


Figure 29 - Side to Side Axis – Endurance Run (30 Hz) - Control

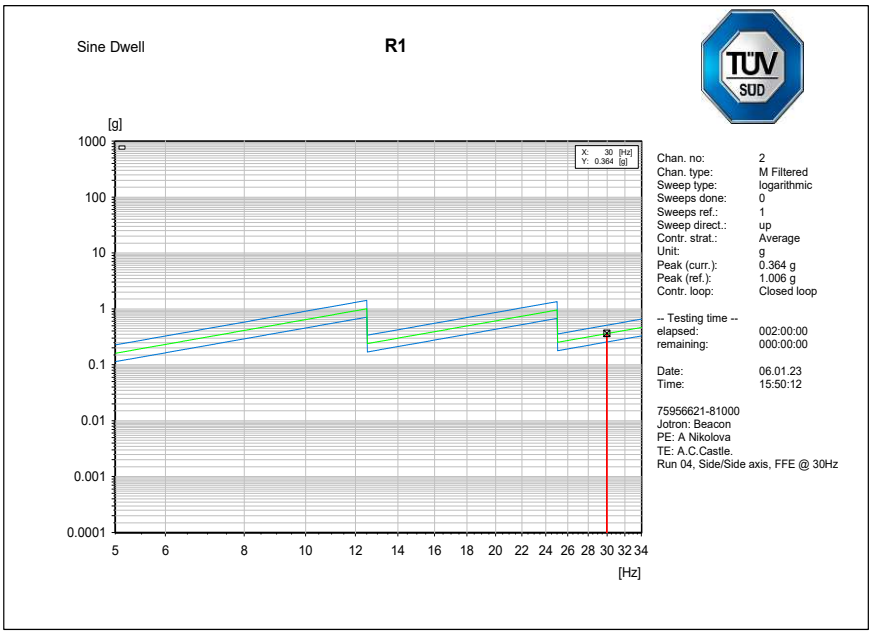


Figure 30 - Side to Side Axis – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 107 Response

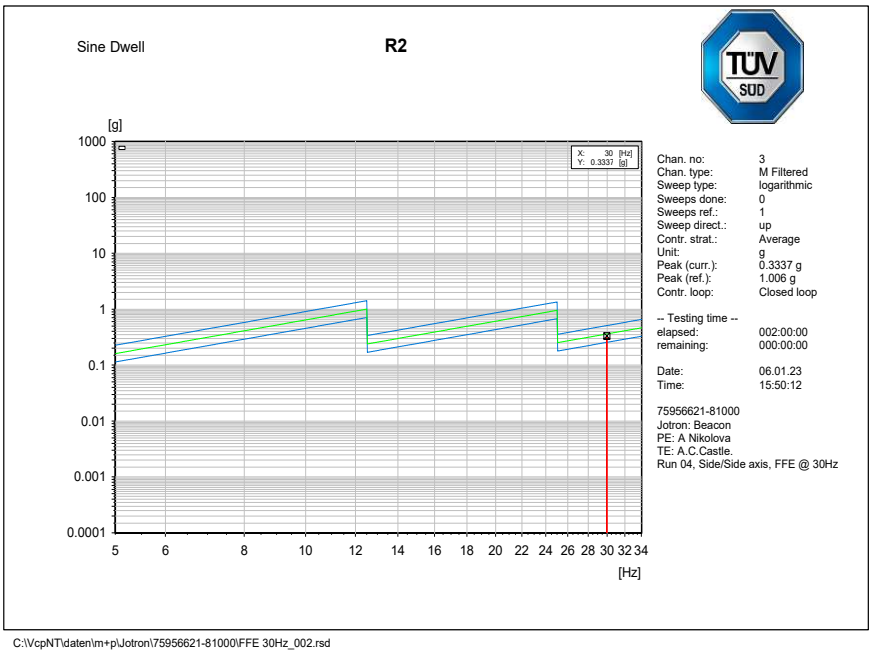


Figure 31 - Side to Side Axis – Endurance Run (30 Hz) - Tron SA20 PLB, S/N: 157 Response

Post Test Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031066
121 MHz Presence	Presence Confirmed

Table 27

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031064
121 MHz Presence	Presence Confirmed

Table 28

Mechanical Inspection

Post-test inspection showed no signs of mechanical degradation were witnessed.

Activation Monitoring

During the test the EUT was monitored for signs of activation, none were found.

2.4.7 Test Location and Test Equipment Used

This test was carried out in the Mechanical Area.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	15-Mar-2023
Vibration System	Ling Dynamic Systems	LDS V964	2515	6	08-Feb-2023
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	11-Mar-2023
Thermal Isotron Accelerometer	PCB Piezotronic	352C03	4340	6	24-Feb-2023
Accelerometer	PCB Piezotronic	352C43	5269	6	19-Jun-2023
Emissions Cable (6M)	Gigatronix Ltd	APFZAAPFZAP4W2-6M	5369	12	Class 1 (Ext)
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
Accelerometer	Endevco	256 10	5707	6	05-Apr-2023
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024
Vibration Control System, Master	m + p International	VibRunner	5993	12	04-Jun-2023

Table 29

2.5 Bump Test

2.5.1 Specification Reference

RTCM 11010.4 Clause A.7

2.5.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.5.3 Date of Test

11 January 2023

2.5.4 Environmental Conditions

Ambient Temperature	18.8 - 19.0 °C
Relative Humidity	44.7 - 46.6 %

2.5.5 Test Method

The EUTs were fixed to the vibration table and were subjected to the following profile:

Peak acceleration:	98 m/s2 +/-10 %
Pulse duration:	16 ms +/-10 %
Wave shape:	Half-cycle sinewave
Test Axis:	Vertical
Number of bumps:	4000

During the test, the EUTs were monitored for inadvertent activation. At the end of the test, each EUT was subjected to a Performance Check.

Figure 32 - Test Setup – Up and Down (Vertical)

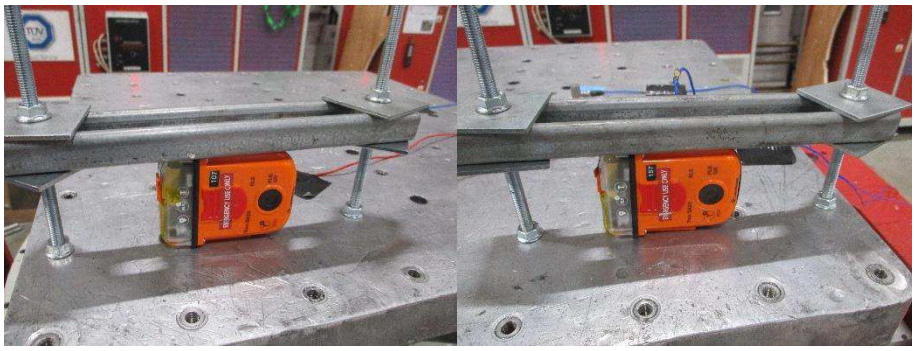


Figure 33 - Test Setup – Side to Side

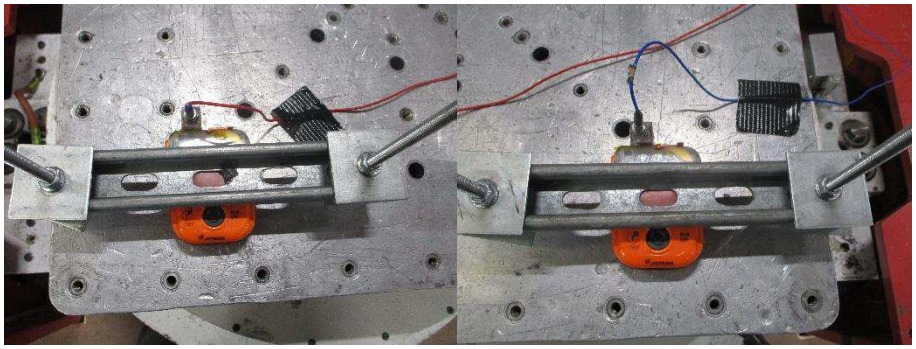


Figure 34 - Test Setup – Forward and Aft (Front/Back)

2.5.1 Test Results

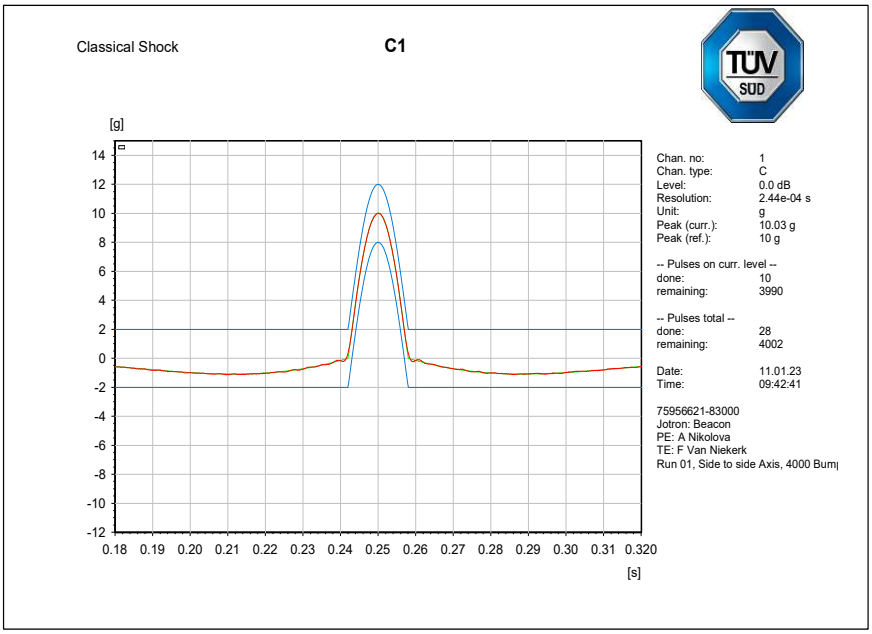


Figure 35 - Side to Side Axis – Control

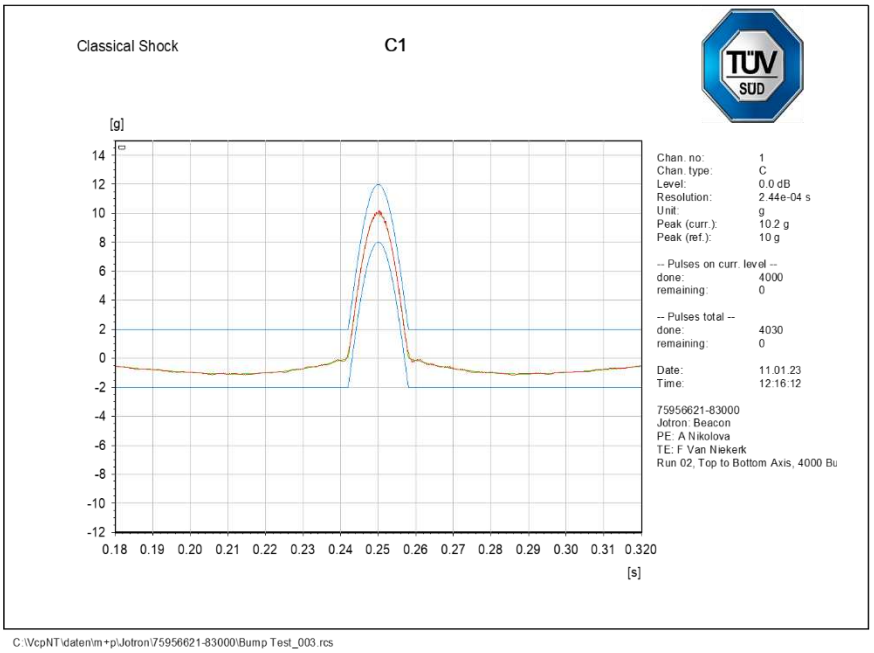
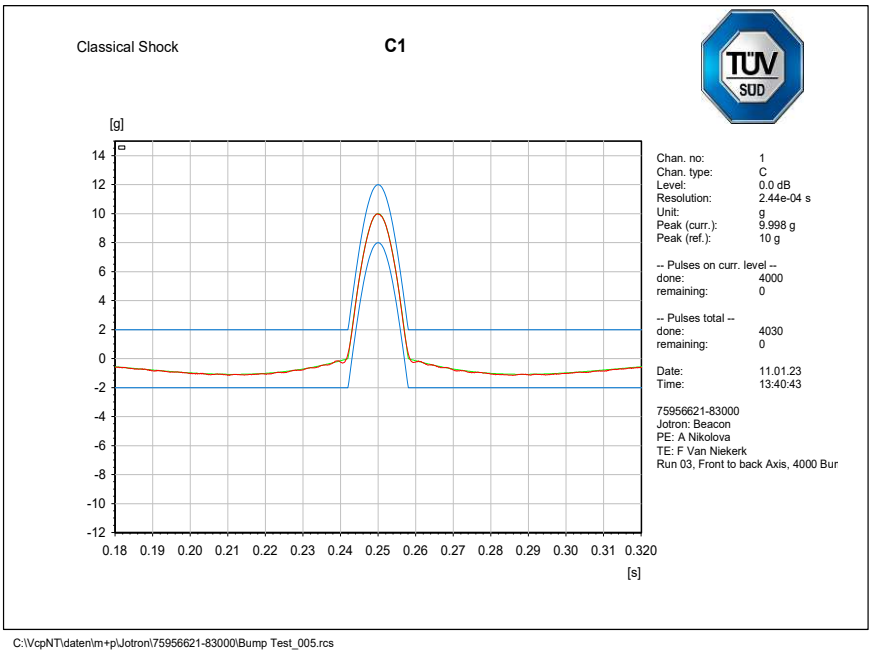


Figure 36 - Up and Down (Vertical) Axis – Control



C:\VcpNT\daten\m+p\Jotron\75956621-83000\Bump Test_005.rcs

Figure 37 - Forward and Aft (Front/Back) Axis – Control

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031066
121 MHz Presence	Presence Confirmed

Table 30

Performance Check

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031058
121 MHz Presence	Presence Confirmed

Table 31

2.5.2 Test Location and Test Equipment Used

This test was carried out in the Mechanical Area.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	15-Mar-2023
Vibration System	Ling Dynamic Systems	LDS V964	2515	6	08-Feb-2023
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	11-Mar-2023
Thermal Isotron Accelerometer	PCB Piezotronic	352C03	4340	6	24-Feb-2023
Accelerometer	PCB Piezotronic	352C43	5269	6	19-Jun-2023
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
Accelerometer	Endevco	256 10	5707	6	05-Apr-2023
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024
Vibration Control System, Master	m + p International	VibRunner	5993	12	04-Jun-2023

Table 32

TU – Traceability Unscheduled

2.6 Drop Test

2.6.1 Specification Reference

RTCM 11010.4, Clause A.9,
IEC 60945, Clause 8.6

2.6.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.6.3 Date of Test

12 January 2023

2.6.4 Environmental Conditions

Ambient Temperature	19.5 - 19.8 °C
Relative Humidity	48.4 - 48.8 %

2.6.5 Test Method

The EUTs were placed in a pre-conditioning climatic chamber at a temperature of -30°C (this deviation satisfies the requirement for RTCM 11010.4) for at least 2 hours.

Within 5 minutes of being removed from the climatic chamber, the EUTs were dropped 6 times, once on each face, from a height of 1000 mm ± 10 mm onto the test surface (solid piece of hardwood).

The EUT's were monitored throughout the test to ensure that they did not activate.
After the test, the EUT's were inspected for signs of damage, and subjected to a performance check.

Figure 38 - Test Setup – Pre-conditioning

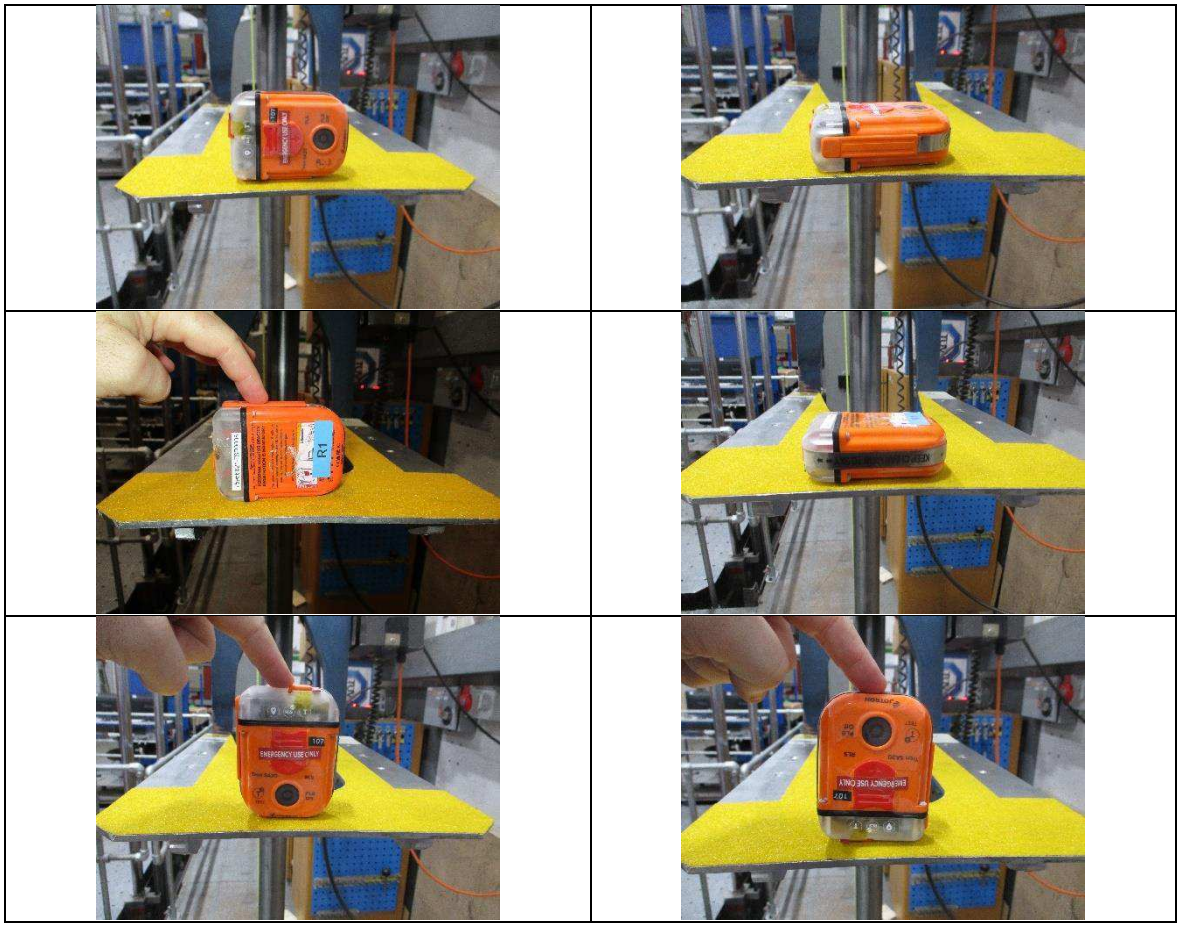


Figure 39 - Test Setup – Drop on to Hard Surface- Tron SA20 PLB, S/N: 107

Figure 40 - Post Drop Test - Tron SA20 PLB, S/N: 107 activation cover off

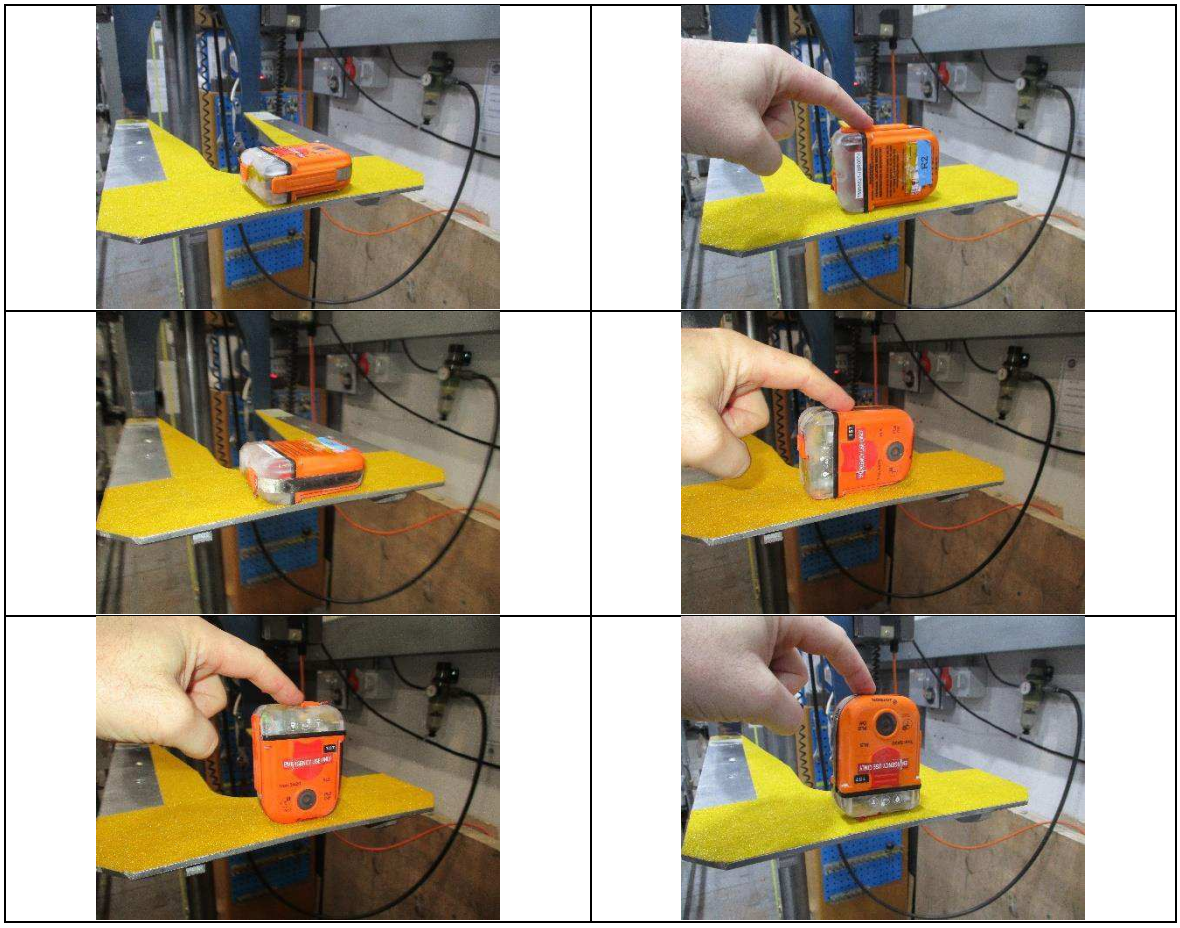


Figure 41 - Test Setup – Drop on to Hard Surface- Tron SA20 PLB, S/N: 157

Figure 42 - Post Drop Test - Tron SA20 PLB, S/N: 157 activation cover off

Note: The activation button cover on Tron SA20 PLB, S/N: 107 came off after the second drop and the activation button cover on Tron SA20 PLB, S/N: 157 came off after the forth drop. In normal circumstances, the EMERGENCY USE ONLY label will be sealed and the cover would not come off so easily.

After the end of the Drop on Hard surface test it was noticed that the Tron SA20 PLB, S/N: 157 had rattle. As this rattle did not affect the performance of the EUT, the sample was opened at the end of the compulsory sequence of tests. Upon disassembling the EUT a small piece of plastic, which is part of the battery pack cradle appeared to have been broken. Please refer to pictures below

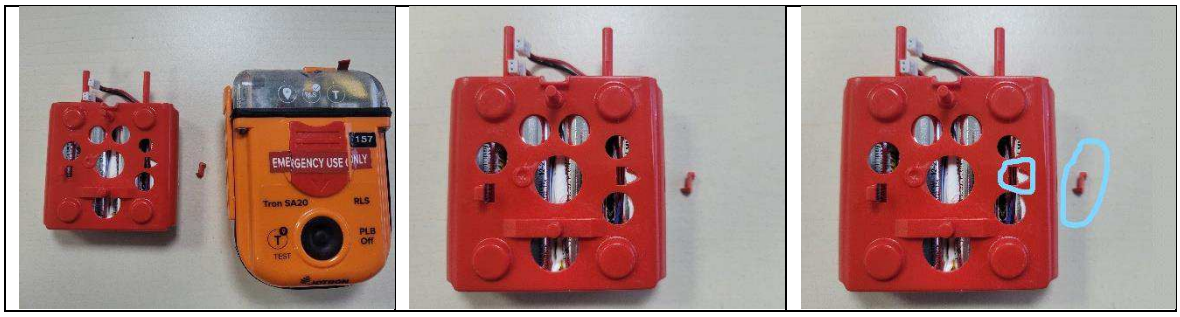


Figure 43 - Post Drop Test - Tron SA20 PLB, S/N: 157 disassembled

2.6.6 Test Results

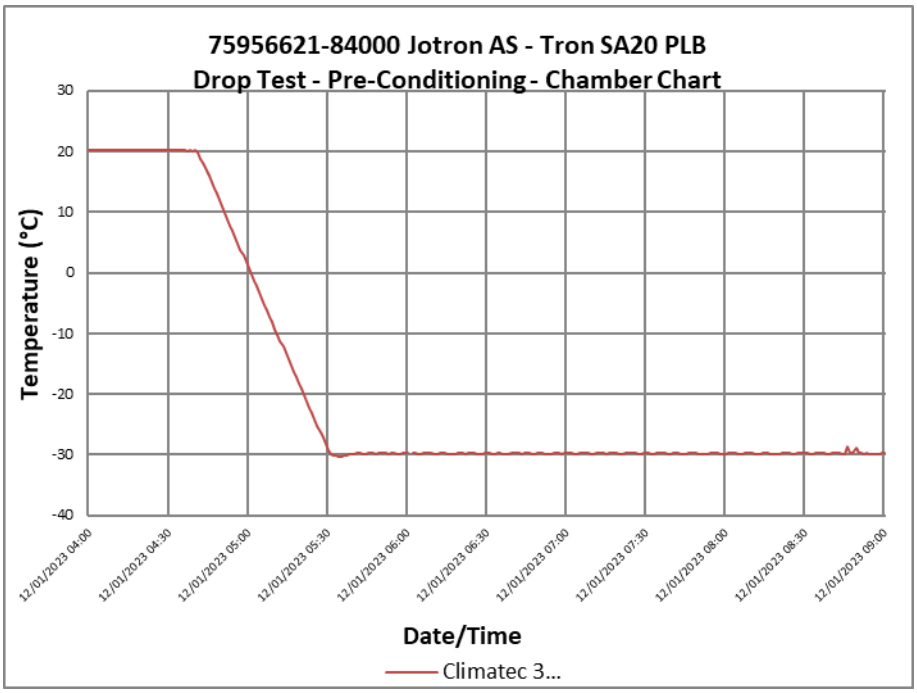


Figure 44 - Temperature Plot – Pre-conditioning

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFFD08FDFEFFF28917861F0FABE*
406 MHz Frequency	406.031018
121 MHz Presence	Presence Confirmed

Table 33

*The performance check for S/N 157 showed an anomaly in the operational message. This was not noticed at the time of test. However, a second sample of the same design and build state (S/N 107) also performed the same test; the performance check on this sample was deemed satisfactory for the operational message. The following test on S/N 157 (Thermal shock – see section 2.7.6) indicated a satisfactory performance check.

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031074
121 MHz Presence	Presence Confirmed

Table 34

2.6.7 Test Location and Test Equipment Used

This test was carried out in the Mechanical Area.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Lansmont	Lansmont	PDT 56E	2291	-	TU
8m Tape Measure	Stanley	FatMax	4148	-	TU
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	15-Mar-2023
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	11-Mar-2023
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024
Climatic Chamber	Climatec	CLIMATEC 3	2846	12	07-Oct-2023

Table 35

TU – Traceability Unscheduled

2.7 Thermal Shock Test

2.7.1 Specification Reference

RTCM 11010.4, Clause A.10
IEC 60945, Clause 8.5

2.7.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.7.3 Date of Test

12 January 2023

2.7.4 Environmental Conditions

Ambient Temperature	19.5 - 20.0 °C
Relative Humidity	50.1 %

2.7.5 Test Method

The EUTs were placed in the pre-conditioning climatic chamber at a temperature of +70 °C (this deviation meets the requirement for EN 60945) for 1 hour.

The EUTs were then immersed in a water vessel (preconditioned for approximately 1 hour) at +25 °C, at a level of 100 mm below the surface of the water (measured to the highest point of the EUT). The EUT's remained immersed for 4 hours. After this period of immersion, the EUTs were inspected and weighed for signs of water ingress and subjected to a performance check.

Figure 45 - Test Setup – Pre-conditioning

Figure 46 - Test Setup – EUT Immersed

2.7.6 Test Results

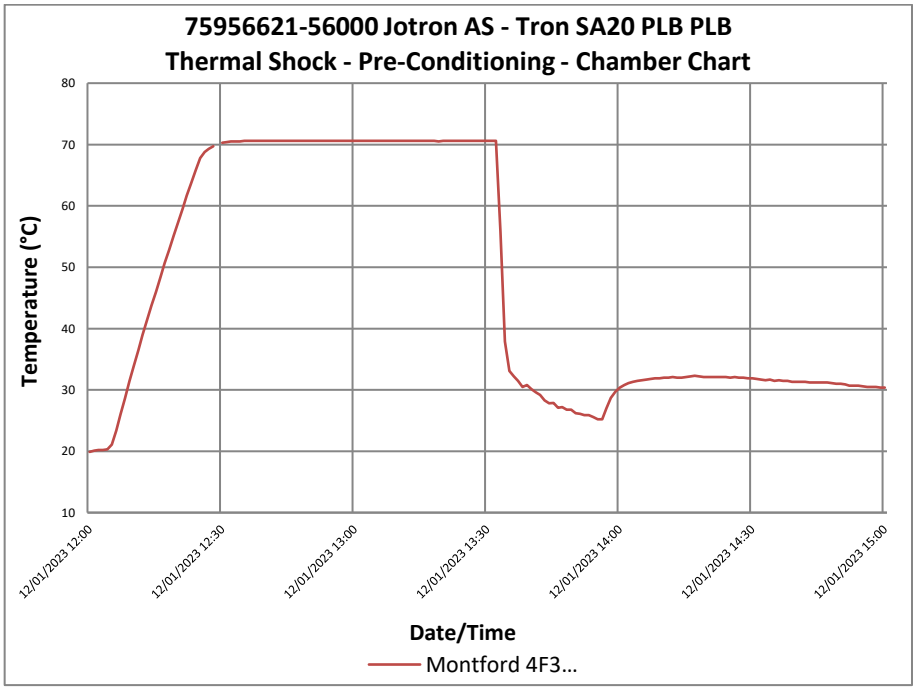


Figure 47 - Temperature Plot – Pre-conditioning

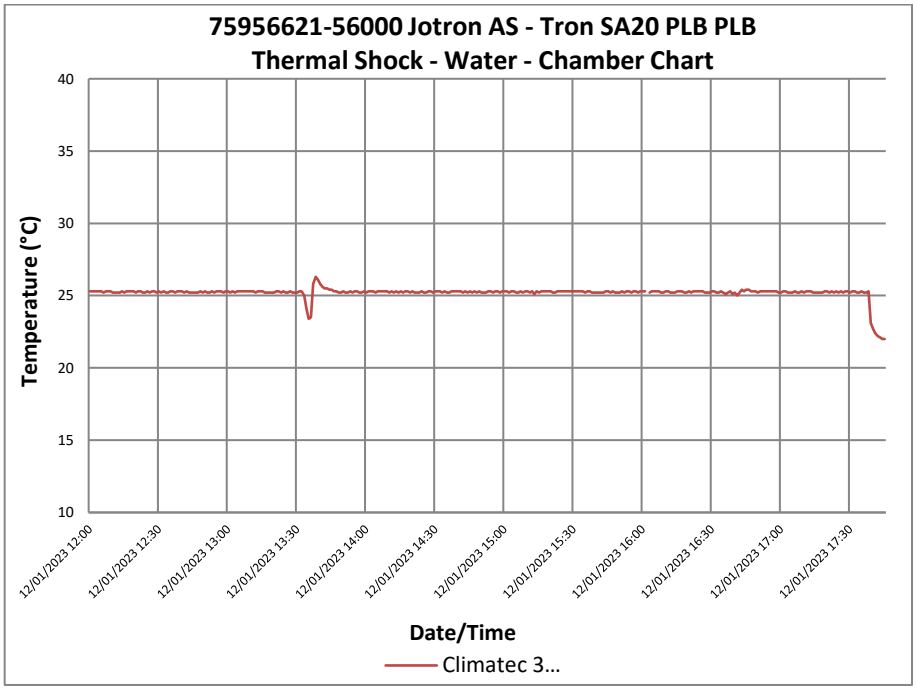


Figure 48 - Temperature Plot – Immersion

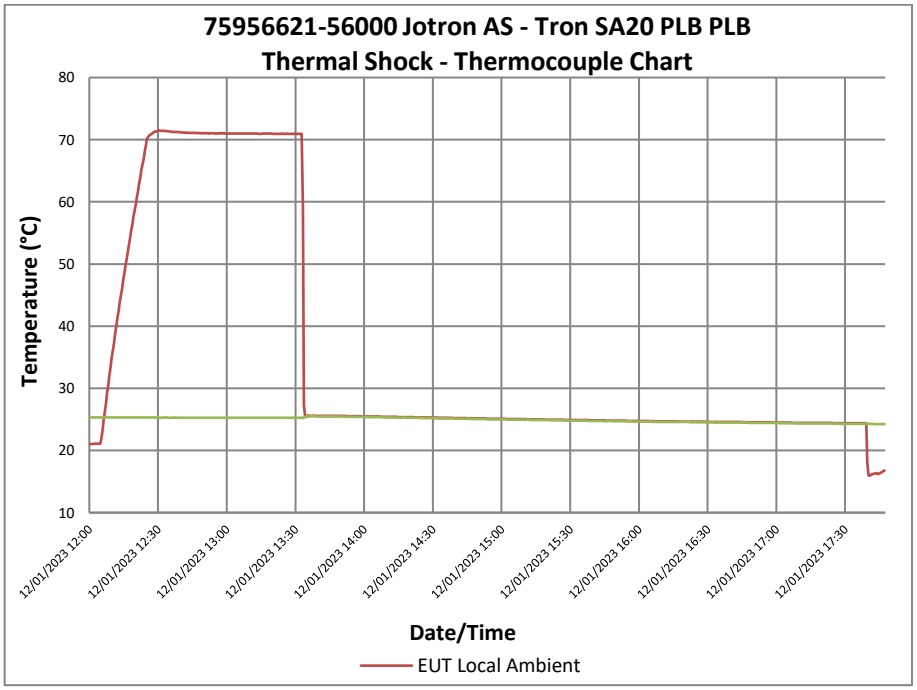


Figure 49 - Temperature Plot – Thermocouple

The EUT was weighed before and after the immersion test:

Tron SA20 PLB, S/N: 157
Pre-immersion weight: 147.15 g
Post-immersion weight: 147.75 g

Tron SA20 PLB, S/N: 107
Pre-immersion weight: 146.85 g
Post-immersion weight: 146.95 g

The difference between the pre and post-test weight can be attributed to water trapped within the recesses and external areas inaccessible to surface drying using a lint free cloth.

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031034
121 MHz Presence	Presence Confirmed

Table 36

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.030952
121 MHz Presence	Presence Confirmed

Table 37

2.7.7 Test Location and Test Equipment Used

This test was carried out in the Climatic Area.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Montford F43	Montford	4FT CUBED	2126	12	21-Mar-2023
Climatic Chamber	Climatec	CLIMATEC 3	2846	12	07-Oct-2023
Temperature Data Logger	Pico Technology Ltd	USB TC-08	3728	12	31-Oct-2023
Bench Scales	Kern-Sohn	CKE16K0.05	4647	12	22-Apr-2023
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	21-Jul-2023
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	15-Mar-2023
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024

Table 38

TU – Traceability Unscheduled

2.8 Immersion Test

2.8.1 Specification Reference

RTCM 11010.4, Clause A.11
IEC 60945, Clause 8.9

2.8.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.8.3 Date of Test

16 January 2023

2.8.4 Environmental Conditions

Ambient Temperature	19.8 - 20.8 °C
Relative Humidity	22.0 - 29.3 %

2.8.5 Test Method

The EUTs were placed in the pre-conditioning climatic chamber at a temperature of +16.5°C overnight.

The EUTs were then immersed in a water container (preconditioned overnight) at +16.6°C to a depth of 1 meter for 1 hour. After this period of immersion, the EUT's were inspected and weighed for signs of water ingress and subjected to a performance check.

Figure 50 - Test Setup – Pre-conditioning

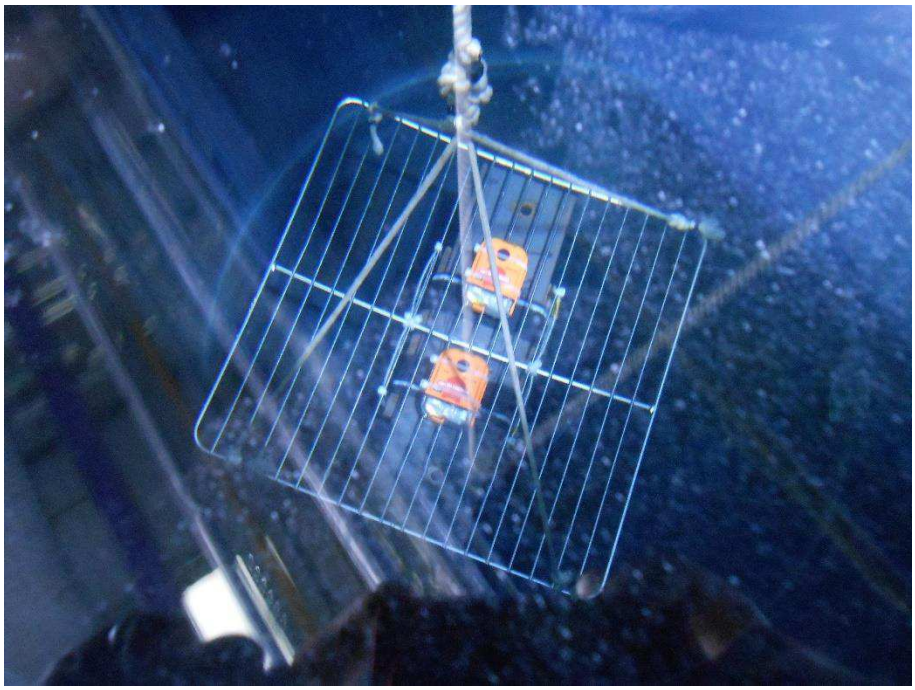


Figure 51 - Test Setup – EUT Immersed

2.8.6 Test Results

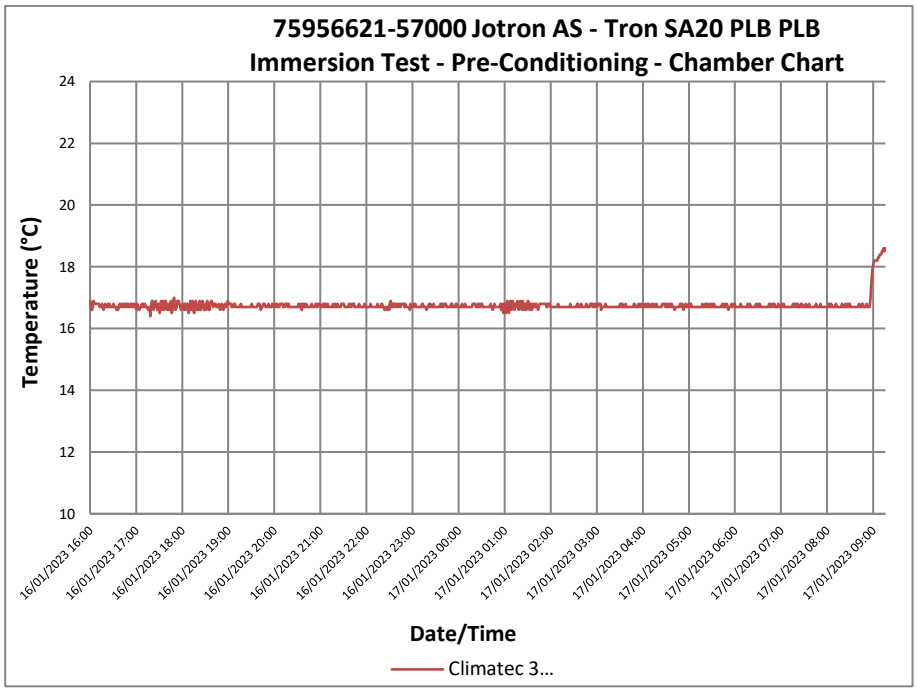


Figure 52 - Temperature Plot – Pre-conditioning and Immersion

The EUT was weighed before and after the Immersion test:

Tron SA20 PLB, S/N: 157
Pre-immersion weight: 146.80 g
Post-immersion weight: 146.95 g

Tron SA20 PLB, S/N: 107
Pre-immersion weight: 147.60 g
Post-immersion weight: 147.70 g

The difference between the pre and post-test weight can be attributed to water trapped within the recesses and external areas inaccessible to surface drying using a lint free cloth.

Performance Check

Tron SA20 PLB, S/N: 157

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.031073
121 MHz Presence	Presence Confirmed

Table 39

Tron SA20 PLB, S/N: 107

Parameter	Result
Normal Mode:	
Normal Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE
406 MHz Frequency	406.030876
121 MHz Presence	Presence Confirmed

Table 40

2.8.7 Test Location and Test Equipment Used

This test was carried out in the Wet test Facility

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
limatic Chamber	Climatec	CLIMATEC 3	2846	12	07-Oct-2023
940 litre Tank	Unknown	940 litre	3574	-	TU
Stop Watch	Radio Spares	Model 694 (974)	4026	12	30-Nov-2023
Bench Scales	Kern-Sohn	CKE16K0.05	4647	12	22-Apr-2023
Type T PFA Insulated Thermocouple	TC Limited	Type-T	4739	12	21-Jul-2023
Themocouple Thermometer	Digitron	2006T	5845	12	09-Nov-2023
Rubidium Frequency Standard	Quartzlock	A10-B	92	12	15-Mar-2023
Tester (Beacon)	WS Technologies	BT200-1100Y	5394	-	TU
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024

Table 41

TU – Traceability Unscheduled

2.9 Spurious Emissions

2.9.1 Specification Reference

RTCM 11010.4, Clause A.12

Refer to Document 75956621-03, Sections 2.5 and 2.7

2.10 Operating Lifetime (Battery capacity) and Self-test

2.10.1 Specification Reference

RTCM 11010.4, Clause A.13

2.10.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 101 - Modification State 0

2.10.3 Date of Test

15 December 2022 to 19 December 2022 – Battery Current Measurements
31 July 2023 to 01 August 2023 – Operating Lifetime Test
24 April 2023, 25 April 2023, 06 November 2023 and 08 November 2023 – Self-Test

2.10.4 Environmental Conditions

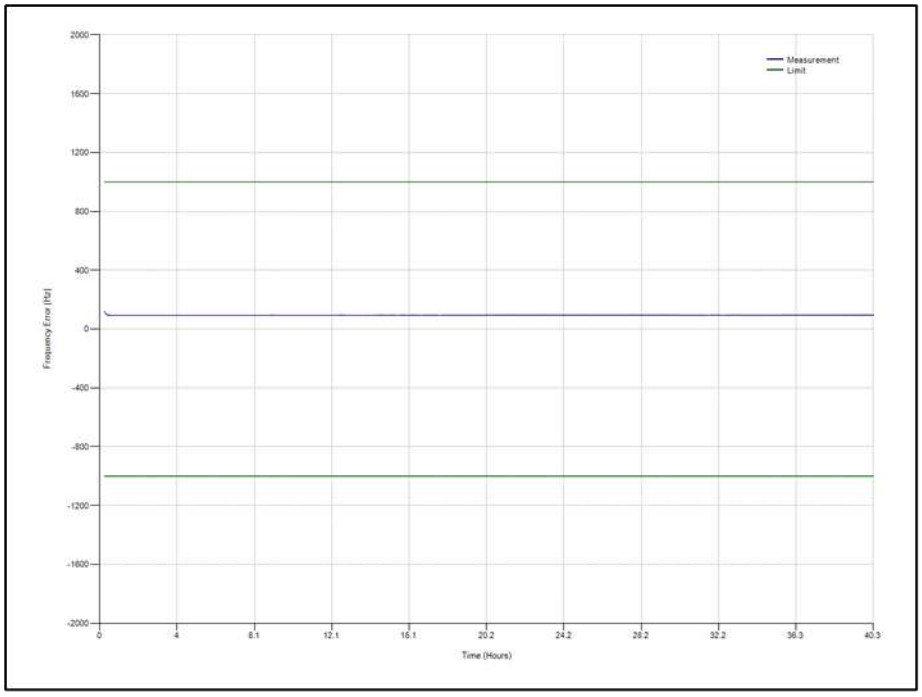
Ambient Temperature	21.0 - 24.3 °C
Relative Humidity	23.2 - 56.7%

2.10.5 Test Method

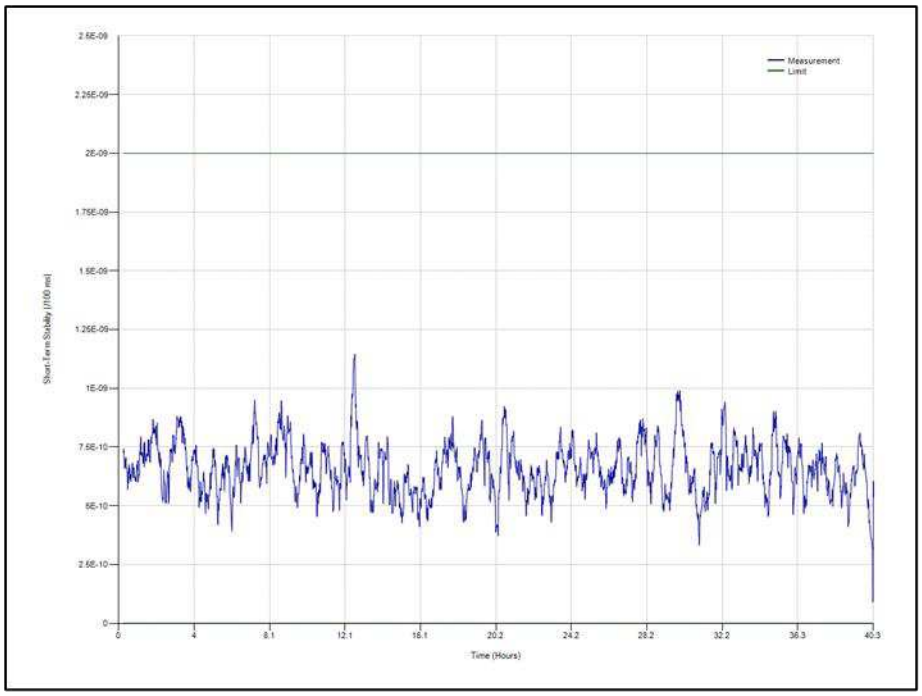
The test was carried out in accordance with the above clause.

2.10.6 Test Results

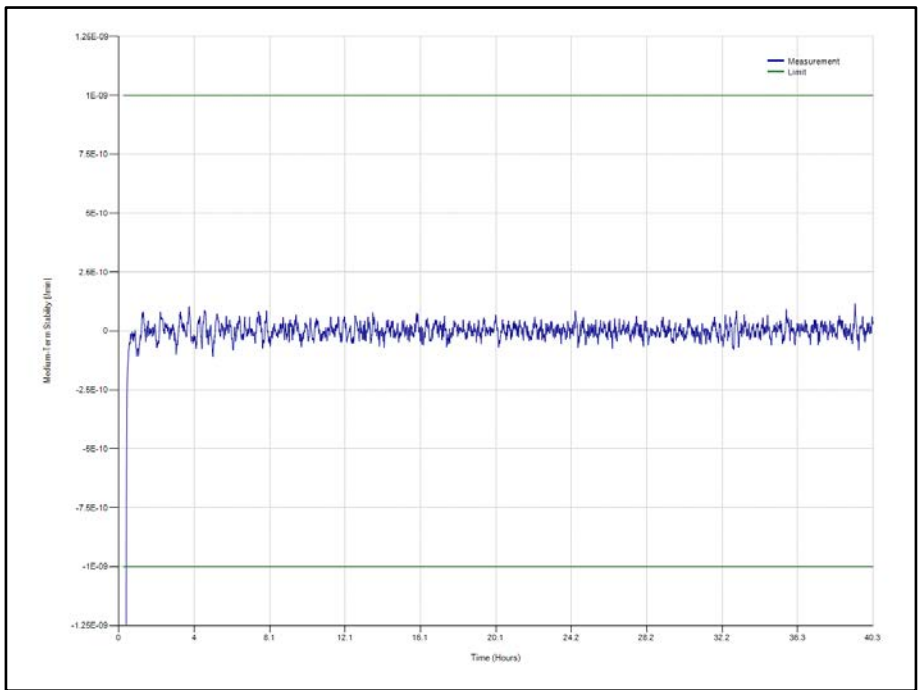
Nominal Frequency



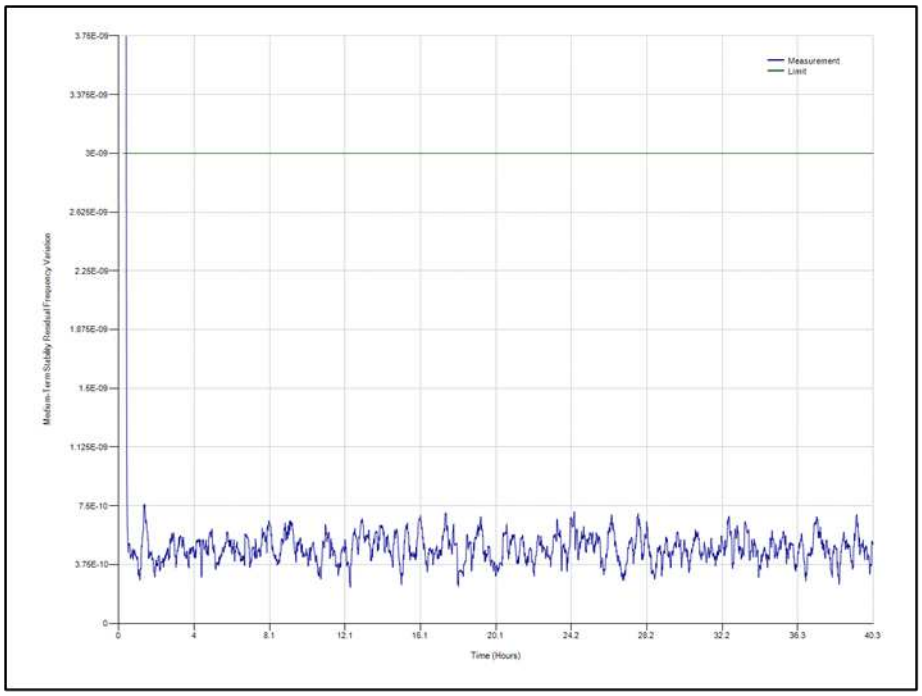
Short Term Stability



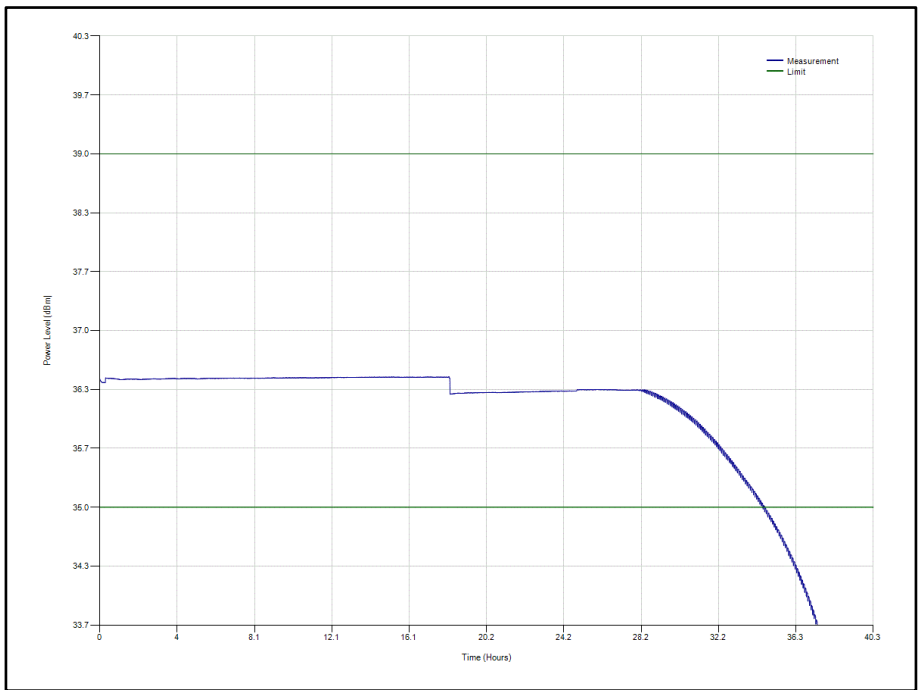
Medium Term Stability - Slope



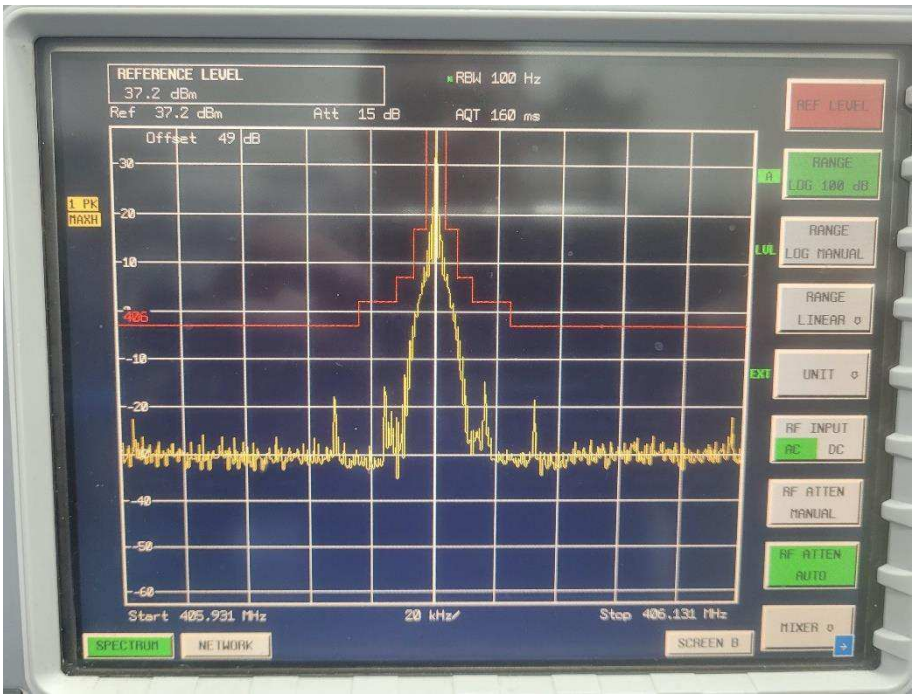
Medium Term stability - Residual



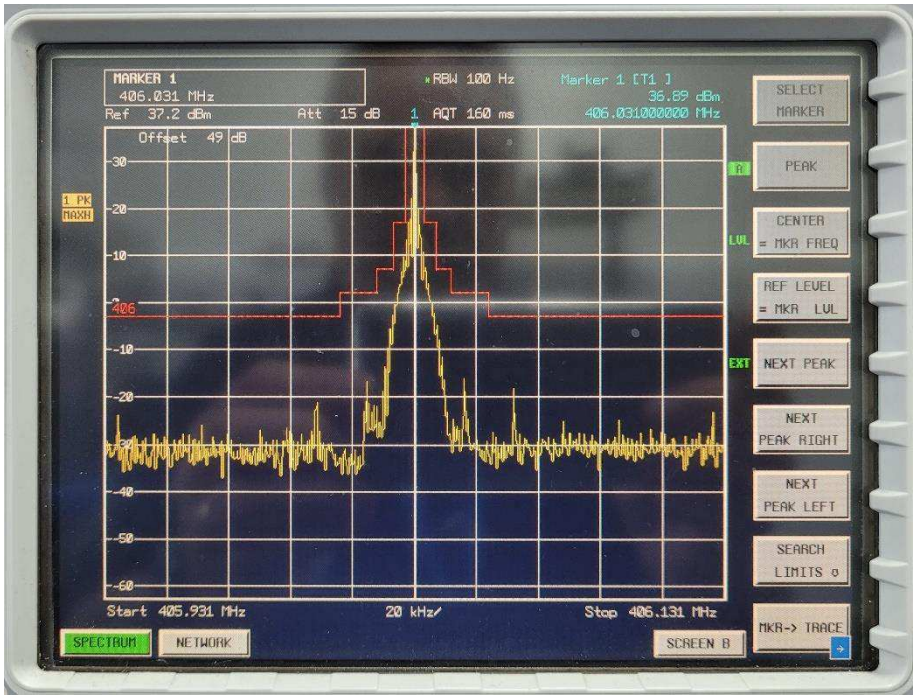
Output Power



Spurious (start of test)



Spurious (end of test)



Digital Message Decode – Navigation Data Denied (start of test)

Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE		
Hex ID	193BF6A031BFDFF		
Position	None - Default Values		
Parameter	Bit	Data Bits	Decoded Value
Bit synchronization	1-15	111111111111111	111111111111111
Frame synchronization	16-24	000101111	000101111
Format Flag	25	1	1
Protocol Flag	26	0	0
Country Code	27-36	0011001001	Albania (Republic of)
Protocol Code	37-40	1101	RLS Location Protocol
Beacon Type	41-42	11	Location Test Protocol
RLS TAC	43-52	1110110101	949
RLS ID Serial Number	53-66	00000001100011	99
N/S	67	0	Default
Latitude Degrees	68-75	11111111	Default
E/W	76	0	Default
Longitude Degrees	77-85	111111111	Default
BCH Code (21 Bit)	86-106	000010011100001110100	000010011100001110100
Calculated BCH Code (21 Bit)	-	000010011100001110100	000010011100001110100
Encoded Position Data Source	107	1	Internal navigation device
121.5 MHz Radio Locating Device	108	1	Yes
Capability to process RLM Type-1:	109	1	Acknowledgement Type-1 accepted by this beacon
Capability to process manually generated RLM	110	0	Manually generated RLM not accepted by this beacon
Feedback on RLM Type-1:	111	0	Acknowledgement Type-1 not (yet) received by this beacon
Feedback on RLM Type-2	112	0	RLM Type-2 not (yet) received by this beacon
RLS Provider Identification:	113-114	01	GALILEO Return Link Service Provider
Delta Latitude +/-	115	1	Default
Delta Latitude Minutes	116-119	0000	Default
Delta Latitude Seconds	120-123	1111	Default
Delta Longitude +/-	124	1	Default
Delta Longitude Minutes	125-128	0000	Default
Delta Longitude Seconds	129-132	1111	Default
BCH Code (12 Bit)	133-144	101010111110	101010111110
Calculated BCH Code (12 Bit)	-	101010111110	101010111110

Digital Message – Navigation Data Denied (end of test)

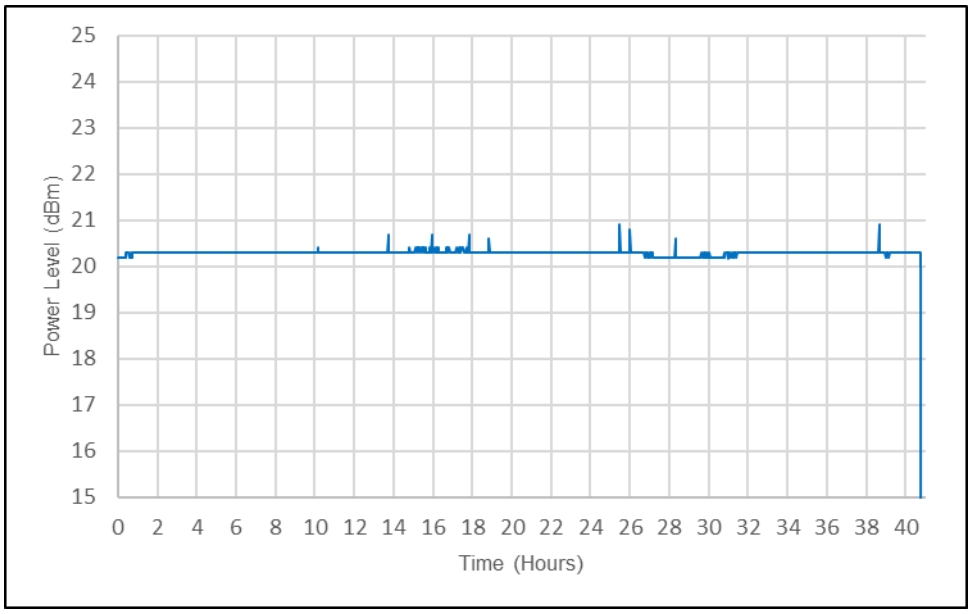
Message	FFFE2F8C9DFB5018DFEFF84E1D3861F0FABE		
Hex ID	193BF6A031BFDFF		
Position	None - Default Values		
Parameter	Bit	Data Bits	Decoded Value
Bit synchronization	1-15	111111111111111	111111111111111
Frame synchronization	16-24	000101111	000101111
Format Flag	25	1	1
Protocol Flag	26	0	0
Country Code	27-36	0011001001	Albania (Republic of)
Protocol Code	37-40	1101	RLS Location Protocol
Beacon Type	41-42	11	Location Test Protocol
RLS TAC	43-52	1110110101	949
RLS ID Serial Number	53-66	00000001100011	99
N/S	67	0	Default
Latitude Degrees	68-75	11111111	Default
E/W	76	0	Default
Longitude Degrees	77-85	111111111	Default
BCH Code (21 Bit)	86-106	000010011100001110100	000010011100001110100
Calculated BCH Code (21 Bit)	-	000010011100001110100	000010011100001110100
Encoded Position Data Source	107	1	Internal navigation device
121.5 MHz Radio Locating Device	108	1	Yes
Capability to process RLM Type-1:	109	1	Acknowledgement Type-1 accepted by this beacon
Capability to process manually generated RLM	110	0	Manually generated RLM not accepted by this beacon
Feedback on RLM Type-1:	111	0	Acknowledgement Type-1 not (yet) received by this beacon
Feedback on RLM Type-2	112	0	RLM Type-2 not (yet) received by this beacon
RLS Provider Identification:	113-114	01	GALILEO Return Link Service Provider
Delta Latitude +/-	115	1	Default
Delta Latitude Minutes	116-119	0000	Default
Delta Latitude Seconds	120-123	1111	Default
Delta Longitude +/-	124	1	Default
Delta Longitude Minutes	125-128	0000	Default
Delta Longitude Seconds	129-132	1111	Default
BCH Code (12 Bit)	133-144	101010111110	101010111110
Calculated BCH Code (12 Bit)	-	101010111110	101010111110

Test Data (0min – 30 min

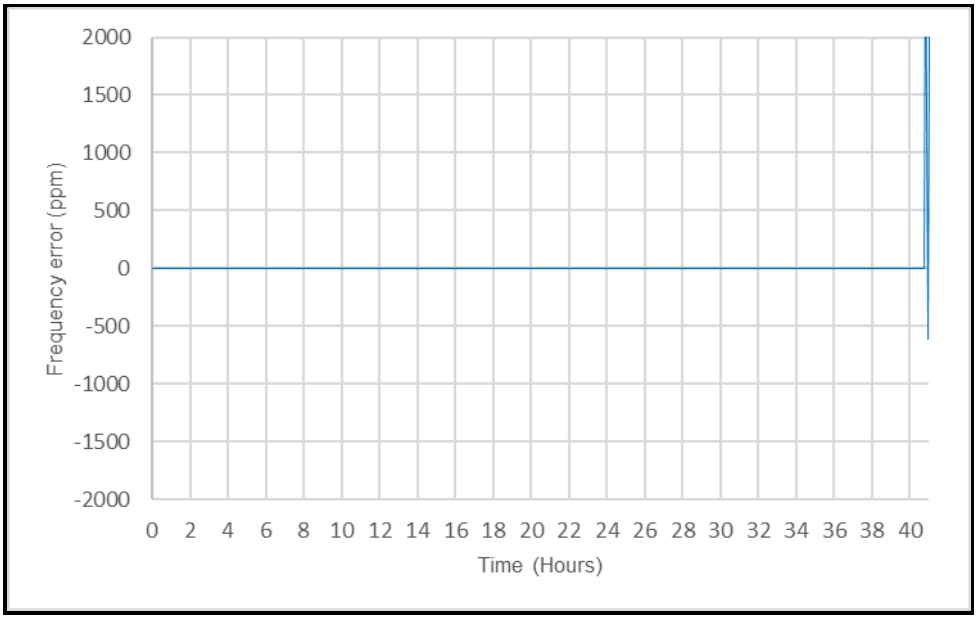
#	Nominal Frequency (Hz)	Short Term Stability (/100 ms)	Medium Term Stability – Slope (/min)	Medium Term Stability – Residual Frequency Variation (no units)	Output Power (dBm)	Time (h)
1	-	-	-	-	36.45	0.000
2	-	-	-	-	36.44	0.014
3	-	-	-	-	36.43	0.027
4	-	-	-	-	36.43	0.042
5	-	-	-	-	36.43	0.056
6	-	-	-	-	36.42	0.070
7	-	-	-	-	36.42	0.084
8	-	-	-	-	36.41	0.097
9	-	-	-	-	36.41	0.111
10	-	-	-	-	36.41	0.125
11	-	-	-	-	36.41	0.139
12	-	-	-	-	36.41	0.153
13	-	-	-	-	36.41	0.167
14	-	-	-	-	36.41	0.181
15	-	-	-	-	36.41	0.195
16	-	-	-	-	36.41	0.209
17	-	-	-	-	36.41	0.223
18	406.0311205	7.34E-10	9.35E-09	-1.18E-08	36.41	0.238
19	406.0311173	7.26E-10	1.14E-08	-1.12E-08	36.41	0.251
20	406.0311142	7.43E-10	1.33E-08	-1.05E-08	36.41	0.265
21	406.0311112	6.90E-10	1.49E-08	-9.53E-09	36.41	0.279
22	406.0311084	6.91E-10	1.58E-08	-8.44E-09	36.46	0.293
23	406.0311058	6.58E-10	1.60E-08	-7.30E-09	36.46	0.306
24	406.0311034	6.73E-10	1.57E-08	-6.13E-09	36.46	0.321
25	406.0311013	6.65E-10	1.48E-08	-4.93E-09	36.46	0.335
26	406.0310995	7.01E-10	1.29E-08	-3.79E-09	36.46	0.348
27	406.0310979	7.01E-10	1.07E-08	-2.72E-09	36.46	0.362
28	406.0310966	7.05E-10	7.61E-09	-1.77E-09	36.46	0.375
29	406.0310956	6.99E-10	4.47E-09	-1.06E-09	36.46	0.389
30	406.031095	6.61E-10	2.24E-09	-6.17E-10	36.46	0.402
31	406.0310947	6.62E-10	1.25E-09	-3.98E-10	36.46	0.416
32	406.0310945	6.59E-10	8.74E-10	-2.77E-10	36.46	0.430
33	406.0310944	6.37E-10	7.26E-10	-2.12E-10	36.46	0.443
34	406.0310943	6.07E-10	6.06E-10	-1.67E-10	36.46	0.457
35	406.0310942	5.69E-10	5.72E-10	-1.53E-10	36.46	0.472
36	406.0310941	6.02E-10	5.05E-10	-1.29E-10	36.46	0.486
37	406.0310941	6.46E-10	4.52E-10	-1.04E-10	36.46	0.501

Results outside of the specification limits are marked in red text. These results are based on measurement data made within the first 15 minutes after activation and are considered acceptable.

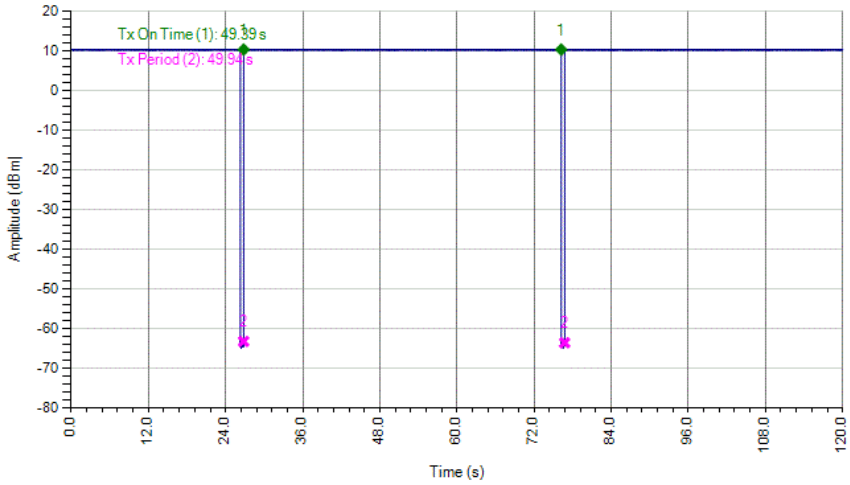
121 MHz Homing Transmitter – Output Power



121 MHz Homing Transmitter – Nominal Frequency

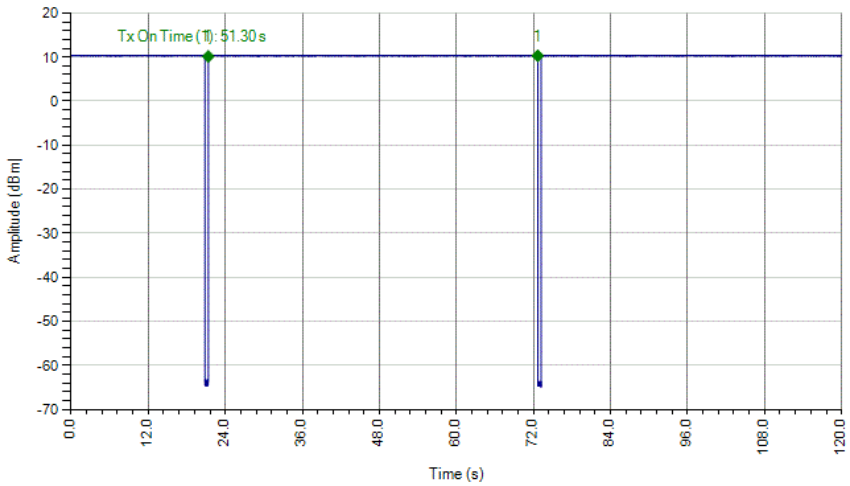


121 Mhz Homing Frequency - Duty Cycle (Start)



Duty Cycle = 49.395 / (49.395+0.542) =98.91%

121 Mhz Homing Frequency - Duty Cycle (End)



Duty cycle = 51.299 / (51.299+0.542) = 98.95%

Operating Current Measurements and Analysis

System Configuration →	A, No Ancillaries 100% duty cycle	B, No Ancillaries 40% duty cycle
Operational Mode ↓		
1, Standby	A1	N/A
2, ON at EUT (Average)	A2	B2
3, ON at EUT (GNSS Search)	A3	B3
4, ON at EUT (GNSS Sleep)	A4	B4
5, Self-Test	A5	N/A
6, Self-Test (Held)	A6	N/A
7, GNSS Self-Test (Timeout)	A7	N/A
8, GNSS Self-Test (Burst)	A8	N/A
9, On at EUT (GNSS Fix await RLS Ack)	A9	N/A
10, On at EUT (GNSS Fix, RLM Ack Rx).	A10	N/A
11, NFC Configuration	A11	N/A
12, NFC Read	A12	N/A

Notes:

GNSS Search refers to the automatic period of search activity performed by the PLB.

GNSS Sleep refers to the automatic period where the search activity is deactivated in the PLB.

GNSS Timeout refers to a test where no GNSS signal is provided.

GNSS Burst refers to the test where a GNSS signal is available to the PLB.

For the RLS and RLM tests a simulated GNSS scenario was applied which provided GNSS signal only for the initial 10 minutes followed thereafter by an RLM acknowledgement message once a minute.

The PLB operation is such that holding the Self-Test button for longer than 3 seconds will initiate the GNSS Self-Test. For 6 above the resulting data reflects the GNSS long test.

The NFC configuration will only be performed in the case where a trained distributor needs to re-configure the PLB for a customer.

The NFC Read is referred to in Manufacturer documentation, but no process to use is stated.

Beacon Operating Mode	Mode: Manually selectable or Automatic	Measurement interval, sec	Average Current, mA	Peak Current, mA
A1	Manual	2000	1.794E-06	0.000005
A2	Manual	2600	55.04	1873
B2	Manual	2600	38.69	1575
A3	Automatic*	215	55.39	1873
B3	Automatic*	215	44.73	1554
A4	Automatic*	215	54.73	1864
B4	Automatic*	215	37.80	1556
A5	Manual	8.5	122.90	1544
A6	Manual	7	0.17	0.217
A7	Manual	137	17.10	57.57
A8	Manual	47.8	38.71	1585
A9	Manual	215	62.02	1804
A10	Automatic*	215	62.21	1801
A11	Manual	2.072	21.09	63.21
A12	Manual	500	0.00002	0.00002

The sampling interval was a nominal 100 ms for all measurements.

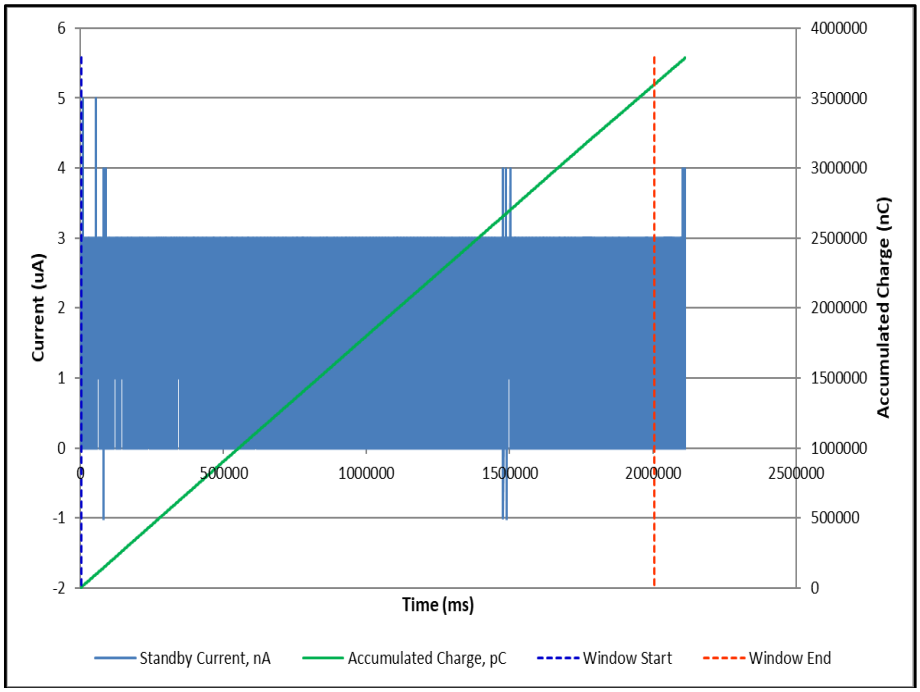
* NOTES, GNSS sleep denoted as Automatic; upon beacon activation the beacon enters GNSS search mode for 30 minutes. The 121.5 homing mode is initiated after a period of 5 minutes from activation. The GNSS sleep mode is initiated after the initial 30 minutes and remain in sleep mode or 3.5 minutes followed by a 1.8 minute search period. This continues cycling until a GNSS signal is attained.

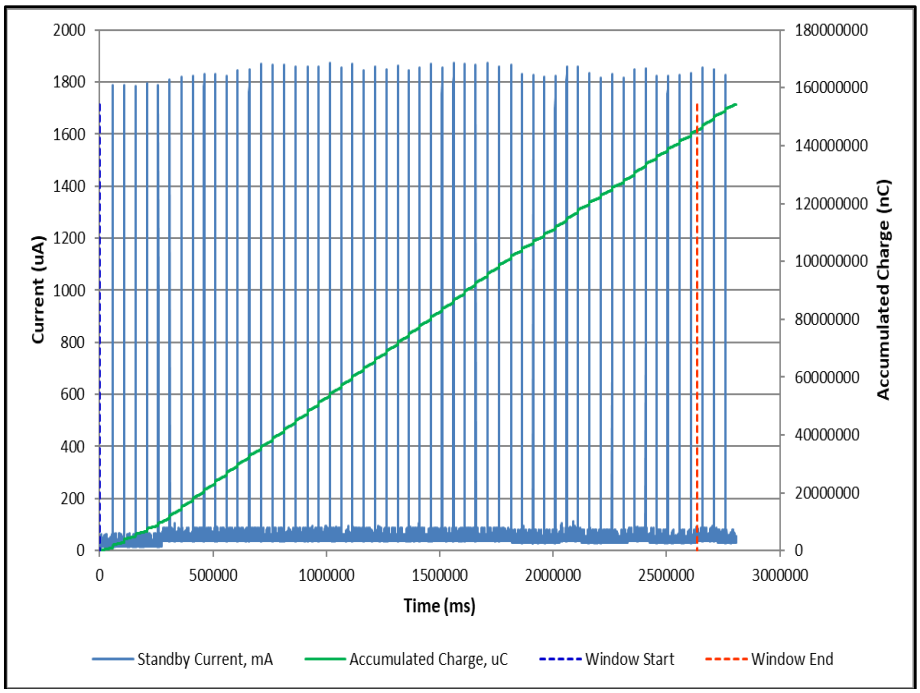
When the Self-Test mode was pressed and held the PLB returned to an average of 0.17mA when held for a period of 6 mins.

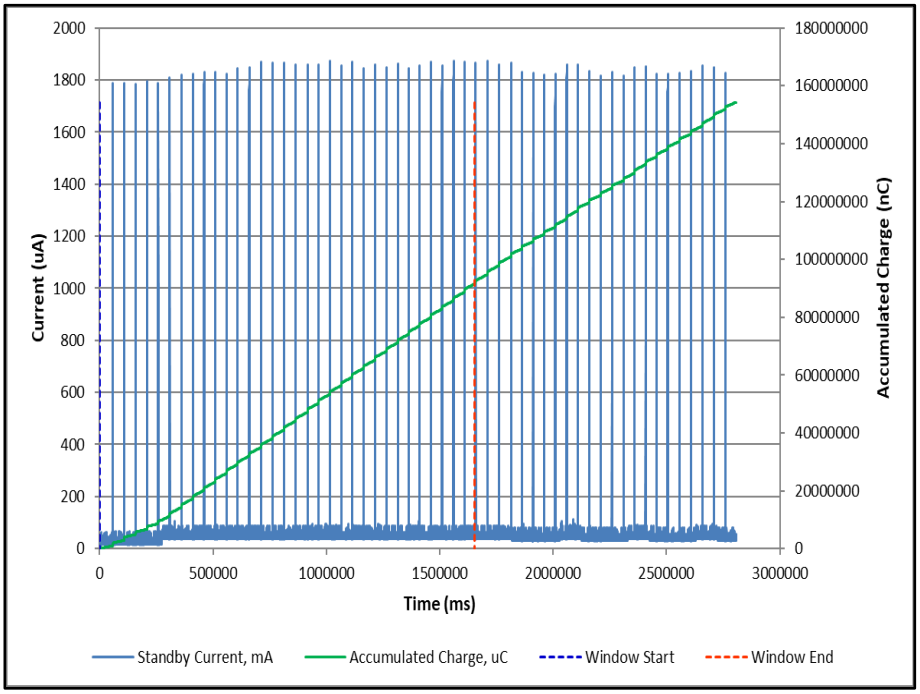
Observations:

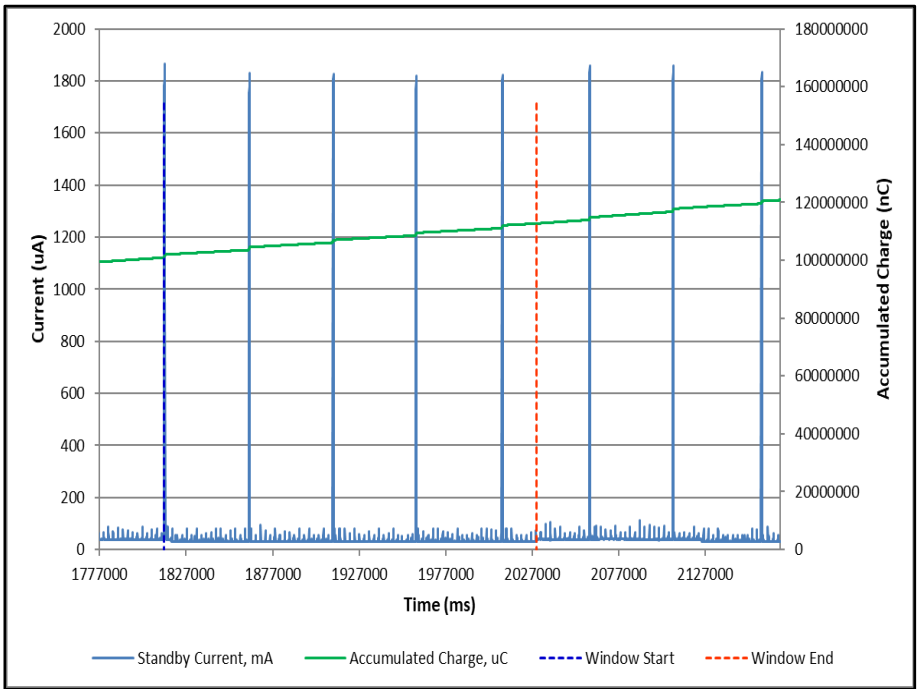
The PLB exhibited slight variations in current dependent upon duty cycle and GNSS search / sleep patterns.

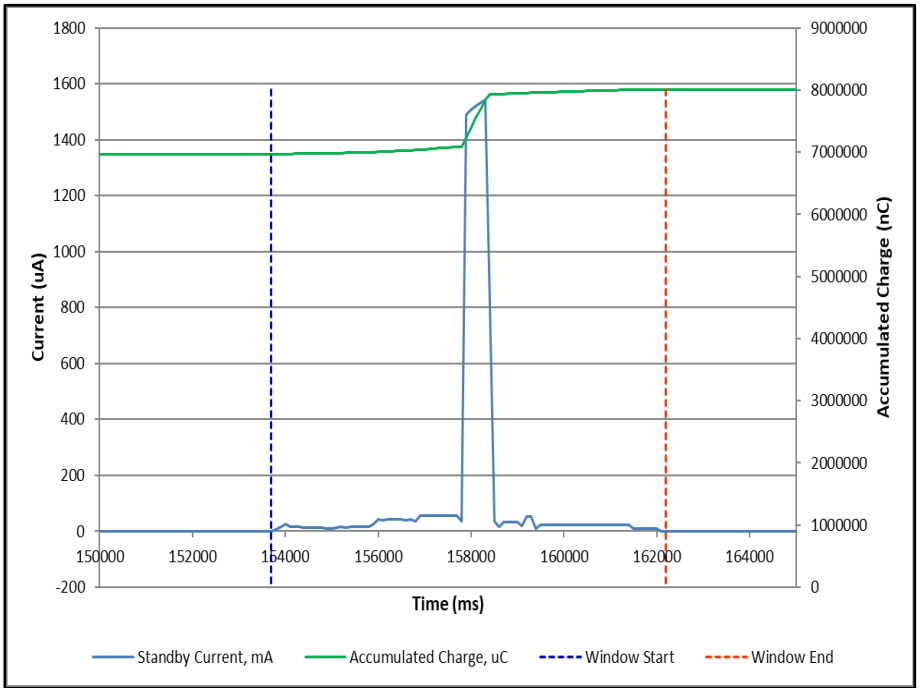
Current Measurement Plots

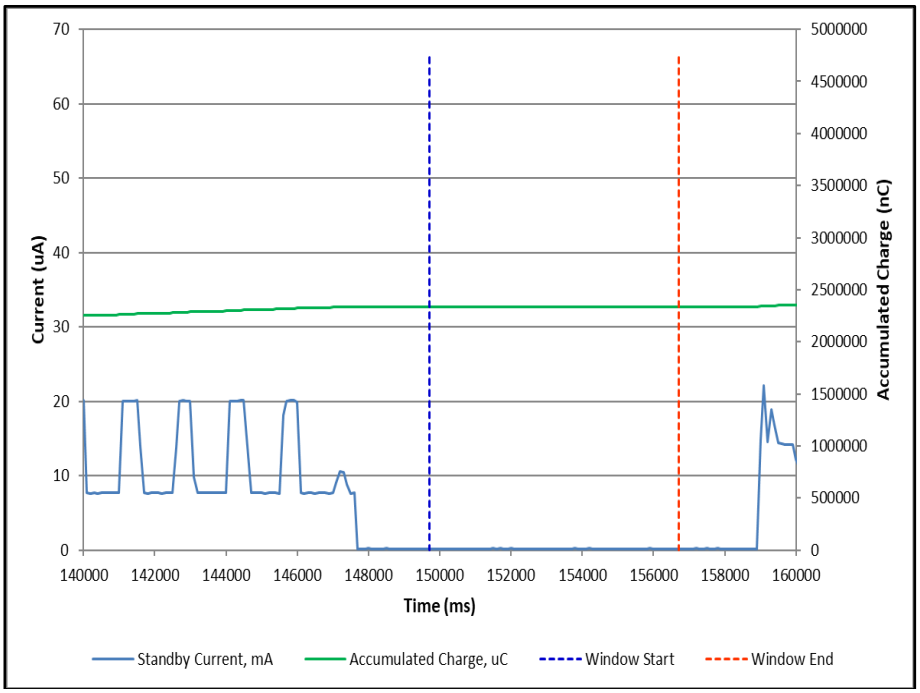


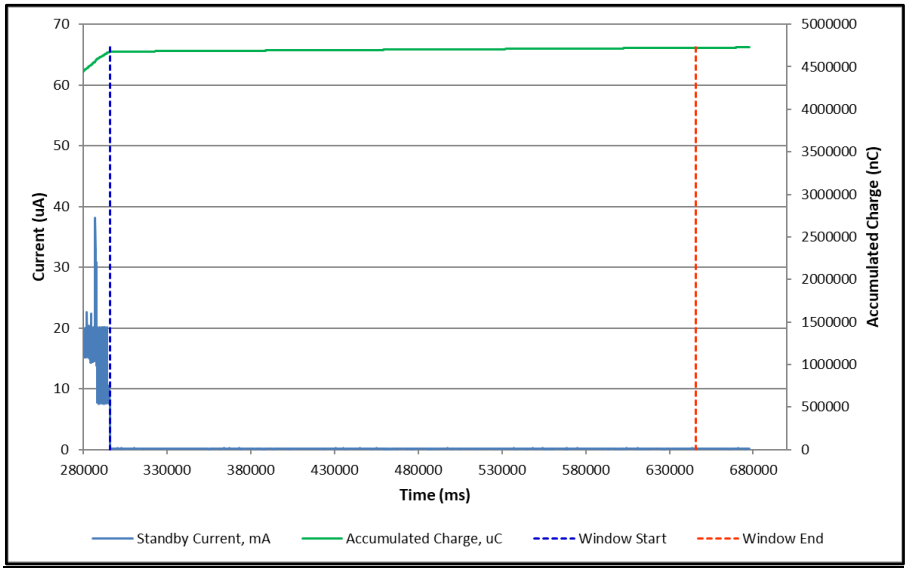


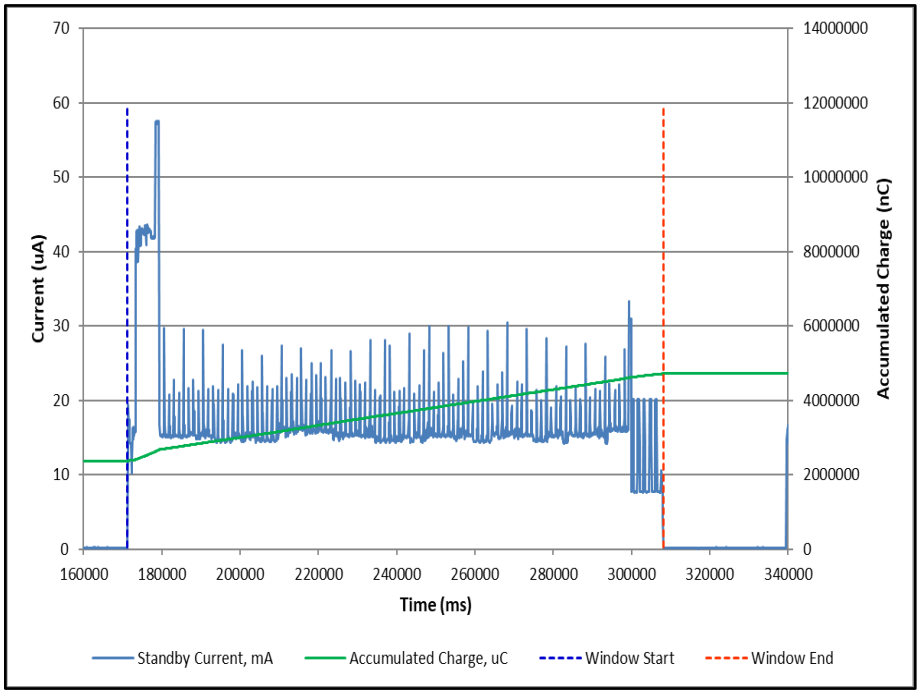

Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End

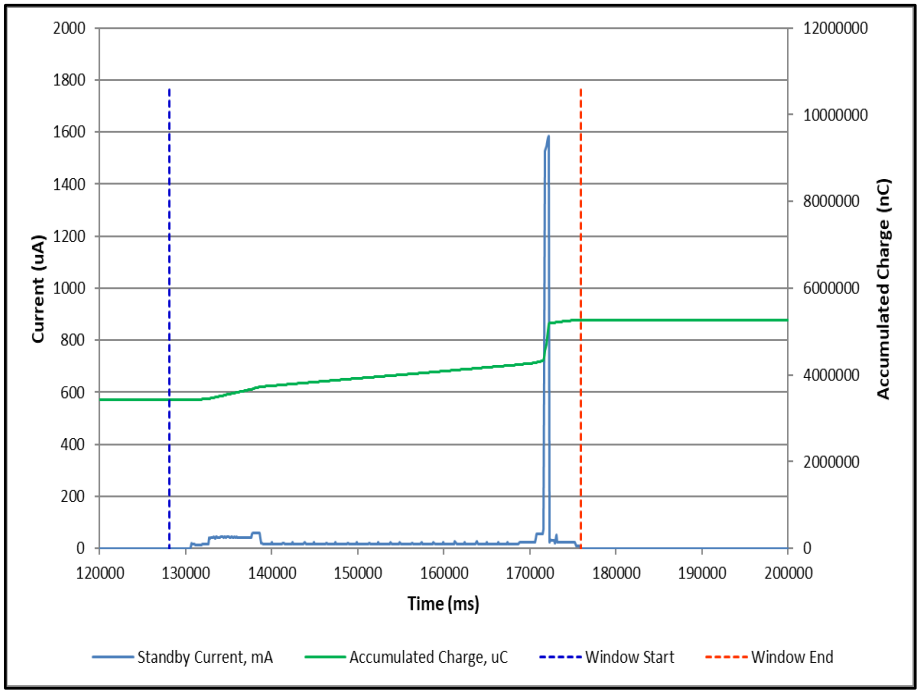

Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End

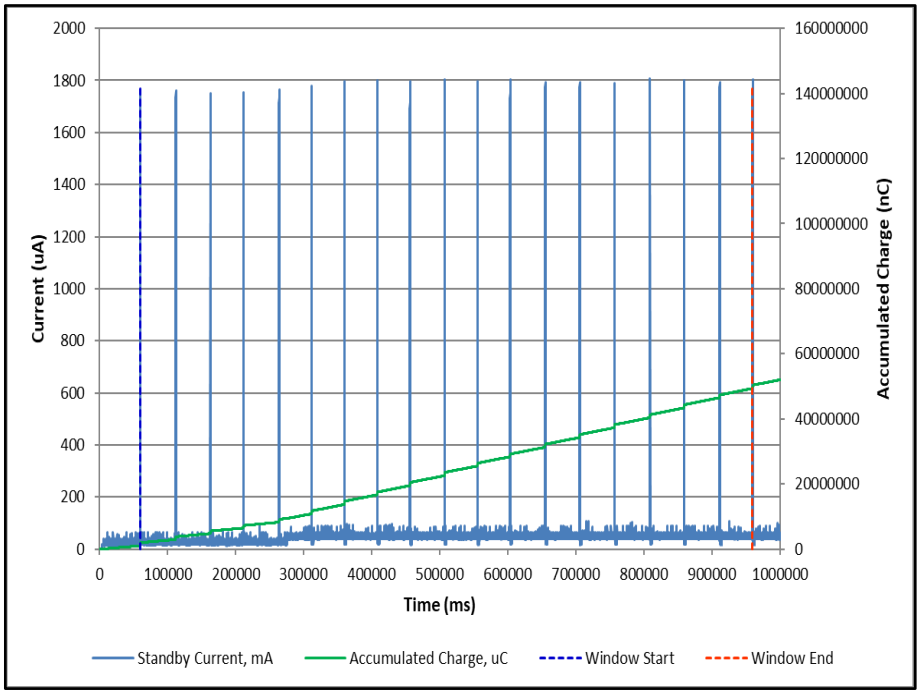

Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End

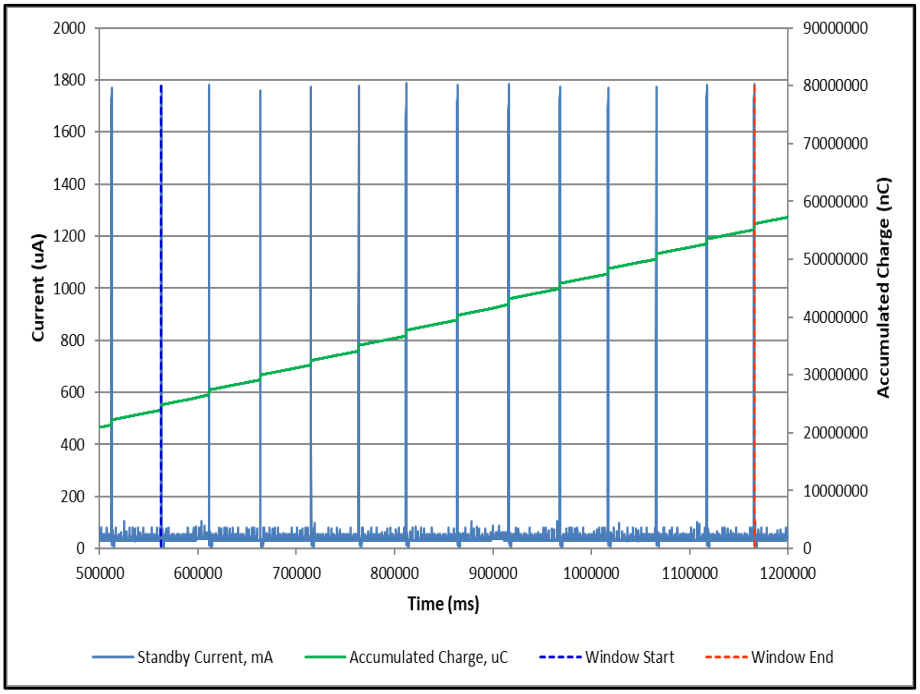

Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End


Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End


Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End


Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End


Current (uA)
Accumulated Charge (nC)
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End


2000
1800
1600
1400
1200
1000
800
600
400
200
0
Current (uA)
90000000
80000000
70000000
60000000
50000000
40000000
30000000
20000000
10000000
0
Accumulated Charge (nC)
500000
600000
700000
800000
900000
1000000
1100000
1200000
Time (ms)
Standby Current, mA
Accumulated Charge, uC
Window Start
Window End

Characteristic	Designation	Units	Value	Comments
Beacon manufacturers declared maximum allowed cell shelf-life (from date of cell manufacture to date of battery pack installation in the beacon)	T_{CS} or TCS	Years	2	
Declared beacon battery replacement period (from date of installation in the beacon to expiry date marked on the beacon)	T_{BR} or TBR	Years	25	
Battery pack electrical configuration	-	-		
Cell model and cell chemistry	-	-		
Nominal cell capacity	-	Ah	3.4	
Nominal battery pack capacity	C_{BN}	Ah	3.4	
Annual battery cell capacity loss (self-discharge) due to aging, as specified by cell manufacturer at ambient temperature	L_{SDC}	%	0.264	Declared for IEC
Calculated battery pack capacity loss due to self-discharge: $L_{CBN} = C_{BN} - [C_{BN} * (1 - L_{SDC}/100)^{TBR+TCS}]$	L_{CBN}	Ah	0.2342	
Number of self-tests per year	N_{ST}	-	12	Manufacturer Declared Value
Average battery current during a self-test	I_{ST}	mA	122.93	
Maximum duration of a self-test	T_{ST}	s	9	Manufacturer Declared Value
Calculated battery pack capacity loss due to self-tests during battery replacement period: $L_{ST} = I_{ST} * T_{ST} * T_{BR} * (N_{ST} / 3600)$	L_{ST}	mAh	92.20	
Maximum Number of GNSS self-tests between battery replacements	N_{GST}	-	60	
Average battery current during a GNSS self-test of maximum duration	I_{GST}	mA	17.1	
Maximum duration of a GNSS self-test	T_{GST}	s	150	
Average battery current during a self-test of maximum duration	$I_{GST\#}$	mA	38.71	
Maximum duration of a self-test	$T_{GST\#}$	s	47.8	
Calculated battery pack capacity loss due to GNSS self-tests during battery replacement period: $L_{GST} = I_{GST} * T_{GST} * (N_{GST} / 3600) + IGST\# * TGST\# * (NGST / 3600)$	L_{GST}	mAh	73.58896667	
Average stand-by battery pack current	I_{SB}	mA	0.00000179	
Other Capacity Losses	L_{OTH}	mAh	0	None declared
Battery pack capacity loss due to constant operation of circuitry prior to beacon activation: $L_{ISB} = I_{SB} * T_{BR} * 8760$	L_{ISB}	mAh	0.3920	
Calculated value of the battery pack pre-test discharge $L_{CDC} = L_{CBN} + ((L_{ST} + L_{GST} + L_{ISB})/1000) + (L_{OTH}/1000)$	L_{CDC}	Ah	0.4004	

Battery Conditioning Results

A fresh battery was used for the test; it was discharged by connection to a resistive load for the pre-test discharge duration calculated as follows:

Pre-test discharge (LCDC) [mAh] = 404.0
Constant current [mA] = 50
Pre-test discharge duration [h] = 404.0 / 5

Pre-test discharge duration [h] (calculated) = 8.08

Actual Discharge duration [mAh]= 434.77

This is an over-discharge of 30.77 mAh or 7.60%.

Self-Test

Ambient Temperature

Message	FFFED08C9DFE7018DFEFF8129DF861F0FABE		
Hex ID	193BFCE031BFDFF		
Position	None - Default Values		
Parameter	Bit	Data Bits	Decoded Value
Bit synchronization	1-15	111111111111111	111111111111111
Frame synchronization	16-24	011010000	011010000
Format Flag	25	1	1
Protocol Flag	26	0	0
Country Code	27-36	0011001001	Albania (Republic of)
Protocol Code	37-40	1101	RLS Location Protocol
Beacon Type	41-42	11	Location Test Protocol
RLS TAC	43-52	1111100111	999
RLS ID Serial Number	53-66	00000001100011	99
N/S	67	0	Default
Latitude Degrees	68-75	11111111	Default
E/W	76	0	Default
Longitude Degrees	77-85	111111111	Default
BCH Code (21 Bit)	86-106	000000100101001110111	000000100101001110111
Calculated BCH Code (21 Bit)	-	000000100101001110111	000000100101001110111
Encoded Position Data Source	107	1	Internal navigation device
121.5 MHz Radio Locating Device	108	1	Yes
Capability to process RLM Type-1:	109	1	Acknowledgement Type-1 accepted by this beacon
Capability to process manually generated RLM	110	0	Manually generated RLM not accepted by this beacon
Feedback on RLM Type-1:	111	0	Acknowledgement Type-1 not (yet) received by this beacon
Feedback on RLM Type-2	112	0	RLM Type-2 not (yet) received by this beacon
RLS Provider Identification:	113-114	01	GALILEO Return Link Service Provider
Delta Latitude +/-	115	1	Default
Delta Latitude Minutes	116-119	0000	Default
Delta Latitude Seconds	120-123	1111	Default
Delta Longitude +/-	124	1	Default
Delta Longitude Minutes	125-128	0000	Default
Delta Longitude Seconds	129-132	1111	Default
BCH Code (12 Bit)	133-144	101010111110	101010111110
Calculated BCH Code (12 Bit)	-	101010111110	101010111110

Table 42

Minimum Temperature

Message	FFFED08C9DFB5018DFEFF84E1D3861F0FABE		
Hex ID	193BF6A031BFDFF		
Position	None - Default Values		
Parameter	Bit	Data Bits	Decoded Value
Bit synchronization	1-15	111111111111111	111111111111111
Frame synchronization	16-24	011010000	011010000
Format Flag	25	1	1
Protocol Flag	26	0	0
Country Code	27-36	0011001001	Albania (Republic of)
Protocol Code	37-40	1101	RLS Location Protocol
Beacon Type	41-42	11	Location Test Protocol
RLS TAC	43-52	1110110101	949
RLS ID Serial Number	53-66	00000001100011	99
N/S	67	0	Default
Latitude Degrees	68-75	11111111	Default
E/W	76	0	Default
Longitude Degrees	77-85	111111111	Default
BCH Code (21 Bit)	86-106	000010011100001110100	000010011100001110100
Calculated BCH Code (21 Bit)	-	000010011100001110100	000010011100001110100
Encoded Position Data Source	107	1	Internal navigation device
121.5 MHz Radio Locating Device	108	1	Yes
Capability to process RLM Type-1:	109	1	Acknowledgement Type-1 accepted by this beacon
Capability to process manually generated RLM	110	0	Manually generated RLM not accepted by this beacon
Feedback on RLM Type-1:	111	0	Acknowledgement Type-1 not (yet) received by this beacon
Feedback on RLM Type-2	112	0	RLM Type-2 not (yet) received by this beacon
RLS Provider Identification:	113-114	01	GALILEO Return Link Service Provider
Delta Latitude +/-	115	1	Default
Delta Latitude Minutes	116-119	0000	Default
Delta Latitude Seconds	120-123	1111	Default
Delta Longitude +/-	124	1	Default
Delta Longitude Minutes	125-128	0000	Default
Delta Longitude Seconds	129-132	1111	Default
BCH Code (12 Bit)	133-144	101010111110	101010111110
Calculated BCH Code (12 Bit)	-	101010111110	101010111110

Table 43

Maximum Temperature

Message	FFFED08C9DFE7018DFEFF8129DF861F0FABE		
Hex ID	193BFCE031BFDFF		
Position	None - Default Values		
Parameter	Bit	Data Bits	Decoded Value
Bit synchronization	1-15	111111111111111	111111111111111
Frame synchronization	16-24	011010000	011010000
Format Flag	25	1	1
Protocol Flag	26	0	0
Country Code	27-36	0011001001	Albania (Republic of)
Protocol Code	37-40	1101	RLS Location Protocol
Beacon Type	41-42	11	Location Test Protocol
RLS TAC	43-52	1111100111	999
RLS ID Serial Number	53-66	00000001100011	99
N/S	67	0	Default
Latitude Degrees	68-75	11111111	Default
E/W	76	0	Default
Longitude Degrees	77-85	111111111	Default
BCH Code (21 Bit)	86-106	000000100101001110111	000000100101001110111
Calculated BCH Code (21 Bit)	-	000000100101001110111	000000100101001110111
Encoded Position Data Source	107	1	Internal navigation device
121.5 MHz Radio Locating Device	108	1	Yes
Capability to process RLM Type-1:	109	1	Acknowledgement Type-1 accepted by this beacon
Capability to process manually generated RLM	110	0	Manually generated RLM not accepted by this beacon
Feedback on RLM Type-1:	111	0	Acknowledgement Type-1 not (yet) received by this beacon
Feedback on RLM Type-2	112	0	RLM Type-2 not (yet) received by this beacon
RLS Provider Identification:	113-114	01	GALILEO Return Link Service Provider
Delta Latitude +/-	115	1	Default
Delta Latitude Minutes	116-119	0000	Default
Delta Latitude Seconds	120-123	1111	Default
Delta Longitude +/-	124	1	Default
Delta Longitude Minutes	125-128	0000	Default
Delta Longitude Seconds	129-132	1111	Default
BCH Code (12 Bit)	133-144	101010111110	101010111110
Calculated BCH Code (12 Bit)	-	101010111110	101010111110

Table 44

Parameters to be Measured	Range of Specification	Units	Test Results		
			Tmin	Tamb	Tmax
			(-20°C)	(+21°C)	(+55°C)
8(a). Self-test Mode					
Model: Tron SA20, S/N: 101, TUV Ref: TSR3 and Modification State 0					
Frame sync	011010000	P / F	P	P	P
Format flag	1 / 0	bit value	1	1	1
Single radiated burst	≤440 / 520 (±1%)	ms	521.380	521.500	521.670
Default position data (if applicable)	correct	P / F	P	P	P
Single burst verification	one burst	P / F	P	P	P
Provides for 15 Hex ID	correct	P / F	P	P	P
121.5 MHz RF power (if applicable)	verify that RF power emitted	P / F	P	P	P
121.5 MHz transmission	≤ 1 sec / 3 sweeps	s	0.9205	0.9195	0.9194
AIS transmission	≤ 26.6ms	ms	N/A	N/A	N/A
AIS Default Position Data	correct	P / F	N/A	N/A	N/A
406 MHz power	verify that RF power emitted	P / F	P	P	P
Distinct indication of Self-Test	provided	Y / N	Y	Y	Y
Distinct indication of RF power being emitted	provided	Y / N	Y	Y	Y
Indication of Self-Test result	provided	Y / N	Y	Y	Y
Distinct indication of insufficient battery capacity	provided	Y / N		Y	
Automatic termination of Self-Test mode upon completion of Self-Test and indication of Self-Test results	verify automatic termination	Y / N	Y	Y	Y

Table 45

2.10.7 Test Location and Test Equipment Used

This test was carried out in the RF Laboratory 4

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Due
Spectrum Analyser	Hewlett Packard	8542E	18	-	TU
Power Meter	Hewlett Packard	436A	94	12	05-Apr-2023
Attenuator (10dB, 75W)	Bird	8308-100	469	12	21-Apr-2023
Termination (50ohm, 6W)	Micronde	R404613	3074	12	02-Dec-2023
Attenuator (20dB, 10W)	Weinschel	23-20-34	3160	12	12-Oct-2024
Bandpass Filter	Trilithic	5BE121.55/35-3-BA	3410	12	25-Nov-2023
Rubidium Frequency Standard	Symmetricom	8040C	3490	12	20-Jun-2023
Oscilloscope	Agilent Technologies	DSO9104A	4142	12	23-Oct-2023
PXA Signal Analyser	Agilent Technologies	N9030A PXA	4409	12	09-Jun-2024
1 MHz / 10 MHz Reference	Quartzlock	E10-X	4973	12	23-Feb-2024
Cable (18 GHz)	Rosenberger	LU7-036-1000	5025	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-036-1000	5027	-	O/P Mon
USB Power Sensor	Boonton	RTP5318	5185	12	10-Feb-2024
Environmental Chamber	ACS	DY110TC	5589	-	O/P Mon
Thermocouple Data Logger	Pico Technology Ltd	TC-08 + Type T Thermocouple	5740	12	09-Mar-2024
MXA Spectrum Analyser	Keysight Technologies	N9020B-ATO-43105	5743	24	10-Feb-2024
RF distribution box	TUV SUD		5626	12	Class 1 (Int)
High resolution data logger	Pico Technology Ltd	PicoLog ADC20	6252	12	27-Sep-2023
Variable Resistive Load	TUV SUD	N/A	5057	12	04-Feb-2023
Termination (50ohm)	Weinschel	50T-054	285	12	28-Jul-2023
Cable (N to N 2m)	Amphenol RF	N/A	5949	12	15-May-2023

Table 46

TU – Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment

2.11 Limited COSPAS-SARSAT type approval test

2.11.1 Specification Reference

RTCM 11010.4, Clause A.13
Refer to Document 75956621 Report 08 for full COSPAS-SARSAT type approval of Tron SA20 PLB

2.11.2 Equipment Under Test and Modification State

Tron SA20 PLB, S/N: 157 - Modification State 0
Tron SA20 PLB, S/N: 107 - Modification State 0

2.11.3 Date of Test

Tron SA20 PLB, S/N: 157:
20 January 2023 – C/S T.007, A.2.1 Electrical and Functional tests (except transmitter power output and VSWR)
18 January 2023 and 23 January 2023 – C/S T.007, A.3.8.2 Position Acquisition Time and Position Accuracy test in Configuration 7 only
18 January 2023 to 19 January 2023 – C/S T.007, A.2.5 Satellite Qualitative test in Configuration 7 only

Tron SA20 PLB, S/N: 107:
06 February 2023 – C/S T.007, A.2.1 Electrical and Functional tests (except transmitter power output and VSWR)
26 April 2023 and 02 May 2023 – C/S T.007, A.2.5 Satellite Qualitative test in Configuration 7 only
07 February 2023 to 08 February 2023 – C/S T.007, A.2.5 Satellite Qualitative test in Configuration 7 only

2.11.4 Test Method

The following results present a summary of limited Cospas-Sarsat measurements which were performed after Environmental testing and in accordance with the requirements for limited Cospas-Sarsat testing under RTCM 11010.4.
Limited measurements were made at ambient temperature only.

S/N: 107

Parameters to be Measured		Range of Specification	Units	Test Results			Comments
				Tmin	Tamb	Tmax	
				(-20°C)	(+21°C)	(+55°C)	
2. Digital Message Coding							**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0							
Bit Sync	1 - 15	15 bits “1”	P / F	NT	P	NT	
Frame sync	16 - 24	“000101111”	P / F	NT	P	NT	
Format flag	25	1 bit	bit value	NT	1	NT	
Protocol flag	26	1 bit	bit value	NT	0	NT	
Identification / position data	27 - 85	59 bits	P / F	NT	P	NT	RLS Protocol
BCH code	86 -106	21 bits	P / F	NT	P	NT	
Emerg. Code/nat. use/supplem. Data	107 - 112	6 bits	bit value	NT	111000	NT	
Additional data / BCH (if applicable)	112 - 144	32 bits	P / F	NT	P	NT	
Position Error (if applicable)		< 5	km	NT	N/A	NT	

NT = Not Tested

Parameters to be Measured	Range of Specification	Units	Test Results			Comments
			Tmin	Tamb	Tmax	
			(-20°C)	(+21°C)	(+55°C)	
3. Digital Message Generator						**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0						
Repetition rate, T_R:						
Average T_R	$48.5 \leq T_{Ravg} \leq 51.5$	seconds	NT	49.743	NT	
Minimum T_R	$47.5 \leq T_{Rmin} \leq 48.0$	seconds	NT	47.701	NT	
Maximum T_R	$52.0 \leq T_{Rmax} \leq 52.5$	seconds	NT	52.261	NT	
Standard deviation	0.5 - 2.0	seconds	NT	1.415	NT	
Bit rate						
Minimum fb	≥ 396	bits/sec	NT	400.00	NT	
Maximum fb	≤ 404	bits/sec	NT	400.00	NT	
Total transmission time						
Short message (maximum)	435.6 - 444.4	ms	NT	N/A	NT	
Short message (minimum)			NT	N/A	NT	
Long message (maximum)	514.8 - 525.2	ms	NT	522.133	NT	
Long message (minimum)			NT	522.125	NT	
Unmodulated carrier						
Minimum T1	≥ 158.4	ms	NT	159.555	NT	
Maximum T1	≤ 161.6	ms	NT	159.570	NT	
First burst delay	≥ 47.5	seconds	NT	53.42	NT	

NT = Not Tested

Parameters to be Measured		Range of Specification	Units	Test Results Tmin (-20°C)	Test Results Tamb (+21°C)	Test Results Tmax (+55°C)	Comments
4. Modulation							**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0							
Biphase-L		P / F	P / F	NT	P	NT	
Rise time	(maximum)	50 - 250	µs	NT	136.8	NT	
	(minimum)	50 - 250	µs	NT	131.2	NT	
Fall time	(maximum)	50 - 250	µs	NT	135.3	NT	
	(minimum)	50 - 250	µs	NT	130.9	NT	
Phase deviation: positive	(maximum)	+(1.0 to 1.2)	radians	NT	1.120	NT	
	(minimum)	+(1.0 to 1.2)	radians	NT	1.064	NT	
Phase deviation: negative	(maximum)	-(1.0 to 1.2)	radians	NT	-1.132	NT	
	(minimum)	-(1.0 to 1.2)	radians	NT	-1.075	NT	
Symmetry measurement		≤ 0.05		NT	0.02939	NT	
5. 406 MHz Transmitted Frequency							**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0							
Nominal Value	(maximum)	C/S T.001	MHz	NT	406.0310384	NT	
	(minimum)			NT	406.0310382	NT	
Short-term stability	(maximum)	≤ $2x10^{-9}$	/100ms	NT	1.80E-10	NT	
	(minimum)			NT	1.36E-10	NT	
Medium-term stability – Slope	(maximum)	(-1 to +1)$x10^{-9}$	/minutes	NT	2.15E-11	NT	
	(minimum)			NT	-8.02E-11	NT	
Medium-term stability – Residual frequency variation	(maximum)	≤ $3x10^{-9}$		NT	2.06E-10	NT	
	(minimum)			NT	1.49E-10	NT	

NT = Not Tested

Parameters to be Measured	Range of Specification	Units	Test Results				Comments
14. Satellite Qualitative Tests							**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0							
Test Configuration	As per C/S T.007		Configuration				
			7				
15 Hex ID Decoded by LUT	correct	P / F	P				
Doppler Location results with error ≤ 5km	≥ 80	%	100				
17. Navigation System							**Result: Pass**
Model: Tron SA20, S/N: 107, TUV Ref: TSR6 and Modification State 0							
Location protocol	C/S T.001		National	Standard	User	RLS	
Configuration 7							
Position accuracy - A.3.8.2.1	C/S T.001	m	NT	NT	NT	22.82	
Position Acquisition Time - A.3.8.2.1	<10/1	min	NT	NT	NT	0.97	
Position accuracy - A.3.8.2.2	C/S T.001	m	NT	NT	NT	35.88	
Position Acquisition Time - A.3.8.2.2	<10/1	min	NT	NT	NT	0.91	

NT = Not Tested

Tron SA20, S/N: 157

Parameters to be Measured		Range of Specification	Units	Test Results			Comments
				Tmin	Tamb	Tmax	
				(-20°C)	(+21°C)	(+55°C)	
2. Digital Message Coding							**Result: Pass**
Model: Tron SA20, S/N: 157, TUV Ref: TSR4 and Modification State 0							
Bit Sync	1 - 15	15 bits “1”	P / F	NT	P	NT	
Frame sync	16 - 24	“000101111”	P / F	NT	P	NT	
Format flag	25	1 bit	bit value	NT	1	NT	
Protocol flag	26	1 bit	bit value	NT	0	NT	
Identification / position data	27 - 85	59 bits	P / F	NT	P	NT	RLS Protocol
BCH code	86 -106	21 bits	P / F	NT	P	NT	
Emerg. Code/nat. use/supplem. Data	107 - 112	6 bits	bit value	NT	111000	NT	
Additional data / BCH (if applicable)	112 - 144	32 bits	P / F	NT	P	NT	
Position Error (if applicable)		< 5	km	NT	N/A	NT	

NT = Not Tested

Parameters to be Measured	Range of Specification	Units	Test Results			Comments
			Tmin	Tamb	Tmax	
			(-20°C)	(+21°C)	(+55°C)	
3. Digital Message Generator						**Result: Pass**
Model: Tron SA20, S/N: 157, TUV Ref: TSR4 and Modification State 0						
Repetition rate, T_R:						
Average T_R	$48.5 \leq T_{Ravg} \leq 51.5$	seconds	NT	50.113	NT	
Minimum T_R	$47.5 \leq T_{Rmin} \leq 48.0$	seconds	NT	47.805	NT	
Maximum T_R	$52.0 \leq T_{Rmax} \leq 52.5$	seconds	NT	52.329	NT	
Standard deviation	0.5 - 2.0	seconds	NT	1.514	NT	
Bit rate						
Minimum fb	≥ 396	bits/sec	NT	399.91	NT	
Maximum fb	≤ 404	bits/sec	NT	400.00	NT	
Total transmission time						
Short message (maximum)	435.6 - 444.4	ms	NT	N/A	NT	
Short message (minimum)			NT	N/A	NT	
Long message (maximum)	514.8 - 525.2	ms	NT	523.500	NT	
Long message (minimum)			NT	519.187	NT	
Unmodulated carrier						
Minimum T1	≥ 158.4	ms	NT	160.242	NT	
Maximum T1	≤ 161.6	ms	NT	160.250	NT	
First burst delay	≥ 47.5	seconds	NT	53.87	NT	

NT = Not Tested