PHOENIX TESTLAB
Phone: +49 (0) 52 35 / 95 00-0
Fax: +49 (0) 52 35 / 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number: F190480E1

Applicant:

Saab AB (publ) TransponderTech

Manufacturer:

Saab AB (publ) TransponderTech

Equipment under Test (EUT):

R60 VDES Base station

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

Laboratory accredited by
Deutsche Akkreditierungsstelle GmbH (DAkkS)
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. D-PL-17186-01-02

REFERENCES

[1] **IEC 62320-1 Ed. 2.0: 2015**: Maritime navigation and radiocommunication equipmnent and systems – Automatic Identification Systems (AIS) -
Part 1: AIS Base Stations – Minimum operational and performance requirements, methods of testing and required test results

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Tested and written by:	Thomas KÜHN		28.10.2019
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		28.10.2019
	Name	Signature	Date

RESERVATION

This test report is only valid in its original form.

Any reproduction of its contents in extracts without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

This test report is valid in hardcopy form as well as in electronic form.

Contents: **Page**

1 Identification

1.1 Applicant

Name:	Saab AB (publ) TransponderTech
Address:	Låsblecksgatan 3 58941 Linköping
Country:	Sweden
Name for contact purposes:	Mr. Christian ANDERSSON
Phone:	+46 13 18 94 86
Fax:	+46 13 18 23 77
eMail Address:	christian.t.andersson@saabgroup.com
Applicant represented during the test by the following person:	Mr. Daniel FERM

1.2 Manufacturer

Name:	Saab AB (publ) TransponderTech
Address:	Låsblecksgatan 3 58941 Linköping
Country:	Sweden
Name for contact purposes:	Mr. Christian ANDERSSON
Phone:	+46 13 18 94 86
Fax:	+46 13 18 23 77
eMail Address:	christian.t.andersson@saabgroup.com
Manufacturer represented during the test by the following person:	Mr. Daniel FERM

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by DGA Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02.

1.4 EUT (Equipment Under Test)

Type: *	VDES Base station					
Type designation: *	R60					
Part Number: *	7000 120-200					
Serial No.: *	100001					
Alignment range: *	156.025 to 162.025 MHz					
Switching range: *	156.025 to 162.025 MHz					
Channel separation: *	25 kHz					
Rated RF output power: *	Nominal low power: 1.0 W / 30 dBm Nominal high power: 12.5 W / 41 dBm					
Supply Voltage (DC): *	U_{nom}=	24.0 V_{DC}	U_{min}=	10.8 V_{DC}	U_{max}=	31.2 V_{DC}
Supply Voltage (AC): *	U_{nom}=	230 V_{AC}	U_{min}=	100 V_{AC}	U_{max}=	240 V_{AC}
Printed circuit designation: *	7000 120-110 Rev B4, 7000 120-130 Rev C3 and NHD-4.3C-FT813					
Hardware version: *	7000 120-100 Rev P6A1					
Software version: *	R60 0.4.11 and R60 0.4.17 (transmitter spurious emissions only)					
Ancillary equipment:	DELL laptop PC type LATITUDE E6400 (provided by the applicant), R40 AIS Basestation S/N 6519 (provided by the applicant).					

*: Declared by the applicant

Note: PHOENIX TESTLAB GmbH does not take samples. The sample used for tests is provided exclusively by the customer.

Ports/Connectors

Identification	Connector		Length
	EUT	Ancillary	
DC power supply	DC-Plug	-	1 m *
AC mains	Rubber connector	-	2 m *
GNSS	TNC	-	Not used
VHF 1	N-female	N-female	3 m *
VHF 2	N-female	-	Not used
I/O	9 pole D-Sub	-	Not used
RS-422	9 pole D-Sub	-	Not used
RS-232	9 pole D-Sub	-	Not used
HOT-STB	9 pole D-Sub	-	Not used
ETH 1	RJ45 plug	RJ45 plug	3 m *
ETH 2	RJ45 plug	-	Not used
ETH 1	RJ45 plug	-	Not used

*: Length during the tests

1.5 Dates

Date of receipt of test sample:	09.09.2019
Start of test:	09.09.2019
End of test:	25.10.2019

2 Operational states

General:
If not otherwise stated, the EUT was powered by an AC-mains network with 230 V_{AC} / 50 Hz. In case of DC power supply, the EUT was supplied by an external laboratory DC power supply (provided by the laboratory) within the voltage range, which was declared by the applicant.

Where tests were required with high output power by the standard [1] these test cases were carried out with high and low power setting of the EUT, as was requested by the applicant.

During all tests the EUT was connected to a laptop PC with a test-software RS radio test 1.3.1 (both provided by the applicant) via Ethernet connection. With this test-software the operation mode of the EUT, its output power and operation frequency could be selected. The test signals 1 and 2 were also generated by the test-software.

The receiver of the EUT is basically a dual SDR receiver.
There are two wideband analogue receiver chains in hardware, both capable of sampling the full marine band (156-162MHz):
- One subsampling, with an ADC working in the 4th Nyquist band.
- One with a local oscillator and IQ-demodulator.

The data from the two hardware receivers are split into eight separate 25 kHz channels digitally within the SDR (eight per hardware receiver), where each of the eight pairs are decoding the same 25 kHz channel. The software then filters out the double receptions which usually occur, unless there is some signal blocking reception on a particular hardware receiver.

Wanted signal:

AIS-transmit mode:
The transmitter operation was set by the test-software.

AIS-receive mode:
The test signal 3 was generated as audio file by the laptop PC with the help of its implemented sound card. This audio output was used to modulate a signal generator from PHOENIX TESTLAB. The received data telegrams were used to calculate the PER by the test software.

Test-signal overview:

Test-signal:	Mode:	Bit pattern:
1	AIS (TDMA)	01010101 (defined in clause 8.2.4.1 [1])
2	AIS (TDMA)	00001111 (defined in clause 8.2.4.2 [1])
3	AIS (TDMA)	200 packets with data (defined in clause 8.2.4.3 [1])

Unwanted signal:
All unwanted-signals were generated by the RF generators from PHOENIX TESTLAB.

3 Additional information

The conducted spurious emissions from the transmitter were tested with the software version R60 0.4.17 and all other tests with the software version R60 0.4.11. The transmitter carrier power and the receiver sensitivity were also checked with the software version R60 0.4.17 and no differences to the results achieved with the software version R60 0.4.11 were found.

4 Test overview

Subclause	Test parameter	Remark	Test result
9.2 [1]	**General transceiver tests**		
9.2.1 [1]	Transceiver protection test	Applicable	Passed
9.2.2 [1]	Transmitter shutdown procedure	Applicable	Passed
9.3 [1]	**TDMA Transmitter**		
9.3.2 [1]	Frequency error	Applicable	Passed
9.3.3 [1]	Carrier power	Applicable	Passed
9.3.4 [1]	Modulation spectrum slotted transmission	Applicable	Passed
9.3.5 [1]	Transmitter test sequence and modulation accuracy verification	Applicable	Passed
9.3.6 [1]	Transmitter output power versus time function	Applicable	Passed
9.3.7 [1]	Intermodulation attenuation	Applicable	Passed
9.4 [1]	**TDMA receivers**		
9.4.1 [1]	Sensitivity	Applicable	Passed
9.4.2 [1]	Error behaviour at high input levels	Applicable	Passed
9.4.3 [1]	Co-channel rejection	Applicable	Passed
9.4.4 [1]	Adjacent channel selectivity	Applicable	Passed
9.4.5 [1]	Spurious response rejection	Applicable	Passed
9.4.6 [1]	Intermodulation response rejection and blocking	Applicable	Passed
9.4.7 [1]	Blocking or desensitisation	Applicable	Passed
9.5 [1]	**Conducted spurious emissions at antenna**		
9.5.1 [1]	Conducted spurious emissions from the receiver	Applicable	Passed
9.5.2 [1]	Conducted spurious emissions from the transmitter	Applicable	Passed

5 General transceiver tests

5.1 Transceiver protection test

Subclause 9.2.1 [1]

Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit as required in 9.2.1.2 [1] 162.025 MHz and with 41 dBm.

Test case	Transmits after test as required	Test result
5 min. open	Yes	Passed
5 min. short	Yes	Passed

Limit: Subclause 9.3.2.3 [1]

The proof that the transceiver is protected against malfunctions at the antenna terminal is substantiated by the ability to pass the remainder of the tests in this clause.

Test equipment used (refer clause 8):

3

5.2 Transmitter shutdown procedure

The transmitter shutdown procedure was checked with the help of the circuit diagram and the additional declaration of the procedure provided by the applicant (refer also to PT-19-0170, A1, Description of R60 TX Shutdown, which is attached to this test report).

Result: A software independent shutdown procedure is implemented.

6 TDMA transmitter

6.1 Frequency error

Subclause 9.3.2 [1]

Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit in AIS-mode without modulation on 156.025 MHz and with 30 dBm.

Test conditions		Frequency	Frequency error	Test result
Temperature	Voltage			
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	156.024844 MHz	-156 Hz	Passed
T_{min} (-15 °C)	U_{min} (10.8 V DC)	156.024794 MHz	-206 Hz	Passed
	U_{max} (31.2 V DC)	156.024816 MHz	-184 Hz	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	156.024844 MHz	-156 Hz	Passed
	U_{max} (31.2 V DC)	156. 024819 MHz	-181 Hz	Passed
Maximum frequency error		-206 Hz		
Measurement uncertainty		$<10^{-7}$		

Operation mode: Transmit in AIS-mode without modulation on 162.025 MHz and with 30 dBm.

Test conditions		Frequency	Frequency error	Test result
Temperature	Voltage			
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	162.024844 MHz	-156 Hz	Passed
T_{min} (-15 °C)	U_{min} (10.8 V DC)	162.024794 MHz	-206 Hz	Passed
	U_{max} (31.2 V DC)	162.024794 MHz	-206 Hz	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	162.024841 MHz	-159 Hz	Passed
	U_{max} (31.2 V DC)	162.024819 MHz	-181 Hz	Passed
Maximum frequency error		-206 Hz		
Measurement uncertainty		$<10^{-7}$		

Operation mode: Transmit in AIS-mode on without modulation 156.025 MHz and with 41 dBm.

Test conditions		Frequency	Frequency error	Test result
Temperature	Voltage			
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	156.024844 MHz	-156 Hz	Passed
T_{min} (-15 °C)	U_{min} (10.8 V DC)	156.024794 MHz	-206 Hz	Passed
	U_{max} (31.2 V DC)	156.024816 MHz	-184 Hz	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	156.024866 MHz	-134 Hz	Passed
	U_{max} (31.2 V DC)	156. 024819 MHz	-181 Hz	Passed
Maximum frequency error		-206 Hz		
Measurement uncertainty		$<10^{-7}$		

Operation mode: Transmit in AIS-mode without modulation on 162.025 MHz and with 41 dBm.

Test conditions		Frequency	Frequency error	Test result
Temperature	Voltage			
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	162.024844 MHz	-156 Hz	Passed
T_{min} (-15 °C)	U_{min} (10.8 V DC)	162.024794 MHz	-206 Hz	Passed
	U_{max} (31.2 V DC)	162.024794 MHz	-206 Hz	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	162.024844 MHz	-156 Hz	Passed
	U_{max} (31.2 V DC)	162.024841 MHz	-159 Hz	Passed
Maximum frequency error		-206 Hz		
Measurement uncertainty		$<10^{-7}$		

Limit: Subclause 9.3.2.3 [1]

The frequency error shall not exceed ±0.5 kHz under normal and ±1 kHz under extreme conditions.

Test equipment used (refer clause 8):

3 – 8

6.2 Carrier power

Subclause 9.3.3 [1]

Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit in AIS-mode without modulation on 156.025 MHz.

Test conditions		Carrier power (Conducted)				
Temperature	Voltage	Power setting 30.0 dBm	Maximum difference to rated power	Power setting 41.0 dBm	Maximum difference to rated power	Test result
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	30.6 dBm	+0.6 dB	40.0 dBm	-1.0 dB	Passed
T_{max} (-15 °C)	U_{min} (10.8 V DC)	27.7 dBm	-2.3 dB	40.1 dBm	-0.9 dB	Passed
	U_{max} (31.2 V DC)	27.3 dBm	-2.7 dB	40.0 dBm	-1.0 dB	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	30.0 dBm	0.0 dB	40.0 dBm	-1.0 dB	Passed
	U_{max} (31.2 V DC)	31.3 dBm	+1.3 dB	39.9 dBm	-1.1 dB	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB				

Operation mode: Transmit in AIS-mode without modulation on 162.025 MHz.

Test conditions		Carrier power (Conducted)				
Temperature	Voltage	Power setting 30.0 dBm	Maximum difference to rated power	Power setting 41.0 dBm	Maximum difference to rated power	Test result
T_{nom} (+20 °C)	U_{nom} (24.0 V DC)	30.5 dBm	+0.5 dB	39.9 dBm	-1.1 dB	Passed
T_{max} (-15 °C)	U_{min} (10.8 V DC)	29.0 dBm	-1.0 dB	40.9 dBm	-1.0 dB	Passed
	U_{max} (31.2 V DC)	29.2 dBm	-0.8 dB	40.9 dBm	-1.0 dB	Passed
T_{max} (+55 °C)	U_{min} (10.8 V DC)	30.5 dBm	+0.5 dB	39.5 dBm	-1.5 dB	Passed
	U_{max} (31.2 V DC)	30.6 dBm	+0.6 dB	39.4 dBm	-1.6 dB	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB				

Limit: Subclause 9.3.3.3 [1]

P_c shall be within ±1.5 dB of the rated carrier power conducted. P_c under extreme test conditions shall be within ±3 dB of the rated carrier power conducted.

Test equipment used (refer clause 8):

3 – 8

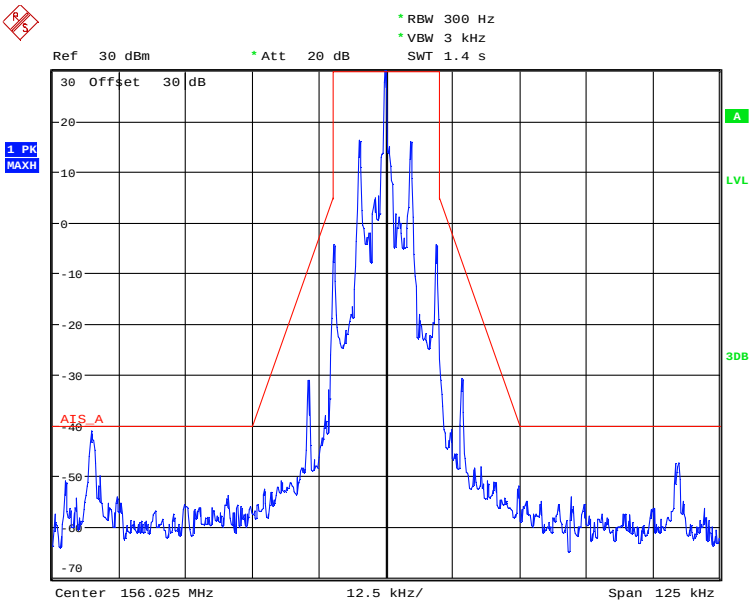
6.3 Modulation spectrum slotted transmission

Subclause 9.3.4 [1]

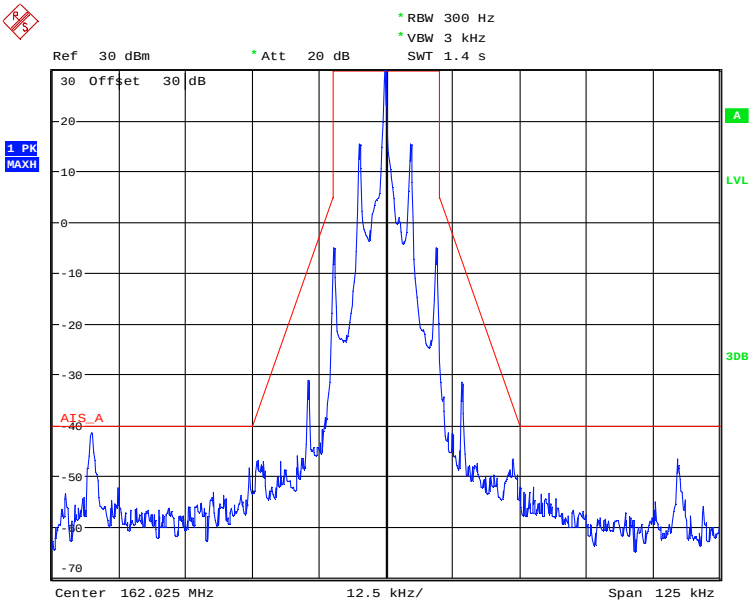
Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit in AIS-mode (test signal number 1).

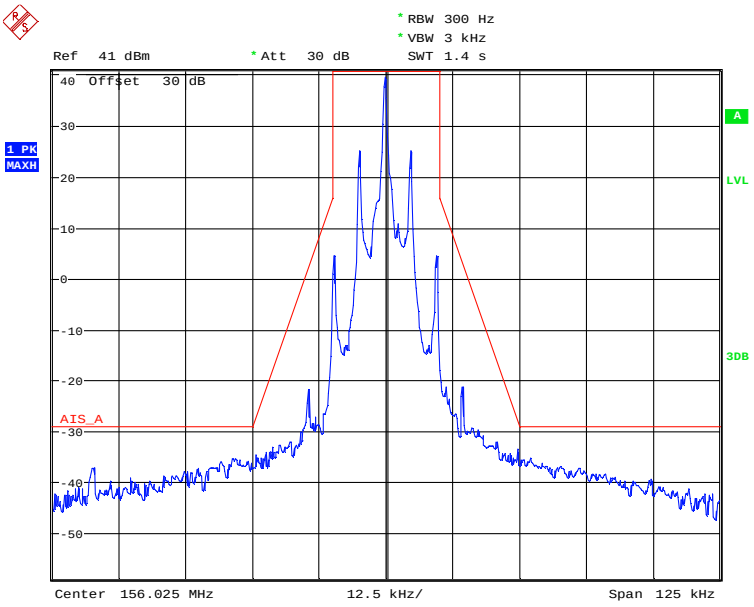
190480_29.wmf: Transmission spectrum, transmit test signal 1 on 156.025 MHz with 30 dBm:



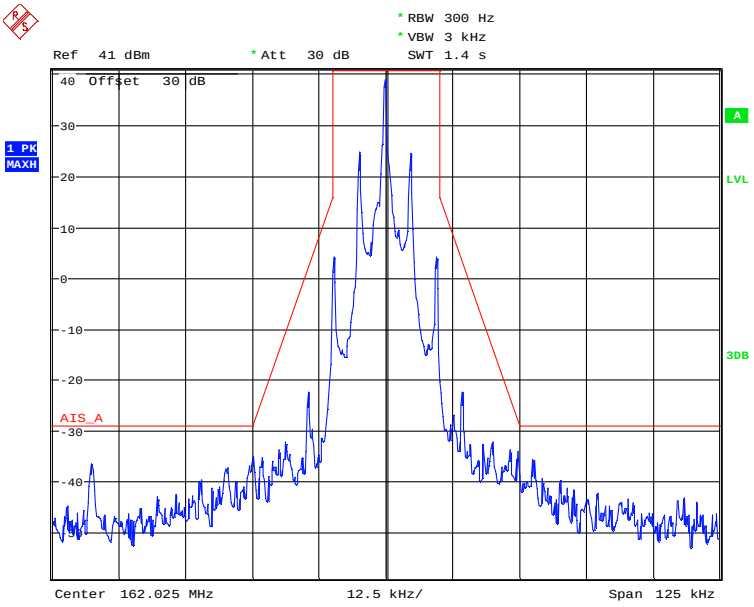
190480_30.wmf: Transmission spectrum, transmit test signal 1 on 162.025 MHz with 30 dBm:



190480_32.wmf: Transmission spectrum, transmit test signal 1 on 156.025 MHz with 41 dBm:

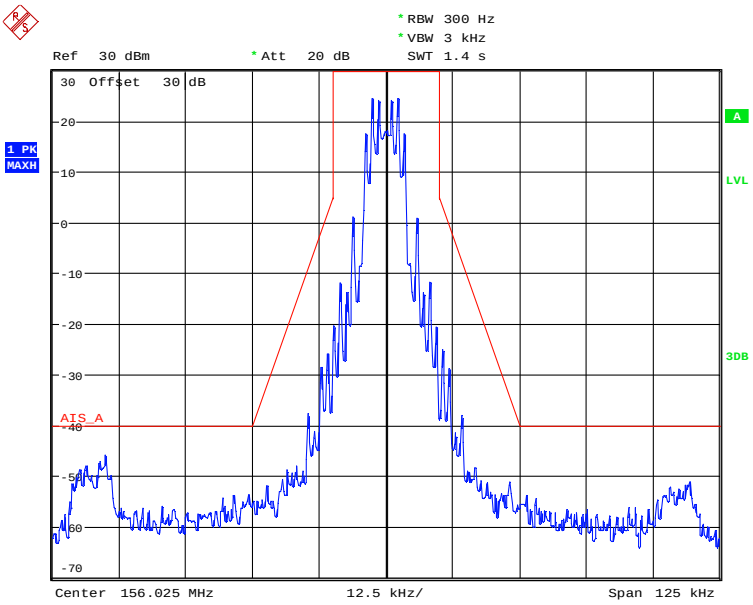


190480_31.wmf: Transmission spectrum, transmit test signal 1 on 162.025 MHz with 41 dBm:

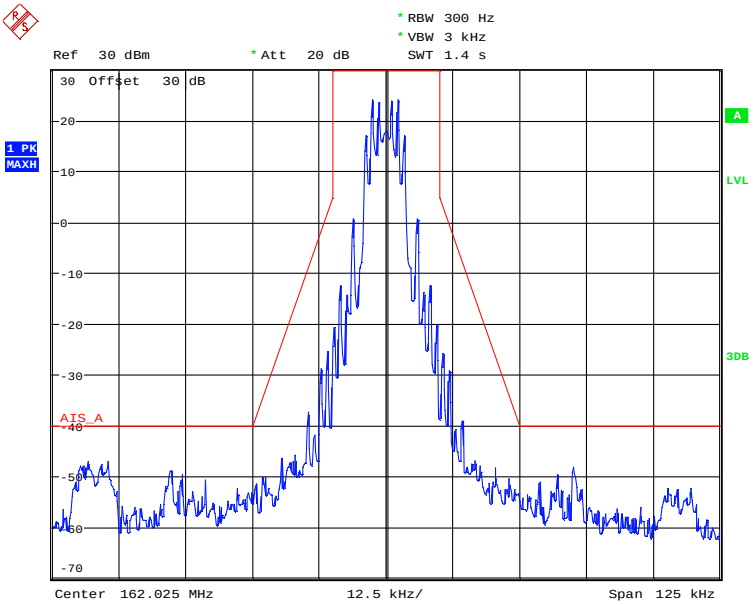


Operation mode: Transmit in AIS-mode (test signal number 2).

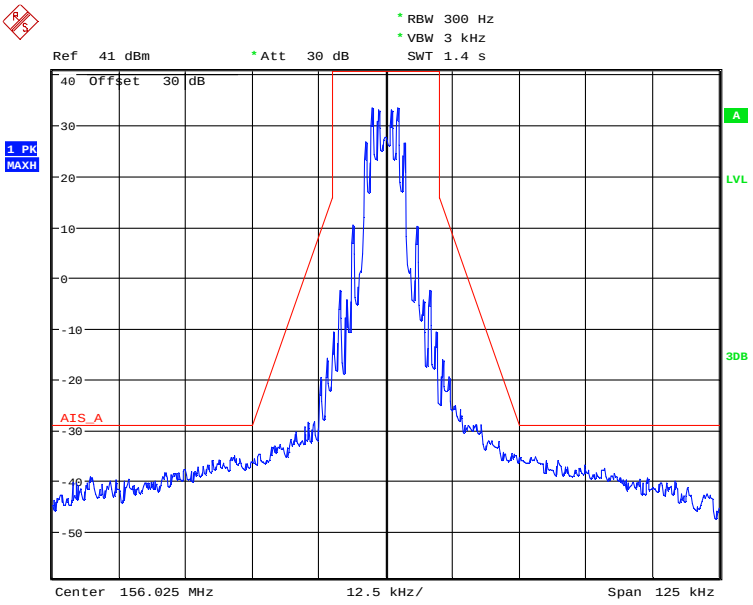
190480_28.wmf: Transmission spectrum, transmit test signal 2 on 156.025 MHz with 30 dBm:



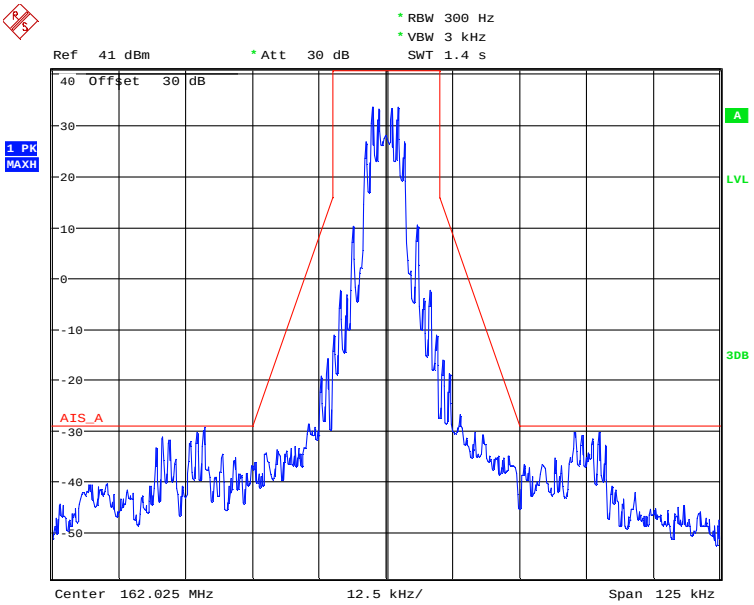
190480_35.wmf: Transmission spectrum, transmit test signal 2 on 162.025 MHz with 30 dBm:



190480_33.wmf: Transmission spectrum, transmit test signal 2 on 156.025 MHz with 41 dBm:



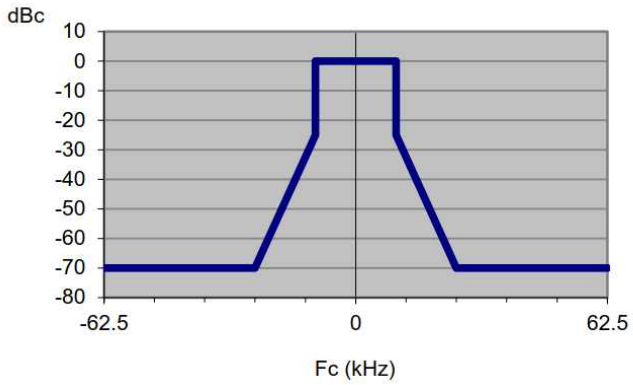
190480_34.wmf: Transmission spectrum, transmit test signal 2 on 162.025 MHz with 41 dBm:



Test result: Passed

Limit: Subclause 9.3.4.3 [1]

The modulation spectrum shall be within the mask detailed in Figure 3



Test equipment used (refer clause 8):

3, 9

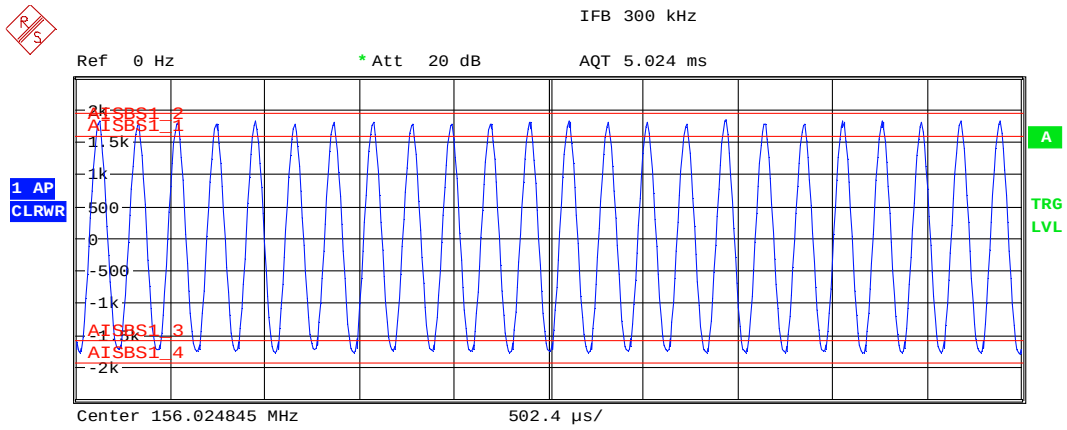
6.4 Transmitter test sequence and modulation accuracy verification

Subclause 9.3.5 [1]

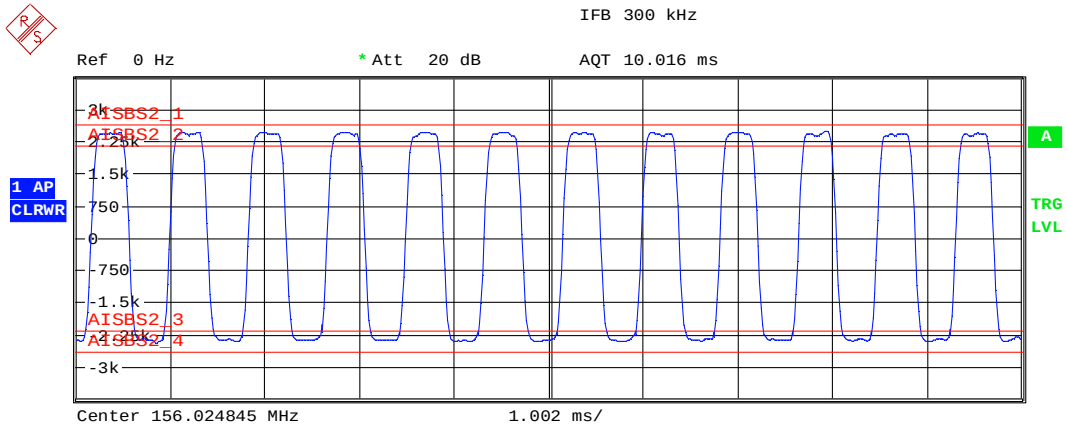
Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit in AIS-mode (test signal number 1 and 2).

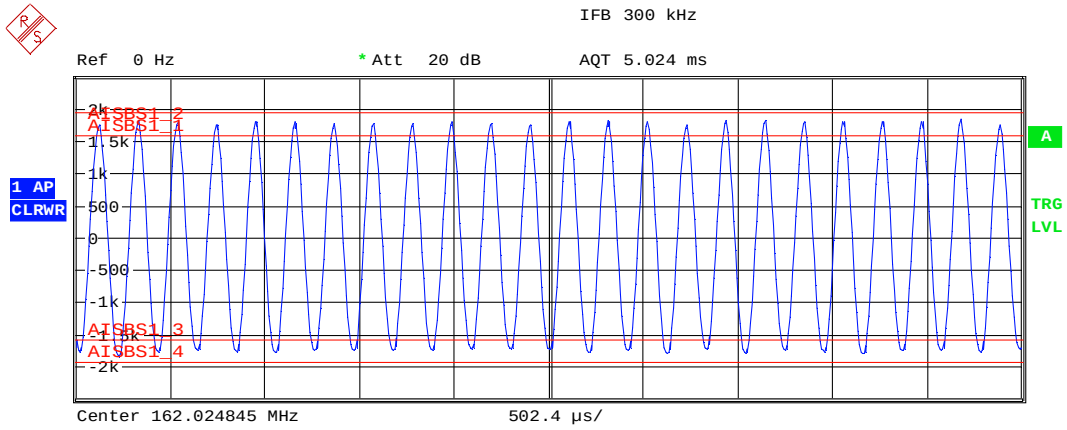
190480_42.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 1 with 30 dBm:



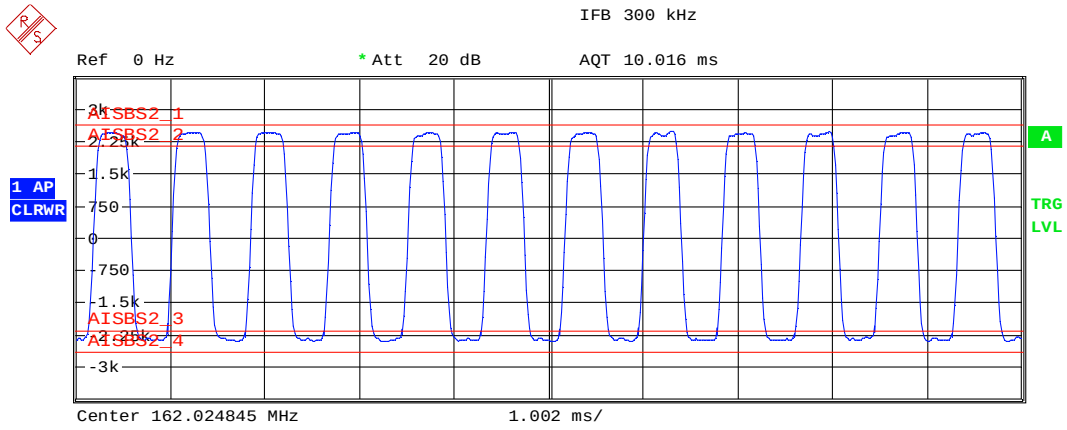
190480_37.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 2 with 30 dBm:



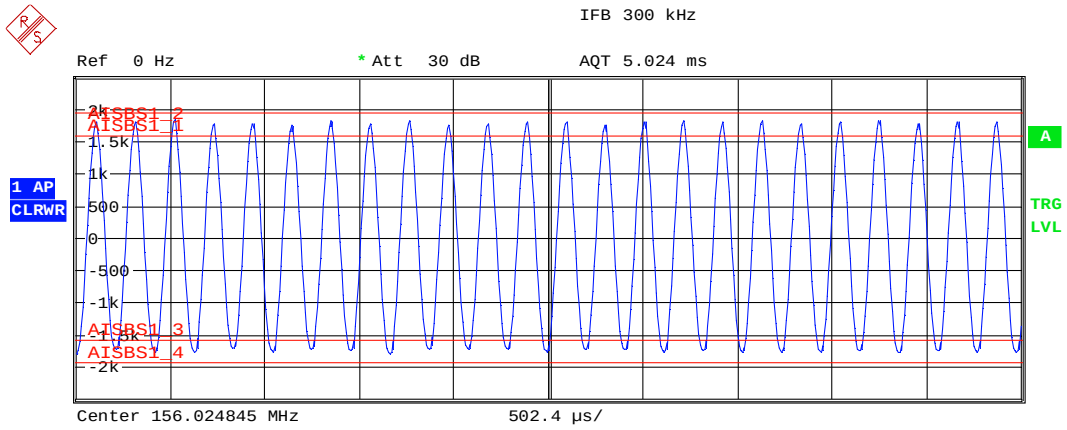
190480_41.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 1 with 30 dBm:



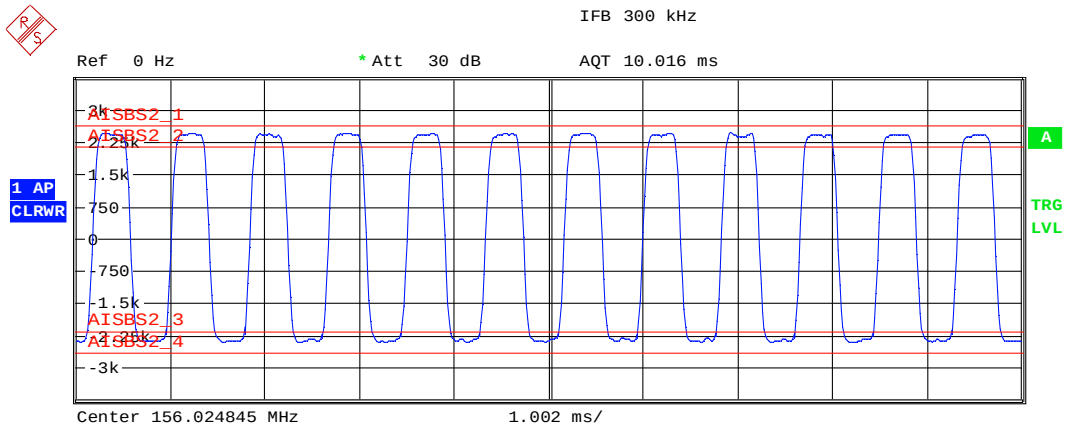
190480_38.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 2 with 30 dBm:



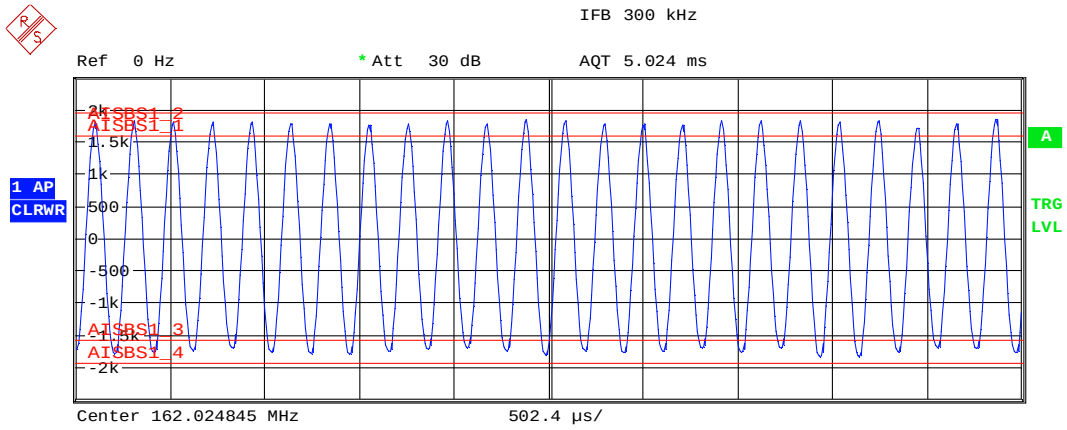
190480_43.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 1 with 41 dBm:



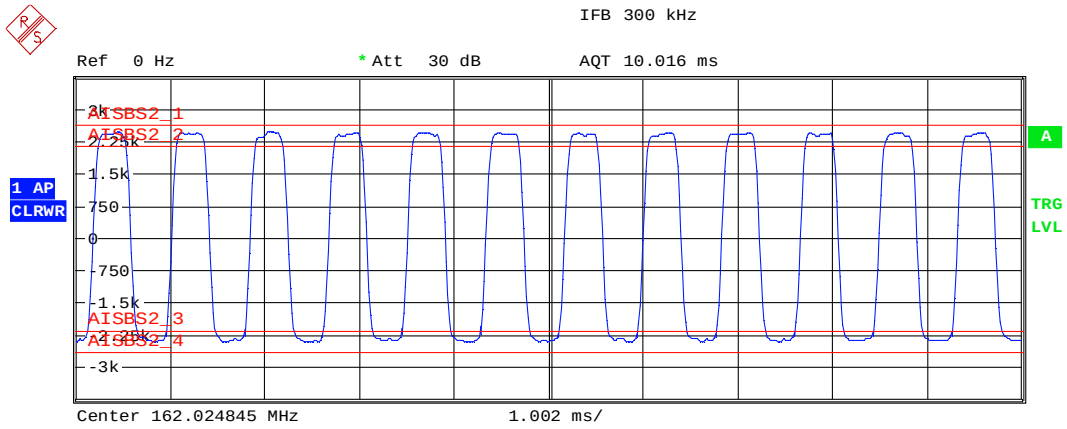
190480_36.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 2 with 41 dBm:



190480_40.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 1 with 41 dBm:



190480_39.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 2 with 41 dBm:



Remark: The frequency offset was set to -155 Hz, which is within the frequency error limit, in order to show the modulation accuracy independent of the frequency error. Because the test signal 1 as defined in [1] has no training sequence, the limit for test signal 1 was set to ± 175 Hz only.

Test Result: Passed

Limit: Subclause 9.3.5.3 [1]

For test signal number 1: the training sequence shall start with a '0' bit and, the peak frequency deviation shall be 1 760 Hz + 352 Hz/ – 176 Hz. For test signal number 2: The peak frequency deviation shall be 2 400 Hz ± 240 Hz.

Test equipment used (refer clause 8):

3, 9

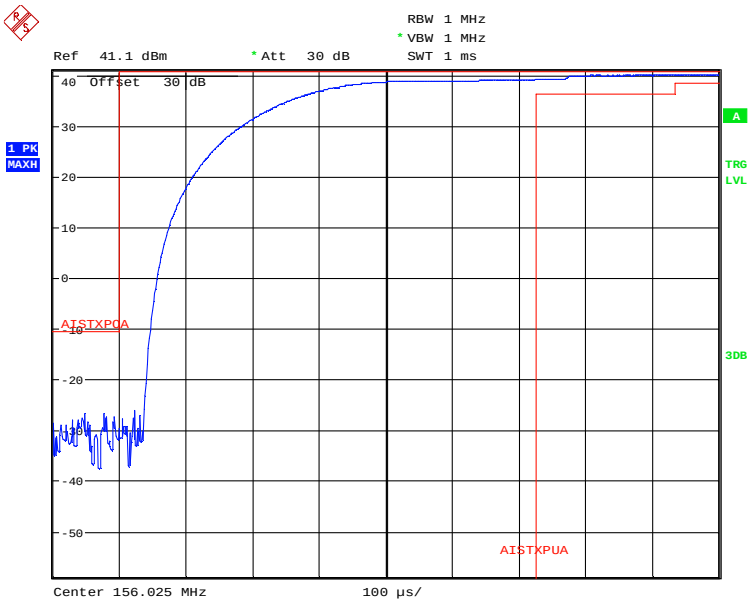
6.5 Transmitter output power versus time function

Subclause 9.3.6 [1]

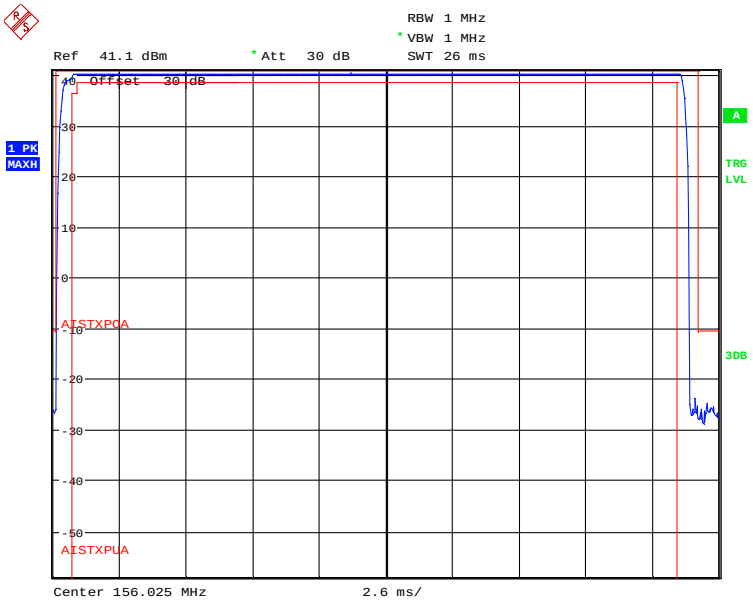
Ambient temperature	22 °C	Relative humidity	47 %

Operation mode: Transmit in AIS-mode (test signal number 2).

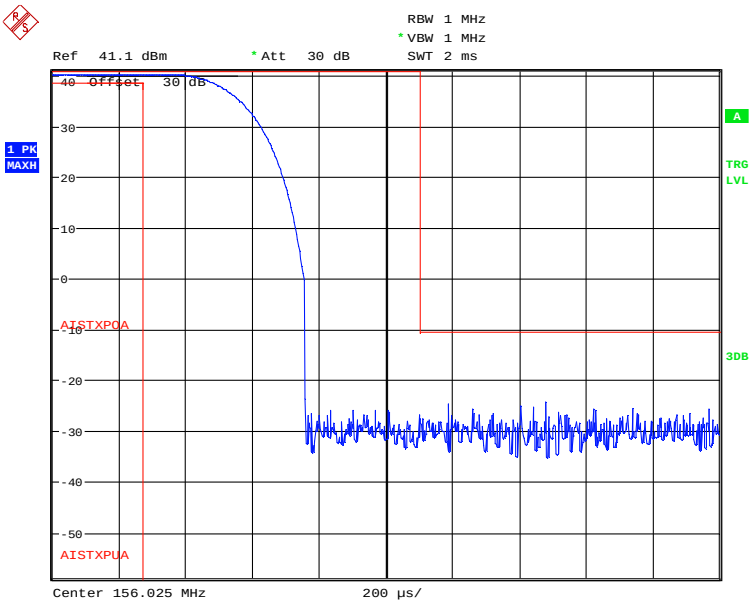
190480_21.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 41 dBm:



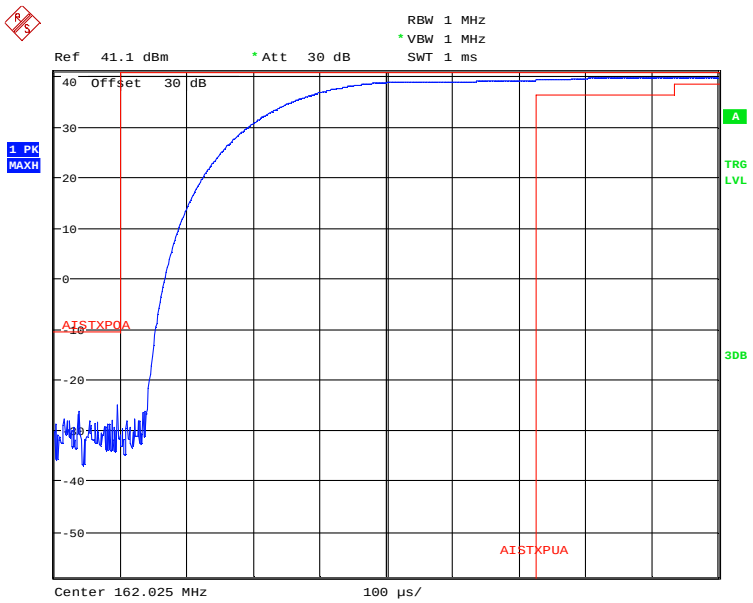
190480_19.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 41 dBm:



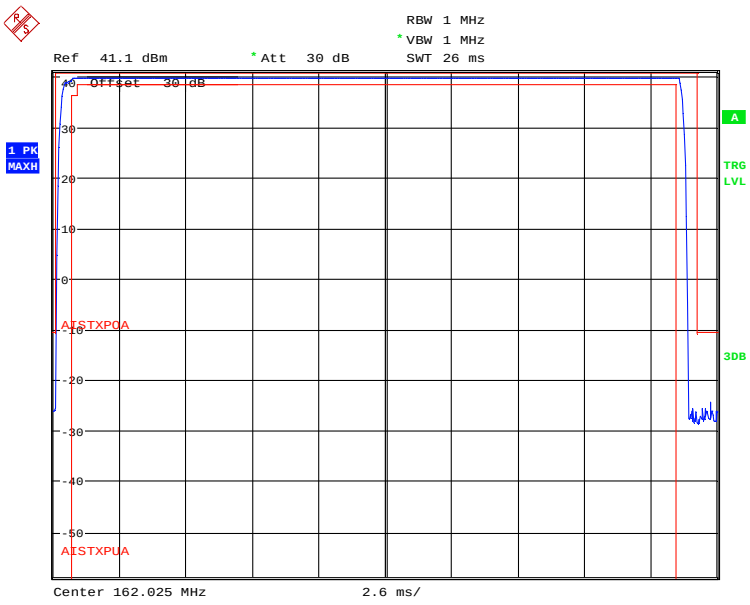
190480_20.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 41 dBm:



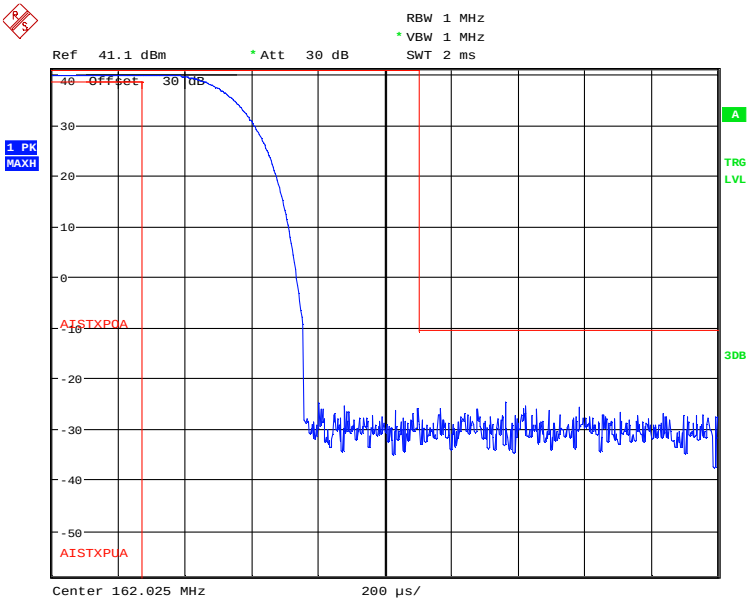
190480_16.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 41 dBm:



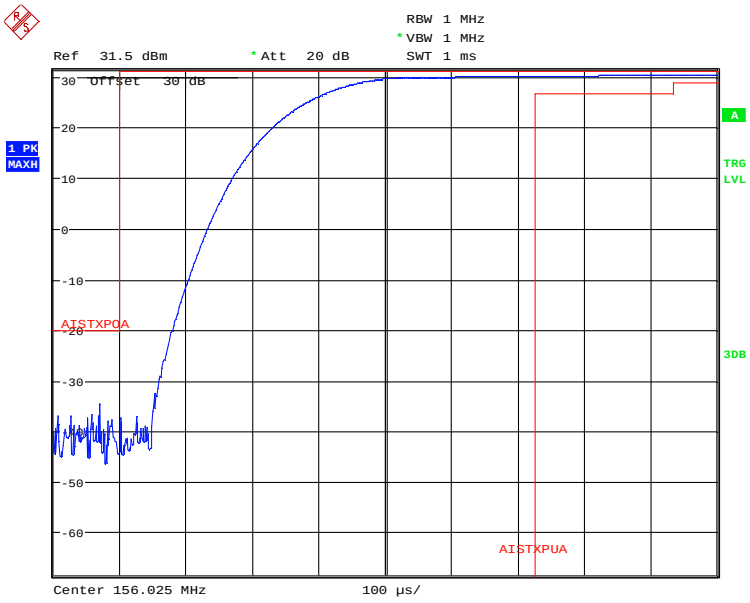
190480_17.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 41 dBm:



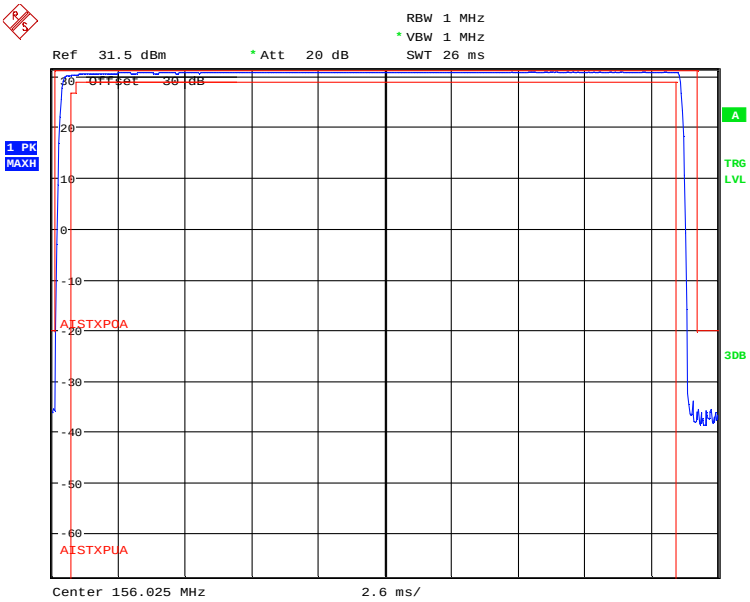
190480_18.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 41 dBm:



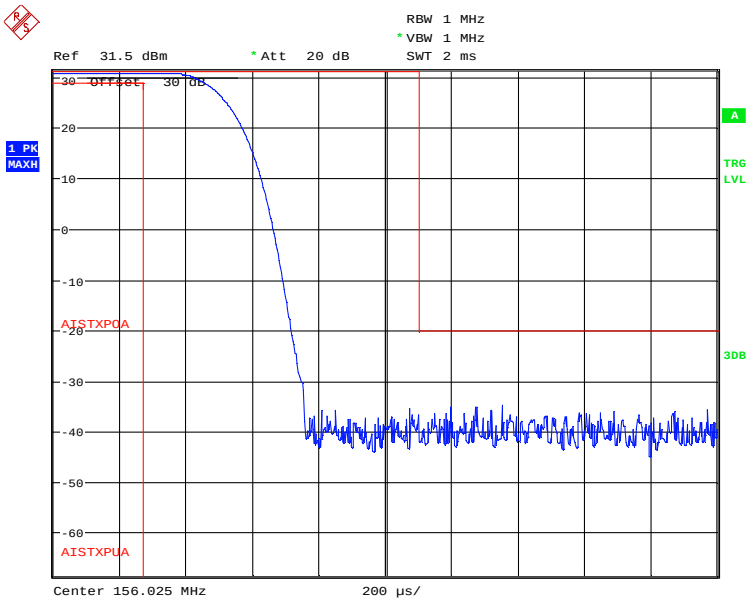
190480_22.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 30 dBm:



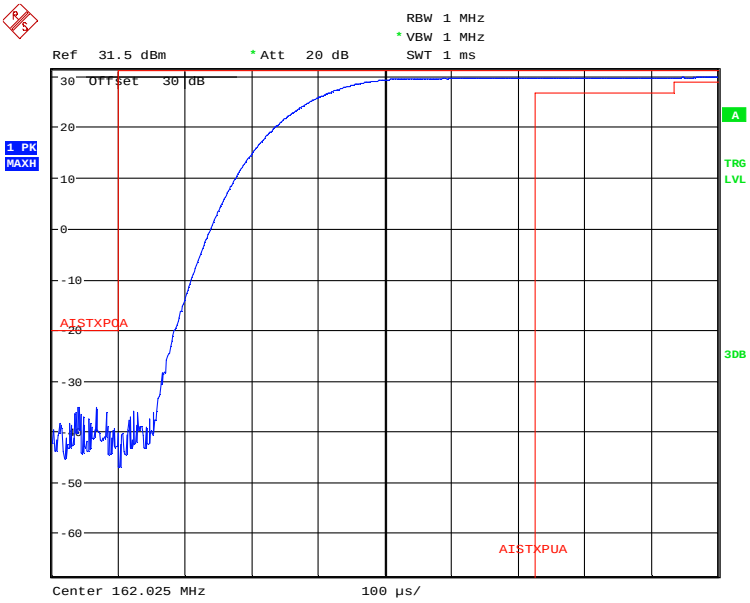
190480_23.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 30 dBm:



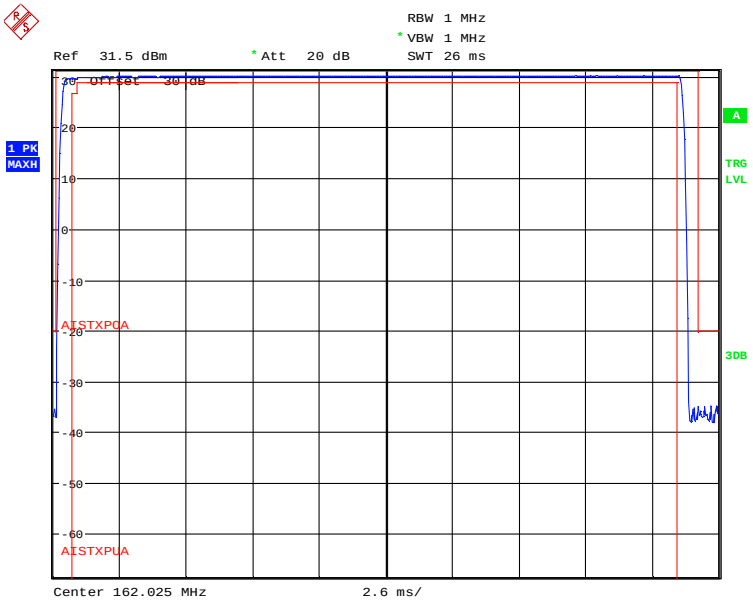
190480_24.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz with 30 dBm:



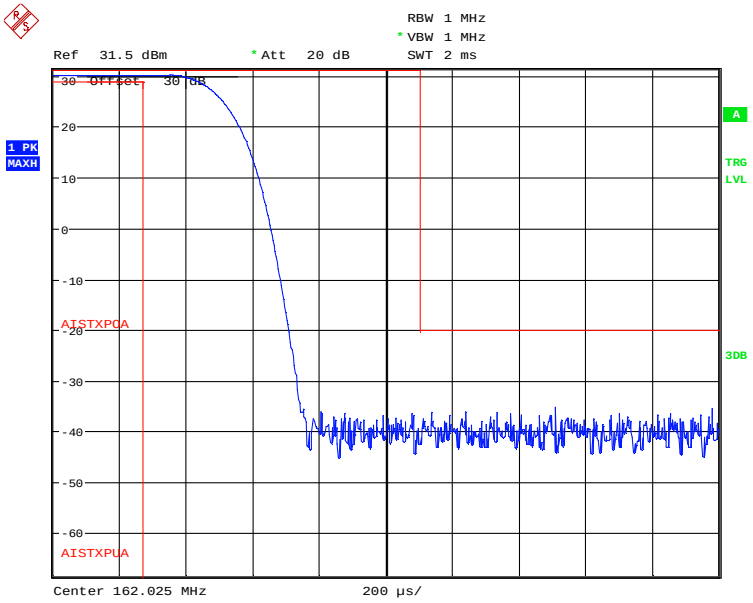
190480_27.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 30 dBm:



190480_26.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 30 dBm:



190480_25.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz with 30 dBm:



Test result: Passed

Limit: Subclause 9.3.6.3 [1]

The transmitter power shall remain within the mask shown in Figure 4 and associated timings given in Table 6.

Test equipment used (refer clause 8):

3, 9

6.6 Intermodulation attenuation

Subclause 9.3.7 [1]

Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Transmit in AIS-mode without modulation on 156.025 MHz.

Interferer source: R40 AIS Basestation S/N 6519 (provided by the applicant).

The interferer frequency was chosen after it was checked, that there are no spurious emissions from the EUT on the second and third order intermodulation frequencies (refer also the plots in annex B of this test report).

Frequency of the Interferer		Intermodulation ratio	Intermodulation frequency	Test result
2 x $f_{TX} - f_{Int}$	156.125 MHz	58.9 dB	155.925 MHz	Passed
Measurement uncertainty:		+0.8 dB / -0.9 dB		

Operation mode: Transmit in AIS-mode without modulation on 162.025 MHz

Frequency of the Interferer		Intermodulation ratio	Intermodulation frequency	Test result
2 x $f_{TX} - f_{Int}$	161.925 MHz	63.7 dB	162.125 MHz	Passed
Measurement uncertainty:		+0.8 dB / -0.9 dB		

Limit: Subclause 9.3.7.3 [1]

The intermodulation ratio shall be not less than 40 dB.

Test equipment used (refer clause 8):

4, 5, 10 – 14

7 TDMA receivers

7.1 Sensitivity

Subclause 9.4.1 [1]

Ambient temperature	22 °C	Relative humidity	41 %

Operation mode: Receive in AIS-mode.
Wanted signal: Test signal 3 on 156.025 MHz (-107 dBm (normal) / -101 dBm (extreme) conditions).

Measurement conditions		Measured packet error rate (PER)			
Temperature	Voltage	Frequency:	PER:	Test result	20 % limit reached at *
T_{nom} (+ 20 °C)	U_{nom} (24.0 V DC)	156.0245 MHz *	0.0 %	Passed	-120 dBm
		156.025 MHz	0.0 %	Passed	-120 dBm
		156.0255 MHz *	0.0 %	Passed	-120 dBm
T_{min} (-15 °C)	U_{min} (10.8 V DC)	156.025 MHz	0.0 %	Passed	-121 dBm
	U_{max} (31.2 V DC)	156.025 MHz	0.0 %	Passed	-121 dBm
T_{max} (55 °C)	U_{min} (10.8 V DC)	156.025 MHz	0.0 %	Passed	-120 dBm
	U_{max} (31.2 V DC)	156.025 MHz	0.0 %	Passed	-120 dBm
Measurement uncertainty		+0.9 dB / -1.0 dB			

*: Applicant requests this test, no limits defined in the standard.

Operation mode: Receive in AIS-mode.
Wanted signal: Test signal 3 on 156.025 MHz (-107 dBm (normal) / -101 dBm (extreme) conditions).

Measurement conditions		Measured packet error rate (PER)			
Temperature	Voltage	Frequency:	PER:	Test result	20 % limit reached at *
T_{nom} (+ 20 °C)	U_{nom} (24.0 V DC)	162.0245 MHz *	0.0 %	Passed	-120 dBm
		162.025 MHz	0.0 %	Passed	-120 dBm
		162.0255 MHz *	0.0 %	Passed	-120 dBm
T_{min} (-15 °C)	U_{min} (10.8 V DC)	162.025 MHz	0.0 %	Passed	-121 dBm
	U_{max} (31.2 V DC)	162.025 MHz	0.0 %	Passed	-121 dBm
T_{max} (55 °C)	U_{min} (10.8 V DC)	162.025 MHz	0.0 %	Passed	-120 dBm
	U_{max} (31.2 V DC)	162.025 MHz	0.0 %	Passed	-120 dBm
Measurement uncertainty		+0.9 dB / -1.0 dB			

*: Applicant requests this test, no limits defined in the standard.

Limit: Subclause 9.4.1.3 [1]

A minimum PER of 20 % is required.

Test equipment used (refer clause 8):

6 – 8, 15

7.2 Error behaviour at high input levels

Subclause 9.4.2 [1]

Ambient temperature	22 °C	Relative humidity	50 %

Operation mode: Receive in AIS-mode.
Wanted signal: Test signal 3 on 156.025 MHz.

RF-input signal level	Measured packet error rate (PER)	Test result
- 77 dBm	0.0 %	Passed
- 7 dBm	0.0 %	Passed
Measurement uncertainty	+0.9 dB / -1.0 dB	

Operation mode: Receive in AIS-mode.
Wanted signal: Test signal 3 on 162.025 MHz.

RF-input signal level	Measured packet error rate (PER)	Test result
- 77 dBm	0.0 %	Passed
- 7 dBm	0.0 %	Passed
Measurement uncertainty	+0.9 dB / -1.0 dB	

Limit: Subclause 9.4.2.3 [1]

The PER shall not exceed 1 % in either case.

Test equipment used (refer clause 8):

15

7.3 Co-channel rejection

Subclause 9.4.3 [1]

Ambient temperature	22 °C	Relative humidity	50 %

Operation mode: Receive in AIS-mode.
Wanted signal: Test-signal 3 on 156.025 MHz, P = -104 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation.

Unwanted signal frequency:	Unwanted signal level:	Signal ratio:	Packet error rate:	Test result
156.025 MHz	-114 dBm	10 dB	0.0 %	Passed
Measurement uncertainty		+0.8 dB / -0.9 dB		

Operation mode: Receive in AIS-mode on 162.025 MHz
Wanted signal: Test-signal 3, P = -104 dBm
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation

Unwanted signal frequency:	Unwanted signal level:	Signal ratio:	Packet error rate:	Test result
162.025 MHz	-114 dBm	10 dB	0.0 %	Passed
Measurement uncertainty		+0.8 dB / -0.9 dB		

Limit: Subclause 9.4.3.3 [1]

The PER shall not exceed 20 %.

Test equipment used (refer clause 8):

15, 16, 18

7.4 Adjacent channel selectivity

Subclause 9.4.4 [1]

Ambient temperature	22 °C

Relative humidity	50 %

Operation mode: Receive in AIS mode.
Wanted signal: Test-signal 3; P = -104 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation; P = -34 dBm.

Wanted signal	Unwanted signal	Signal Ratio	Packet error rate	Test result
156.025 MHz	156.000 MHz	70 dB	0.0 %	Passed
	156.050 MHz	70 dB	0.0 %	Passed
162.025 MHz	162.000 MHz	70 dB	1.0 %	Passed
	162.050 MHz	70 dB	1.0 %	Passed
Measurement uncertainty		+0.8 dB / -0.9 dB		

Limit: Subclause 9.4.4.3 [1]

The PER shall not exceed 20 %.

Test equipment used (refer clause 8):

15, 16, 18

7.5 Spurious response rejection

Subclause 9.4.5 [1]

Ambient temperature	22 °C

Relative humidity	50 %

Operation mode: Receive in AIS mode
(receiver A, LO-Freq. = 159.000 MHz, receiver B, ADC-frequency 98.304 MHz).
IF frequency: IF_1 = -2.975 MHz.
Wanted signal: 156.025 MHz with P = -101 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation, P = -31 dBm.

Results of the specific frequencies of interest			
Definition	Unwanted frequency	Packet Error Rate PER	Test result
1st IF	2.975 MHz	0.0 %	Passed
1st LO-Freq. – IF	161.975 MHz	0.0 %	Passed
2 x 1st LO-Freq. – IF	320.975 MHz	0.0 %	Passed
2 x 1st LO-Freq. + IF	315.025 MHz	0.0 %	Passed
3 x 1st LO-Freq. – IF	479.975 MHz	0.0 %	Passed
3 x 1st LO-Freq. + IF	474.025 MHz	0.0 %	Passed
4 x 1st LO-Freq. – IF	638.975 MHz	0.0 %	Passed
4 x 1st LO-Freq. + IF	633.025 MHz	0.0 %	Passed
ADC (1st Nyquist band)	40.583 MHz	0.0 %	Passed
ADC (2nd Nyquist band)	57.721 MHz	0.0 %	Passed
ADC (3rd Nyquist band)	138.887 MHz	0.0 %	Passed
ADC (5th Nyquist band)	188.039 MHz	0.0 %	Passed
ADC (6th Nyquist band)	254.329 MHz	0.0 %	Passed
ADC (7th Nyquist band)	344.064 MHz	0.0 %	Passed
ADC (8th Nyquist band)	352.633 MHz	0.0 %	Passed
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Continued next page:

Limited frequency range: 153.025 MHz to 164.975 MHz (stepped with 5 kHz).
Operation mode: Receive in AIS mode
(receiver A, LO-Freq. = 159.000 MHz, receiver B, ADC-frequency 98.304 MHz).
IF frequency: IF_1 = -2.975 MHz.
Wanted signal: 156.025 MHz with P = -101 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation,
P = -31 dBm (measurement) / -21 dBm (searching over the limited frequency range).

Results of the measurement over the limited frequency range			
Definition	Unwanted frequency	Packet Error Rate PER	Test result
Search result	153.910 MHz	0.0 % (receiver A blocked)	Passed
Search result	154.570 MHz	0.0 %	Passed
Search result	154.800 MHz	0.0 %	Passed
Search result	155.895 MHz	0.0 % (receiver A blocked)	Passed
Search result	155.915 MHz	0.0 % (receiver A blocked)	Passed
Search result	155.940 MHz	0.0 % (receiver A blocked)	Passed
Search result	155.975 MHz	0.0 %	Passed
Search result	156.080 MHz	0.0 %	Passed
Search result	157.670 MHz	0.0 % (receiver A blocked)	Passed
Search result	158.005 MHz	0.0 % (receiver A blocked)	Passed
Search result	158.405 MHz	0.0 % (receiver A blocked)	Passed
Search result	158.670 MHz	0.0 %	Passed
Search result	159.195 MHz	0.0 % (receiver A blocked)	Passed
Search result	159.425 MHz	0.0 % (receiver A blocked)	Passed
Search result	159.990 MHz	0.0 % (receiver A blocked)	Passed
Search result	160.035 MHz	0.0 %	Passed
Search result	160.385 MHz	0.0 % (receiver A blocked)	Passed
Search result	160.660 MHz	0.0 %	Passed
Search result	160.860 MHz	0.0 % (receiver A blocked)	Passed
Search result	161.505 MHz	0.0 % (receiver A blocked)	Passed
Search result	161.975 MHz	0.0 % (receiver A blocked)	Passed
Search result	162.475 MHz	0.0 % (receiver A blocked)	Passed
Search result	162.550 MHz	0.0 % (receiver A blocked)	Passed
Search result	162.765 MHz	0.0 % (receiver A blocked)	Passed
Search result	162.935 MHz	0.0 % (receiver A blocked)	Passed
Search result	163.320 MHz	0.0 %	Passed
Search result	163.295 MHz	0.0 % (receiver A blocked)	Passed
Search result	163.720 MHz	0.0 % (receiver A blocked)	Passed
Search result	163.740 MHz	0.0 % (receiver A blocked)	Passed
Search result	164.085 MHz	0.0 % (receiver A blocked)	Passed

Continued next page:

Operation mode: Receive in AIS mode
(receiver A, LO-Freq. = 159.000 MHz, receiver B, ADC-frequency 98.304 MHz).
IF frequency: IF_1 = 3.025 MHz.
Wanted signal: 162.025 MHz with P = -101 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation, P = -31 dBm

Results of the specific frequencies of interest			
Definition	Unwanted frequency	Packet Error Rate PER	Test result
1st IF	3.025 MHz	0.0 %	Passed
1st LO-Freq. – IF	155.975 MHz	0.0 %	Passed
2 x 1st LO-Freq. – IF	314.975 MHz	0.0 %	Passed
2 x 1st LO-Freq. + IF	321.025 MHz	0.0 %	Passed
3 x 1st LO-Freq. – IF	473.975 MHz	0.0 %	Passed
3 x 1st LO-Freq. + IF	480.025 MHz	0.0 %	Passed
4 x 1st LO-Freq. – IF	632.975 MHz	0.0 %	Passed
4 x 1st LO-Freq. + IF	639.025 MHz	0.0 %	Passed
ADC (1st Nyquist band)	34.583 MHz	0.0 %	Passed
ADC (2nd Nyquist band)	63.721 MHz	0.0 %	Passed
ADC (3rd Nyquist band)	132.887 MHz	0.0 %	Passed
ADC (5th Nyquist band)	182.039 MHz	0.0 %	Passed
ADC (6th Nyquist band)	260.329 MHz	0.0 %	Passed
ADC (7th Nyquist band)	344.064 MHz	0.0 %	Passed
ADC (8th Nyquist band)	358.633 MHz	0.0 %	Passed
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Continued next page:

Limited frequency range: 152.975 MHz to 165.025 MHz (stepped with 5 kHz)
Operation mode: Receive in AIS mode
(receiver A, LO-Freq. = 159.000 MHz, receiver B, ADC-frequency 98.304 MHz).
IF frequency: IF_1 = 3.025 MHz.
Wanted signal: 162.025 MHz with P = -101 dBm.
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation,
P = -31 dBm (measurement) / -21 dBm (searching over the limited frequency range)

Results of the measurement over the limited frequency range			
Definition	Unwanted frequency	Packet Error Rate PER	Test result
Search result	153.895 MHz	0.0 % (receiver A blocked)	Passed
Search result	154.690 MHz	0.0 % (receiver A blocked)	Passed
Search result	155.055 MHz	0.0 % (receiver A blocked)	Passed
Search result	155.965 MHz	0.0 % (receiver A blocked)	Passed
Search result	157.145 MHz	0.0 % (receiver A blocked)	Passed
Search result	157.990 MHz	0.0 % (receiver A blocked)	Passed
Search result	158.570 MHz	0.0 % (receiver A blocked)	Passed
Search result	159.605 MHz	0.0 % (receiver A blocked)	Passed
Search result	160.320 MHz	0.0 % (receiver A blocked)	Passed
Search result	160.700 MHz	0.0 % (receiver A blocked)	Passed
Search result	161.965 MHz	0.0 %	Passed
Search result	162.075 MHz	4.0 %	Passed
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Limit: Subclause 9.4.5.9 [1]

At any frequency separated from the specified frequency of the receiver by two channels or more, the PER shall not exceed 20 %.

Test equipment used (refer clause 8):

15, 16, 18

7.6 Intermodulation response rejection

Subclause 9.4.6 [1]

Ambient temperature	22 °C

Relative humidity	50 %

Wanted signal A: Test-signal 3, P = -101 dBm.
Unwanted signal B: Unmodulated, P = -27 dBm.
Unwanted signal C: Modulated 400 Hz / 3 kHz, RF-level -27 dBm.

Operation mode: Receive in AIS-mode.

Frequencies of the unwanted signals			Packet error rate PER	Test result
Generator A	Generator B	Generator C		
156.025 MHz	156.525 MHz	157.025 MHz	0.0 %	Passed
156.025 MHz	155.525 MHz	155.025 MHz	0.0 %	Passed
Measurement uncertainty:			+0.8 dB / -0.9 dB	

Operation mode: Receive in AIS-mode.

Frequencies of the unwanted signals			Packet error rate PER	Test result
Generator A	Generator B	Generator C		
162.025 MHz	161.525 MHz	161.025 MHz	0.5 %	Passed
162.025 MHz	162.525 MHz	163.025 MHz	0.0 %	Passed
Measurement uncertainty:			+0.8 dB / -0.9 dB	

Limit: Subclause 9.4.6.3 [1]

The PER shall not exceed 20 %.

Test equipment used (refer clause 8):

15 – 22

7.7 Blocking or Desensitisation

Subclause 9.4.7 [1]

Ambient temperature	22 °C

Relative humidity	50 %

Operation mode: Receive in AIS-mode.
Wanted signal A: 156.025 MHz, P = -101 dBm, test signal number 3.
Unwanted signal B: Unmodulated, P = -15dBm.

Frequency of the unwanted signal	Packet Error Rate PER	Test result
161.750 MHz	0.0 %	Passed
Measurement uncertainty	+ 0.8 dB / - 0.9 dB	

Blocking or desensitisation (Continued):

Operation mode: Receive in AIS-mode.
Wanted signal A: 162.025 MHz P = -101 dBm, test signal number 3.
Unwanted signal B: Unmodulated, P = -15

Frequency of the unwanted signal	Packet Error Rate PER	Test result
156.300 MHz	0.0 %	Passed
Measurement uncertainty	+ 0.8 dB / - 0.9 dB	

Limit: Subclause 9.4.7.3[1]

The PER shall not exceed 20 %.

Test equipment used (refer clause 8):

15, 16, 18

7.9 Spurious emissions from the receiver

Subclause 9.5.1 [1]

Ambient temperature	22 °C	Relative humidity	50 %

Operation mode : Receive in AIS-mode.

Spurious emission level (conducted)					
f [MHz]	Level [dBm]	Bandwidth [kHz]	Limit [dBm]	Margin [dB]	Result
-	-	No emissions above the noise floor of the system found		-	-
-	-			-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
Measurement uncertainty		+0.66 dB / -0.72 dB			

Remark: This measurement includes the spurious emission results of both receivers.

Test result: Passed

Limit: Subclause 9.5.1.3 [1]

The power of any spurious emission in the specified range at the antenna terminal shall not exceed –57 dBm in the frequency range 9 kHz to 1 GHz and –47 dBm in the frequency range 1 GHz to 4 GHz.

Test equipment used (refer clause 8):

10, 9

7.10 Spurious emissions from the transmitter

Subclause 9.5.2 [1]

Ambient temperature	22 °C

Relative humidity	49 %

Operation mode of the transmitter: Transmit without modulation.

Spurious emissions level (conducted, transmitter operates on 156.025 MHz, P = 30 dBm)					
f [MHz]	Level [dBm]	Bandwidth [kHz]	Limit [dBm]	Margin [dB]	Result
156.315	-45.3	100	-36.0	9.3	Passed
312.050	-57.6	100	-36.0	11.6	Passed
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
Measurement uncertainty		+0.66 dB / -0.72 dB			

Spurious emissions level (conducted, transmitter operates on 156.025 MHz, P = 41 dBm)					
f [MHz]	Level [dBm]	Bandwidth [kHz]	Limit [dBm]	Margin [dB]	Result
157.757	-43.9	100	-36.0	7.9	Passed
312.050	-36.3	100	-36.0	0.3	Passed
468.075	-51.7	100	-36.0	15.7	Passed
624.100	-51.3	100	-36.0	15.3	Passed
780.125	-57.5	100	-36.0	1.5	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB			

Spurious emissions level (conducted, transmitter operates on 162.025 MHz, P = 30 dBm)					
f [MHz]	Level [dBm]	Bandwidth [kHz]	Limit [dBm]	Margin [dB]	Result
161.502	-47.1	100	-36.0	11.1	Passed
324.050	-52.7	100	-36.0	16.7	Passed
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
Measurement uncertainty		+0.66 dB / -0.72 dB			

Spurious emissions level (conducted, transmitter operates on 162.025 MHz, P = 41 dBm)					
f [MHz]	Level [dBm]	Bandwidth [kHz]	Limit [dBm]	Margin [dB]	Result
156.125	-53.0	100	-36.0	17.0	Passed
161.470	-43.8	100	-36.0	7.8	Passed
324.050	-36.2	100	-36.0	0.2	Passed
486.075	-50.0	100	-36.0	14.0	Passed
648.100	-51.8	100	-36.0	15.8	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB			

Limits: Subclause 9.5.2.3

The power of any spurious emission at any frequency shall not exceed –36 dBm in the frequency range 9 kHz to 1 GHz and –30 dBm in the frequency range 1 GHz to 4 GHz.

Test equipment used (refer clause 8):

9, 10, 13, 14, 23

8 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M21	B83117-B1232-T162	Albatross	26491	481966	Calibration not necessary	
2	Shielded chamber M21-1				481967		
3	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	31.10.2018	10.2020
4	10 dB attennuator	33-10-34	Weinschel	BH4878	410129	Calibration not necessary	
5	20 dB attennuator	WA47-20-34	Weinschel	#A1169	481452	Calibration not necessary	
6	Dynamic temperature chamber	MK 240	WTB Binder	05-79022	480462	10.07.2019	07.2020
7	DC Power Supply	TOE8951	Toellner	81995	481252	Calibration not necessary	
8	Multimeter	971A	Hewlett Packard	JP39009358	480721	19.02.2019	20.2020
9	30 dB attennuator	8498A	Hewlett Packard	3318A06321	481817	Calibration not necessary	
10	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	15.03.2019	03.2020
11	Directional coupler	3060-20	Narda	-	480351	Calibration not necessary	
12	10 dB attennuator	33-10-34	Weinschel	BH4856	410130	Calibration not necessary	
13	High pass filter	WHJ9-167-200-2000-60EF	Wainwright	1	481811	Calibration not necessary	
14	Tunable Notch Filter	WTRCD5-150-165-0.05-0.61-40EEK	Wainwright	1	481810	Calibration not necessary	
15	Signal Generator	SMBV100A	Rohde & Schwarz	255092	481326	04.04.2019	04.2020
16	Signal Generator	SMHU 58	Rohde & Schwarz	844170/017	480266	28.02.2018	02.2020
17	Signal Generator	SMG	Rohde & Schwarz	833449/030	480013	07.03.2018	03.2020
18	Power divider	ZFSC-2-11	Mini-Circuits	-	410169	Calibration not necessary	
19	Zirculator	-	Dirk Fischer Elektronik	4	410165	Calibration not necessary	
20	Zirculator			2	410163		
21	Zirculator			3	410164		
22	Power divider	ZFSC-2-11	Mini-Circuits		410170	Calibration not necessary	
23	Highpass Filter	WHJS1000C11/60EF	Wainwright	1	480413	Calibration not necessary	

9 Report history

Report Number	Date	Comment
F190480E1	28.10.2019	Document created

10 List of annexes

Annex A	Photographs	12 pages
Annex B	Measurement results	26 pages
PT-19-0170, A1, Description of R60 TX Shutdown		2 pages