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Test Report

Report Number:

F161141E1

Equipment under Test (EUT):

**AIS Class B SO Transponder
WideLink B600**

Applicant:

ALLTEK MARINE ELECTRONICS CORP.

Manufacturer:

ALLTEK MARINE ELECTRONICS CORP.

REFERENCES

- [1] IEC 62287-2 Edition 1.0: 2013-03: Maritime navigation and radiocommunication equipment and systems - Class -B shipborne equipment of the automatic identification system (AIS) - Part 2: Self-organising time division multiple access (SOTDMA) techniques

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.

Test engineer:	Thomas KÜHN		22.07.2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		22.07.2016
	Name	Signature	Date

RESERVATION

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1 Identification

1.1 Applicant

Name:	ALLTEK MARINE ELECTRONICS CORP.
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Country:	Taiwan
Name for contact purposes:	Mr. Ken CHENG
Phone:	+88 62 86 91 85 68 - 323
eMail Address:	kencheng@alltekmarine.com
Applicant represented during the test by the following person:	Mr. Ken CHENG

1.2 Manufacturer

Name:	ALLTEK MARINE ELECTRONICS CORP.
Address:	14F-2, No. 237, Sec. 1, Datong Rd., Xizhi Dist. New Taipei City 22161
Country:	Taiwan
Name for contact purposes:	Mr. Ken CHENG
Phone:	+88 62 86 91 85 68 - 323
eMail Address:	kencheng@alltekmarine.com
Manufacturer represented during the test by the following person:	Mr. Ken CHENG

1.3 Test laboratory

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

1.4 EUT (Equipment Under Test)

Type: *	AIS Class B SO Transponder					
Type designation: *	WideLink B600					
Serial No.: *	A6K600004					
Alignment range: *	156.025 to 162.025 MHz					
Switching range: *	156.025 to 162.025 MHz					
Channel separation: *	25 kHz					
Rated RF output power: *	5 W / 37 dBm (high power) and 1 W / 30 dBm (low power)					
Supply Voltage: *	U _{nom} =	12.0 V DC	U _{min} =	9.6 V DC	U _{max} =	31.2 V DC
Printed circuit designation: *	M-PCB-B601MBV2; M-PCB-B601IOBV2; M-PCB-B601PWRV2; M-PCB-B601WFBV1					
Hardware version: *	V2					
Software version: *	V1.1.4.3 (the software will be changed to V1.1.5 for mass production)					
Temperature range: *	-15 °C to 55 °C					

*: Declared by the applicant

Ports/Connectors

Identification	Connector		Length
	EUT	Ancillary	
DC-power-supply	8-PIN-Connector	none	1 m
GPS-antenna	TNC	-	Not used during the test
VHF-antenna	SO-239	N-Connector	1 m
NMEA0183	12-PIN-Connector	D-Sub	1 m
USB	Mini-USB	USB	Not used during the test

1.5 Dates

Date of receipt of test sample:	18.07.2016
Start of test:	18.07.2016
End of test:	21.07.2016

2 Operational states

General:

Full tests were carried out at 156.025 MHz and 162.025 MHz (AIS) and 156.525 MHz (DSC).
The EUT was powered by an external DC power supply.

Wanted signal:

AIS-Mode:

The Test-Signals were generated either by a modulation source (supplied by the applicant, standard test signal 4) or by the AIS-Simulator "Attingimus" (standard test signal 3).

For the receiver-tests the output signal either of the modulation source or of the simulator was used to modulate a calibrated RF generator from PHOENIX TESTLAB. The received data telegrams were compared transmitted data telegrams.

A number of 200 packets (unless otherwise stated) were used to calculate the Packet Error Rate PER.

DSC-Mode:

The DSC test signal 1 was generated by the signal generator AFG320 from SONY-Tektronix.
A number of 100 packets (unless otherwise stated) were used to calculate the Bit Error Rate BER.

Test-signal overview:

Test-signal:	Bit pattern:
Standard test signal 1	01010101 (defined in subclause 8.4.1 [1])
Standard test signal 2	00001111 (defined in subclause 8.4.2 [1])
Standard test signal 3	Pseudo Random Bit Sequence (defined in subclause 8.4.3 [1])
Standard test signal 4	Pseudo Random Bit Sequence (defined in subclause 8.4.4 [1])
DSC test signal 1	010101 (dotting pattern, refer to ITU-R M.825-3) (defined in subclause A.3.1 [1])

Unwanted signal:

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

3 Additional information

The yellow wire visible on the test sample photographs is the trigger output, which will be used for several transmitter test cases. It will be not installed for mass production.

4 Test overview

Subclause	Test parameter	Remark	Test result	Refer page
11.1 [1]	TDMA Transmitter			
11.1.1 [1]	Frequency error	Applicable	Passed	8
11.1.2 [1]	Carrier power	Applicable	Passed	9 et seq.
11.1.3 [1]	Transmission spectrum	Applicable	Passed	11 et seq.
11.1.4 [1]	Modulation accuracy	Applicable	Passed	13 et seq.
11.1.5 [1]	Transmitter output power versus time function	Applicable	Passed	16 et seq.
11.2 [1]	TDMA Receiver			
11.2.1 [1]	Sensitivity	Applicable	Passed	19
11.2.2 [1]	Error behaviour at high input level	Applicable	Passed	20
11.2.3 [1]	Co-channel rejection	Applicable	Passed	21
11.2.4 [1]	Adjacent channel selectivity	Applicable	Passed	22
11.2.5 [1]	Spurious response rejection	Applicable	Passed	23 et seq.
11.2.6 [1]	Intermodulation response rejection	Applicable	Passed	25
11.2.7 [1]	Blocking or desensitisation	Applicable	Passed	26 et seq.
11.3 [1]	Conducted spurious emissions			
11.3.1 [1]	Spurious emissions from the receiver	Applicable	Passed	28
11.3.2 [1]	Spurious emissions from the transmitter	Applicable	Passed	29
A.5 [1]	DSC Receiver Tests			
A.5.2 [1]	Maximum sensitivity	Applicable	Passed	30
A.5.3 [1]	Error behaviour at high input levels	Applicable	Passed	31
A.5.4 [1]	Co-channel rejection	Applicable	Passed	32
A.5.5 [1]	Adjacent channel selectivity	Applicable	Passed	33
A.5.6 [1]	Spurious response rejection	Applicable	Passed	34
A.5.7 [1]	Intermodulation response rejection	Applicable	Passed	35
A.5.8 [1]	Blocking or desensitisation	Applicable	Passed	36

5 Transmitter Requirements

5.1 Frequency error

Subclause 11.1.1

Ambient temperature	23 °C	Relative humidity	60 %
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Operation mode: Continuous transmit on 156.025 MHz without modulation

Temperature	Voltage	Frequency	Frequency error
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	156.024936 MHz	-64 Hz
T _{min} (-15 °C)	U _{min} (9.6 V DC)	156.024856 MHz	-144 Hz
	U _{max} (31.2 V DC)	156.024856 MHz	-144 Hz
T _{max} (+55 °C)	U _{min} (9.6 V DC)	156.025008 MHz	+8 Hz
	U _{max} (31.2 V DC)	156.025008 MHz	+8 Hz
Maximum frequency error		- Hz / + Hz	
Measurement uncertainty		± 10 Hz	

Operation mode: Continuous transmit on 162.025 MHz without modulation

Temperature	Voltage	Frequency	Frequency error
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	162.024936 MHz	-64 Hz
T _{min} (-15 °C)	U _{min} (9.6 V DC)	162.024840 MHz	-160 Hz
	U _{max} (31.2 V DC)	162.024840 MHz	-160 Hz
T _{max} (+55 °C)	U _{min} (9.6 V DC)	162.025016 MHz	+16 Hz
	U _{max} (31.2 V DC)	162.025016 MHz	+16 Hz
Maximum frequency error		- Hz / + Hz	
Measurement uncertainty		± 10 Hz	

Limits: Subclause 11.1.1.3

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

Test equipment used (please refer clause 7 for details)

1, 7, 8, 12, 16

5.2 Carrier power (conducted)

Subclause 11.1.2

Ambient temperature	23 °C	Relative humidity	60 %
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Operation mode: Continuous transmit on 156.025 MHz without modulation, high power mode

Temperature	Voltage	Carrier power (Conducted)
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	36.2 dBm
T _{min} (-15 °C)	U _{min} (9.6 V DC)	36.5 dBm
	U _{max} (31.2 V DC)	36.6 dBm
T _{max} (+55 °C)	U _{min} (9.6 V DC)	35.9 dBm
	U _{max} (31.2 V DC)	35.8 dBm
Measurement uncertainty		+ 0.66 dB / - 0.72 dB

Operation mode: Continuous transmit on 162.025 MHz without modulation. high power mode

Temperature	Voltage	Carrier power (Conducted)
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	36.6 dBm
T _{min} (-15 °C)	U _{min} (9.6 V DC)	37.7 dBm
	U _{max} (31.2 V DC)	37.6 dBm
T _{max} (+55 °C)	U _{min} (9.6 V DC)	36.4 dBm
	U _{max} (31.2 V DC)	36.1 dBm
Measurement uncertainty		+ 0.66 dB / - 0.72 dB

Operation mode: Continuous transmit on 156.025 MHz without modulation, low power mode

Temperature	Voltage	Carrier power (Conducted)
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	31.0 dBm
T _{min} (-15 °C)	U _{min} (9.6 V DC)	29.3 dBm
	U _{max} (31.2 V DC)	29.1 dBm
T _{max} (+55 °C)	U _{min} (9.6 V DC)	30.1 dBm
	U _{max} (31.2 V DC)	30.1 dBm
Measurement uncertainty		+ 0.66 dB / - 0.72 dB

Operation mode: Continuous transmit on 162.025 MHz without modulation. low power mode

Temperature	Voltage	Carrier power (Conducted)
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	30.4 dBm
T _{min} (-15 °C)	U _{min} (9.6 V DC)	30.6 dBm
	U _{max} (31.2 V DC)	30.6 dBm
T _{max} (+55 °C)	U _{min} (9.6 V DC)	30.2 dBm
	U _{max} (31.2 V DC)	30.2 dBm
Measurement uncertainty		+ 0.66 dB / - 0.72 dB

Limits: Subclause 11.1.2.3

At all test frequencies, the carrier power shall be for high power 37 dBm $\pm$ 1,5 dBm and 30 dBm $\pm$ 1,5 dBm for low power under normal test conditions.
At all test frequencies, the carrier power shall be for high power 37 dBm $\pm$ 3,0 dBm and 30 dBm $\pm$ 3,0 dBm for low power under extreme test conditions.

Test equipment used (please refer clause 7 for details)

1, 7, 8, 12, 16

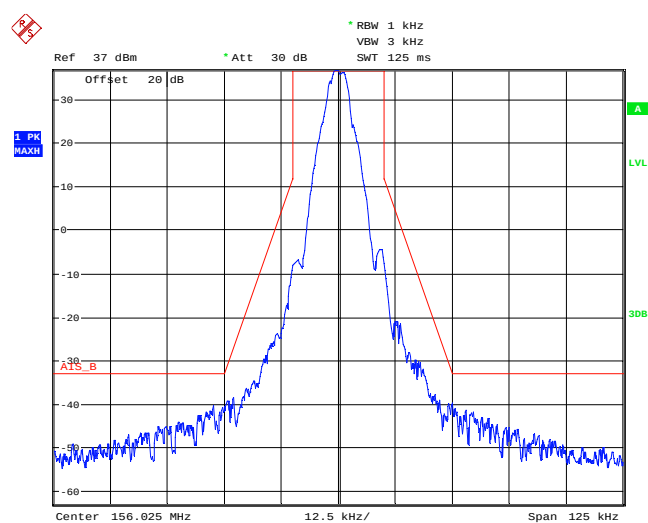
5.3 Transmission spectrum

Subclause 11.1.3

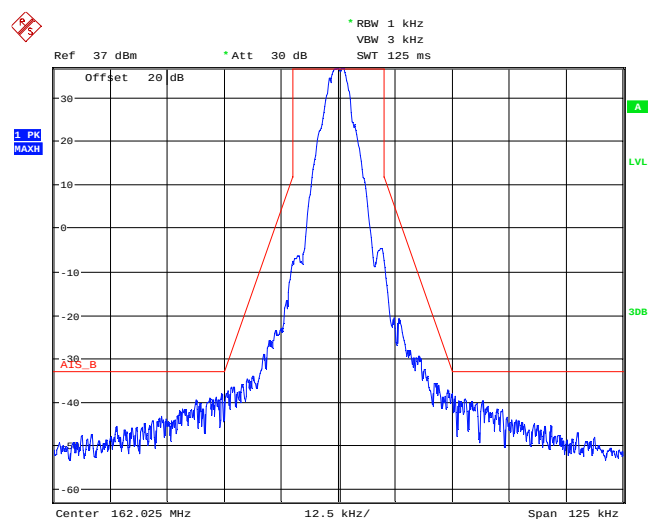
Ambient temperature	23 °C	Relative humidity	57 %
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Operation mode: Transmit in AIS-mode (test signal number 3) in high power mode

161141_008.wmf: Transmission spectrum, transmit on 156.025 MHz:



161141_009.wmf: Transmission spectrum, transmit on 162.025 MHz:



Limits: Subclause 11.1.3.3

The spectrum for slotted transmission shall be within the emission mask as follows:

- in the region between the carrier and ± 10 kHz removed from the carrier, the modulation and transient sidebands shall be below 0 dBc;
- at ± 10 kHz removed from the carrier, the modulation and transient sidebands shall be below -25 dBc;
- at ± 25 kHz to $\pm 62,5$ kHz removed from the carrier, the modulation and transient sidebands shall be below the lower value of -70 dBc;
- in the region between ± 10 kHz and ± 25 kHz removed from the carrier, the modulation and transient sidebands shall be below a line specified between these two points.

Test equipment used (please refer clause 7 for details)

1, 7, 12, 16

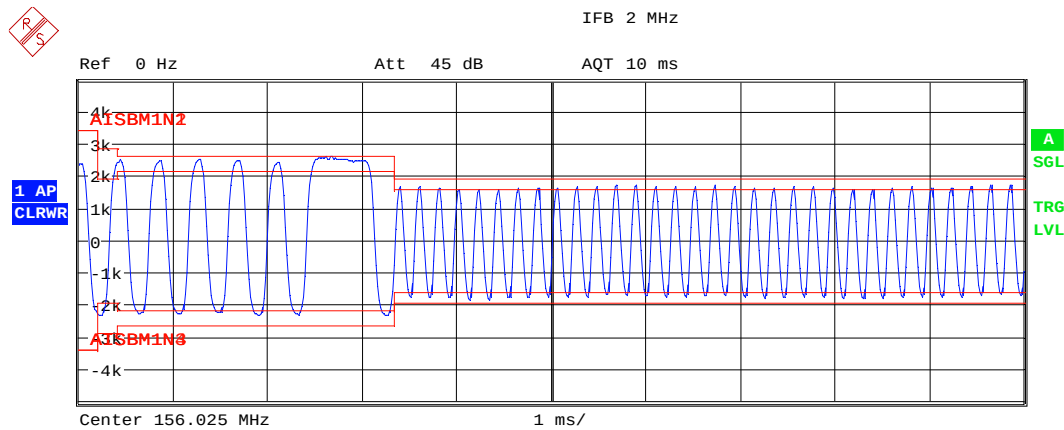
5.4 Modulation accuracy

Subclause 11.1.4

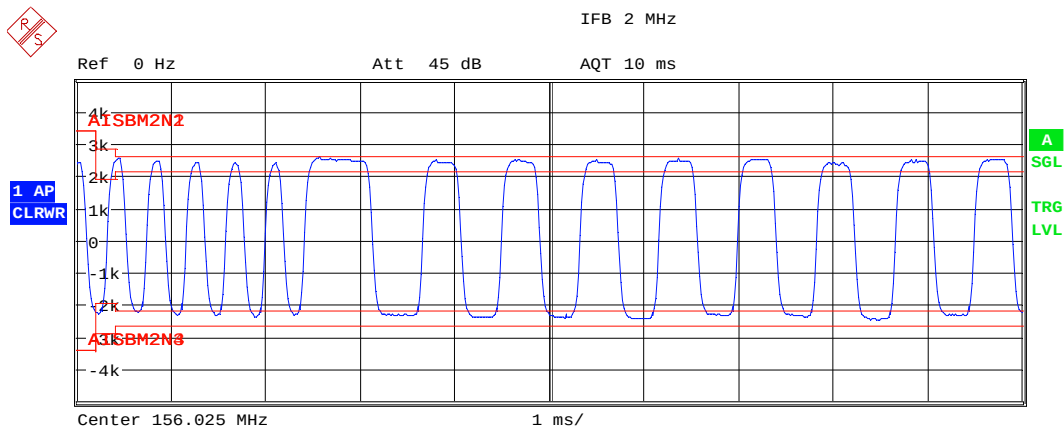
Ambient temperature	23 °C	Relative humidity	60 %
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Operation mode: Transmit in AIS-mode (test signal number 1 and 2)

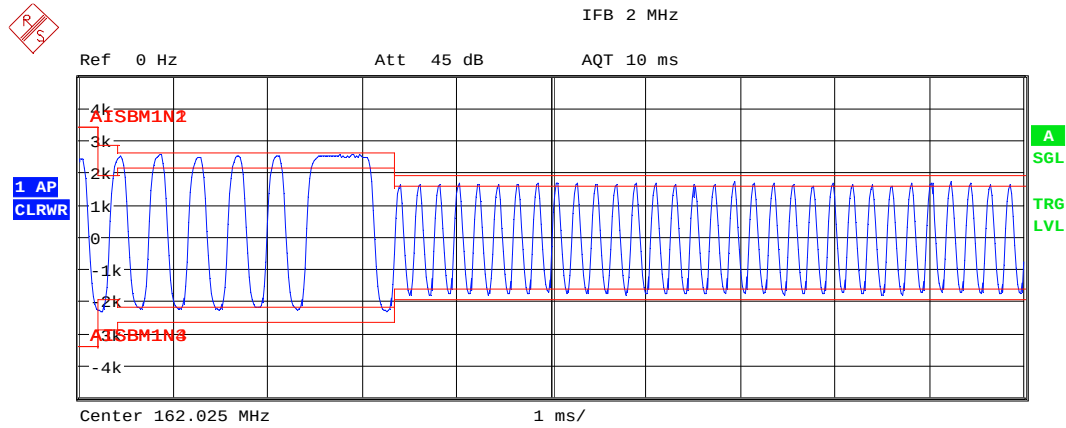
161141_039.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 1:



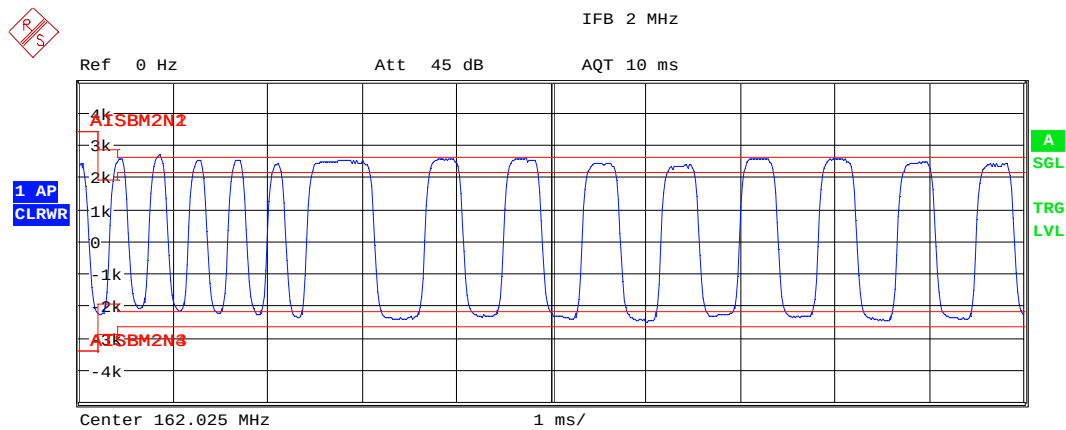
161141_040.wmf: Modulation accuracy, transmit on 156.025 MHz with test signal 2:



161141_042.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 1:



161141_041.wmf: Modulation accuracy, transmit on 162.025 MHz with test signal 2:



Additional Information:

The measurement results for the modulation accuracy under extreme conditions are documented in Annex B of this test report.

Limits: Subclause 11.1.4.3

Peak frequency deviation at various points within the data frame shall comply with Table 12. These limits apply to both the positive and negative modulation peaks. Bit 0 is defined as the first bit of the training sequence.

Measurement period from centre to centre of each bit	Test signal 1		Test signal 2	
	Normal	Extreme	Normal	Extreme
Ramp up	<3 400 Hz			
Bit 0 to bit 1	<3 400 Hz			
Bit 2 to bit 3	2 400 ± 480 Hz			
Bit 4 to bit 31	2 400 ± 240 Hz	2 400 ± 480 Hz	2 400 ± 240 Hz	2 400 ± 480 Hz
Bit 32 to bit 199	1 740 ± 175 Hz	1 740 ± 350 Hz	2 400 ± 240 Hz	2 400 ± 480 Hz

Test equipment used (please refer clause 7 for details)

1, 7, 8, 12, 16

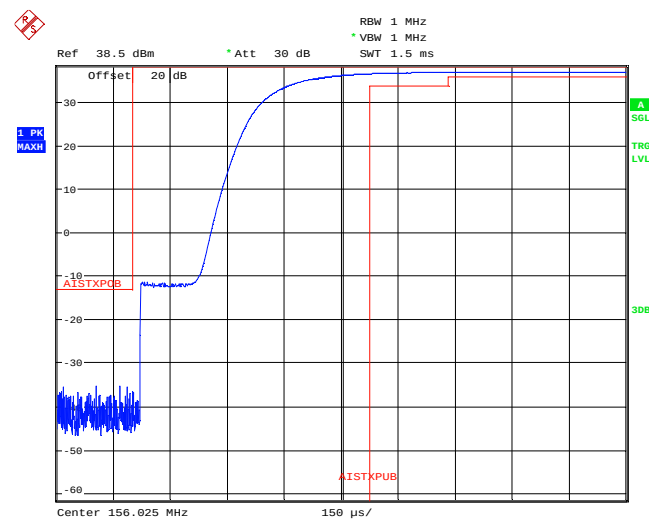
5.5 Transmitter output power versus time function

Subclause 11.1.5

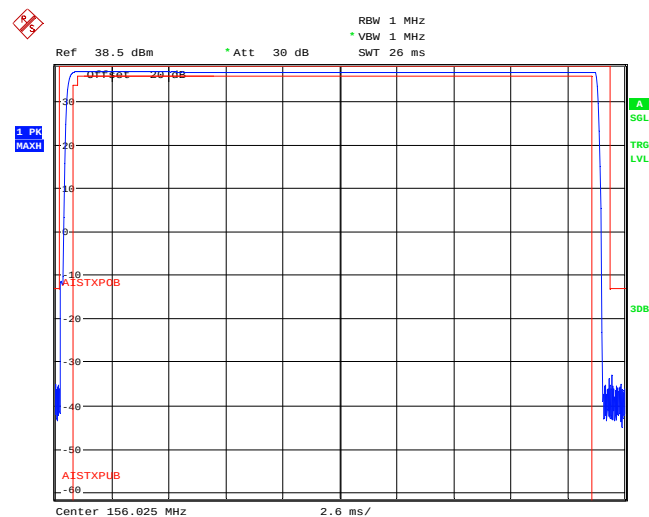
Ambient temperature	23 °C	Relative humidity	57 %
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Operation mode: Transmit in AIS-mode (test signal number 2) in high power mode

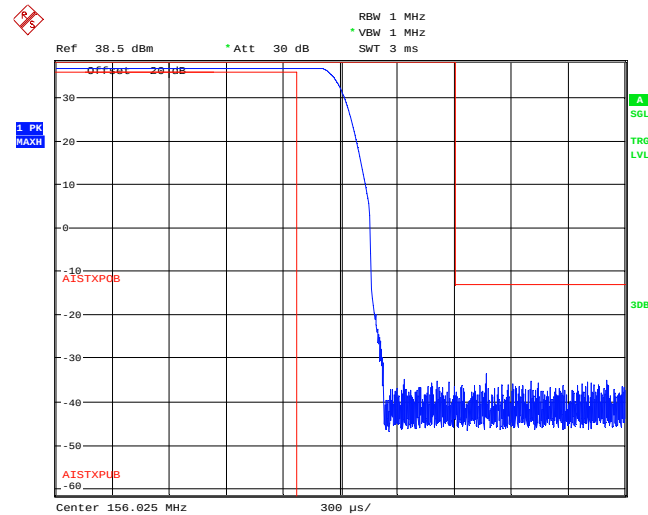
161141_015_.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz:



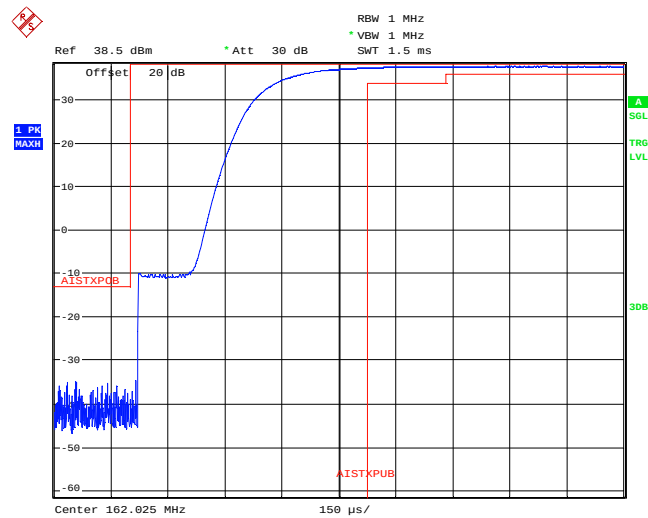
161141_014_.wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz:



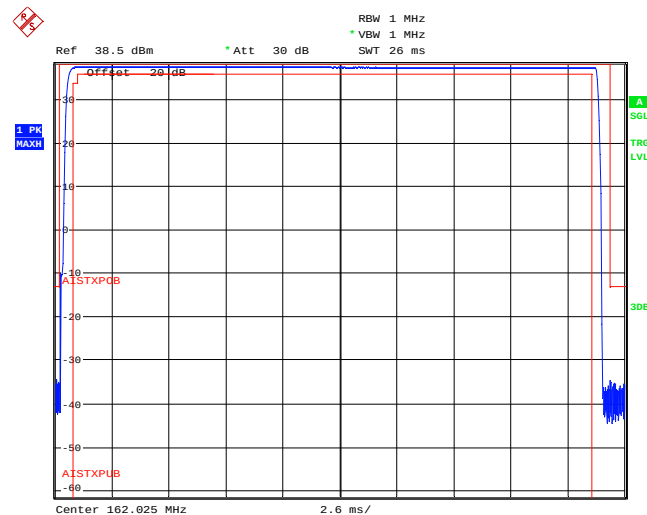
161141_013 .wmf: Transmitter power versus time characteristics, transmit on 156.025 MHz:



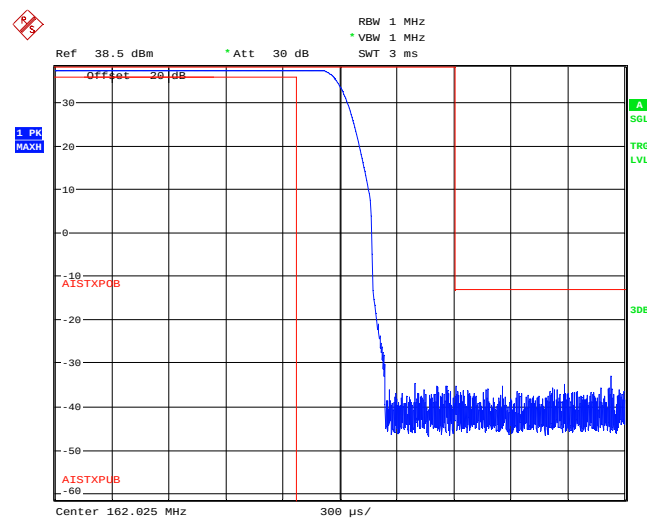
161141_010 .wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz:



161141_011.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz:



161141_012.wmf: Transmitter power versus time characteristics, transmit on 162.025 MHz:



Limits: Subclause 11.1.5.3

The transmitter power shall remain within the mask shown in Figure 2 [1] and associated timings given in Table 7 [1].

Test equipment used (please refer clause 7 for details)

1, 7, 12, 16

6 Receiver requirements

6.1 TDMA receiver sensitivity

Subclause 11.2.1

Ambient temperature	23 °C	Relative humidity	54 %
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Operation mode: Receive on 156.025 MHz ((-107 dBm/-104 dBm (normal) and -101 dBm (extreme) conditions)

Temperature	Voltage	Frequency	Packet Error Rate
T _{nom} (+ 20 °C)	U _{nom} (12.0 V DC)	156.0245 MHz	0.0 %
		156.025 MHz	0.0 %
		156.0255 MHz	0.0 %
T _{min} (-15 °C)	U _{min} (9.6 V DC)	156.025 MHz	0.0 %
	U _{max} (31.2 V DC)	156.025 MHz	0.0 %
T _{max} (+55 °C)	U _{min} (9.6 V DC)	156.025 MHz	0.0 %
	U _{max} (31.2 V DC)	156.025 MHz	1.4 %
Measurement uncertainty		+ 0.9 dB / - 1.0 dB	

Operation mode: Receive on 162.025 MHz (-107 dBm/-104 dBm (normal) and -101 dBm (extreme) conditions)

Temperature	Temperature	Frequency	Packet Error Rate
T _{nom} (+ 20 °C)	U _{nom} (12.0 V DC)	162.0245 MHz	0.0 %
		162.025 MHz	0.4 %
		162.0255 MHz	0.0 %
T _{min} (-15 °C)	U _{min} (9.6 V DC)	162.025 MHz	0.0 %
	U _{max} (31.2 V DC)	162.025 MHz	0.0 %
T _{max} (+55 °C)	U _{min} (9.6 V DC)	162.025 MHz	0.0 %
	U _{max} (31.2 V DC)	162.025 MHz	0.0 %
Measurement uncertainty		+ 0.9 dB / - 1.0 dB	

Limits: Subclause 11.2.1.3

The PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

4, 7, 16

6.2 TDMA receiver error behaviour at high input levels

Subclause 11.2.2

Ambient temperature	23 °C	Relative humidity	54 %
---------------------	-------	-------------------	------

Operation mode: Receive in AIS-mode on 156.025 MHz

RF-input signal level	Packet Error Rate
-77 dBm	0.0 %
-7 dBm	0.4 %
Measurement uncertainty	+ 0.9 dB / - 1.0 dB

Operation mode: Receive in AIS-mode on 162.025 MHz

RF-input signal level	Packet Error Rate
-77 dBm	0.0 %
-7 dBm	0.0 %
Measurement uncertainty	+ 0.9 dB / - 1.0 dB

Limits: Subclause 11.2.2.3

The maximum PER shall not exceed 2 % at -77 dBm and 10 % at -7 dBm.

Test equipment used (please refer clause 7 for details)

4, 7, 16

6.3 TDMA receiver co-channel rejection

Subclause 11.2.3

Ambient temperature	23 °C
---------------------	-------

Relative humidity	54 %
-------------------	------

Operation mode: Receive in AIS-mode on 156.025 MHz
Wanted signal: P = -101 dBm

Unwanted signal frequency	Unwanted signal level	Signal ratio	Packet error rate
156.024 MHz	-111 dBm	10 dB	15.1 %
156.025 MHz	-111 dBm	10 dB	12.9 %
156.026 MHz	-111 dBm	10 dB	14.7 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Operation mode: Receive in AIS-mode on 162.025 MHz

Unwanted signal frequency	Unwanted signal level	Signal ratio	Packet error rate
162.024 MHz	-111 dBm	10 dB	8.9 %
162.025 MHz	-111 dBm	10 dB	10.2 %
162.026 MHz	-111 dBm	10 dB	11.1 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Limits: Subclause 11.2.3.3

The maximum PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

2, 4, 5, 7, 16, 18

6.4 TDMA receiver adjacent channel selectivity

Subclause 11.2.4

Ambient temperature	23 °C
---------------------	-------

Relative humidity	54 %
-------------------	------

Operation mode: Receive in AIS mode
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Modulated with 400 Hz / 3 kHz deviation, P = -31 dBm

Wanted signal	Unwanted signal	Signal Ratio	Packet error rate
156.025 MHz	156.000 MHz	70 dB	12.4 %
	156.050 MHz	70 dB	13.3 %
162.025 MHz	162.000 MHz	70 dB	1.8 %
	162.050 MHz	70 dB	0.0 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Limits: Subclause 11.2.4.3

The maximum PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

2, 4, 5, 7, 16

6.5 TDMA receiver spurious response rejection

Subclause 11.2.5

Ambient temperature	23 °C	Relative humidity	54 %
---------------------	-------	-------------------	------

Operation mode: Receive in AIS-mode on 156.025 MHz (1st LO-Freq. = 134.625 MHz)
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Modulated with 400 Hz / 3 kHz deviation, P = -27 dBm

Definition	Unwanted frequency	Packet Error Rate
1 st IF	21.4 MHz	0.0 %
1 st LO-Freq. - IF	113.225 MHz	0.0 %
2 x 1 st LO-Freq. – IF	247.850 MHz	0.0 %
2 x 1 st LO-Freq. + IF	290.650 MHz	1.3 %
3 x 1 st LO-Freq. – IF	382.475 MHz	1.8 %
3 x 1 st LO-Freq. + IF	425.275 MHz	0.9 %
4 x 1 st LO-Freq. – IF	517.100 MHz	0.0 %
4 x 1 st LO-Freq. + IF	599.900 MHz	2.7 %
-	No other spurious response rejection frequencies found.	-
-		-
-		-
Measurement uncertainty		+ 0.8 dB / - 0.9 dB

Remark:

An additional frequency sweep of the unwanted signal generator was carried out to make sure that there are no other unwanted frequencies not calculated according to the table above.

Continued next page:

Continued:

Operation mode: Receive in AIS-mode on 162.025 MHz (1st LO-Freq. = 140.625 MHz)
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Modulated with 400 Hz / 3 kHz deviation, P = -27 dBm

Definition	Unwanted frequency	Packet Error Rate
1 st IF	21.4 MHz	1.3 %
1 st LO-Freq. - IF	119.225 MHz	0.0 %
2 x 1 st LO-Freq. – IF	259.850 MHz	0.9 %
2 x 1 st LO-Freq. + IF	302.650 MHz	0.0 %
3 x 1 st LO-Freq. – IF	400.475 MHz	0.0 %
3 x 1 st LO-Freq. + IF	443.275 MHz	0.0 %
4 x 1 st LO-Freq. – IF	541.100 MHz	0.0 %
4 x 1 st LO-Freq. + IF	583.900 MHz	0.4 %
-	No other spurious response rejection frequencies found.	-
-		-
-		-
Measurement uncertainty		+ 0.8 dB / - 0.9 dB

Remark:

An additional frequency sweep of the unwanted signal generator was carried out to make sure that there are no other unwanted frequencies not calculated according to the table above.

Limits: Subclause 11.2.5.6

At any frequency separated from the specified frequency of the receiver by 50 kHz or more, the PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

2, 4, 5, 7, 16

6.6 TDMA receiver intermodulation response rejection

Subclause 11.2.6

Ambient temperature	23 °C	Relative humidity	54 %
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Operation mode: Receive in AIS-mode on 162.025 MHz
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Unmodulated, P = -36 dBm
 Unwanted signal C: Modulated with 400 Hz / 3 kHz-deviation, P = -36 dBm

Frequencies of the signals			Packet Error Rate
Generator A	Generator B	Generator C	
162.025 MHz	162.075 MHz	162.125 MHz	15.6 %
	161.975 MHz	161.925 MHz	10.7 %
Measurement uncertainty			+ 0.8 dB / - 0.9 dB

Operation mode: Receive in AIS-mode on 156.025 MHz
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Unmodulated, P = -36 dBm
 Unwanted signal C: Modulated with 400 Hz / 3 kHz-deviation, P = -36 dBm

Frequencies of the signals			Packet Error Rate
Generator A	Generator B	Generator C	
156.025 MHz	156.075 MHz	156.125 MHz	9.8 %
	155.975 MHz	155.925 MHz	10.2 %
Measurement uncertainty			+ 0.8 dB / - 0.9 dB

Limits: Subclause 11.2.6.3

The PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

2 - 7, 13 - 16

6.7 TDMA receiver blocking or desensitisation

Subclause 11.2.7

Ambient temperature	22 °C
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Relative humidity	57 %
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Operation mode: Receive in AIS-mode on 156.025 MHz
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Unmodulated, P = -23 dBm / -15 dBm*

Frequencies of the unwanted signal		Packet Error Rate
-10 MHz	146.025 MHz*	0.0 %
-5 MHz	151.025 MHz*	0.0 %
-2 MHz	154.025 MHz	0.0 %
-1 MHz	155.025 MHz	0.4 %
-500 kHz	155.525 MHz	0.0 %
+500 kHz	156.525 MHz	0.9 %
+1 MHz	157.025 MHz	0.0 %
+2 MHz	158.025 MHz	1.3 %
+5 MHz	161.025 MHz*	3.6 %
+10 MHz	166.025 MHz*	0.0 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB

Operation mode: Receive in AIS-mode on 162.025 MHz
 Wanted signal A: P = -101 dBm
 Unwanted signal B: Unmodulated, P = -23 dBm / -15 dBm*

Frequencies of the unwanted signal		Packet Error Rate
-10 MHz	152.025 MHz*	6.3 %
-5 MHz	157.025 MHz*	8.4 %
-2 MHz	160.025 MHz	0.0 %
-1 MHz	161.025 MHz	0.0 %
-500 kHz	161.525 MHz	0.4 %
+500 kHz	162.525 MHz	0.0 %
+1 MHz	163.025 MHz	0.4 %
+2 MHz	164.025 MHz	0.0 %
+5 MHz	167.025 MHz*	7.1 %
+10 MHz	172.025 MHz*	8.9 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB

Limits: Subclause 11.2.7.3

The PER shall not exceed 20 %.

Test equipment used (please refer clause 7 for details)

2, 4, 5, 7, 16

6.8 Spurious emissions from the receiver

Subclause 11.3.1

Ambient temperature	22 °C
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Relative humidity	57 %
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Operation mode: Receiver 1: f = 156.025 MHz, AIS-mode
Receiver 2: f = 162.025 MHz, AIS-mode

Spurious emissions level			
Frequency	Measured level	Limit	Margin
100 kHz	-75.0 dBm	-57.0 dBm	18.0 dB
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
Measurement uncertainty		+0.66 dB / -0.72 dB	

Limits: Subclause 11.3.1.3

Frequency range	9 kHz to 1 GHz	1 GHz to 4 GHz
Rx operating	2 nW (- 57 dBm)	20 nW (- 47 dBm)

Test equipment used (please refer clause 7 for details)

1, 7, 11, 12, 16

6.9 Spurious emissions from the transmitter

Subclause 11.3.2

Ambient temperature	23 °C	Relative humidity	60 %
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Operation mode: Continuous transmission

Spurious emissions level (Conducted, transmitter operates on 156.025 MHz)					
f	Level	Bandwidth	Limit	Margin	Result
180.715 kHz	-41.3 dBm	30 kHz	-36.0 dBm	5.3 dB	Passed
15.000 MHz	-57.6 dBm	10 kHz	-36.0 dBm	21.6 dB	Passed
155.506 MHz	-36.8 dBm	10 kHz	-36.0 dBm	0.8 dB	Passed
155.729 MHz	-47.7 dBm	10 kHz	-36.0 dBm	11.7 dB	Passed
156.545 MHz	-37.4 dBm	10 kHz	-36.0 dBm	1.4 dB	Passed
162.052 MHz	-43.2 dBm	10 kHz	-36.0 dBm	7.2 dB	Passed
165.000 MHz	-47.2 dBm	10 kHz	-36.0 dBm	11.1 dB	Passed
171.024 MHz	-47.2 dBm	10 kHz	-36.0 dBm	11.1 dB	Passed
312.050 MHz	-45.5 dBm	100 kHz	-36.0 dBm	9.5 dB	Passed
468.075 MHz	-56.6 dBm	100 kHz	-36.0 dBm	19.4 dB	Passed
Spurious emissions level (Conducted, transmitter operates on 162.025 MHz)					
f	Level	Bandwidth	Limit	Margin	Result
180.715 kHz	-41.3 dBm	30 kHz	-36.0 dBm	5.3 dB	Passed
15.000 MHz	-62.2 dBm	10 kHz	-36.0 dBm	26.2 dB	Passed
27.400 MHz	-61.8 dBm	10 kHz	-36.0 dBm	25.8 dB	Passed
155.581 MHz	-40.8 dBm	100 kHz	-36.0 dBm	4.8 dB	Passed
159.045 MHz	-44.1 dBm	100 kHz	-36.0 dBm	8.1 dB	Passed
161.507 MHz	-37.6 dBm	10 kHz	-36.0 dBm	1.6 dB	Passed
161.729 MHz	-46.4 MHz	10 kHz	-36.0 dBm	10.4 dB	Passed
162.323 MHz	-51.9 MHz	10 kHz	-36.0 dBm	15.9 dB	Passed
162.545 MHz	-38.1 dBm	10 kHz	-36.0 dBm	2.1 dB	Passed
177.026 MHz	-50.9 dBm	30 kHz	-36.0 dBm	14.9 dB	Passed
324.050 MHz	-46.1 dBm	100 kHz	-36.0 dBm	10.1 dB	Passed
486.075 MHz	-56.6 dBm	100 kHz	-36.0 dBm	20.6 dB	Passed
Measurement uncertainty		+ 0.66 dB / - 0.72 dB			

Limits: Subclause 11.3.2.3

Frequency range	150 kHz to 1 GHz	1 to 4 GHz
TX operating	0.25 µW (- 36 dBm)	1 µW (- 30 dBm)

Test equipment used (please refer clause 7 for details)

1, 7, 9, 10, 12, 16

6.10 DSC receiver maximum Sensitivity

Subclause A 5.2

Ambient temperature	22 °C	Relative humidity	57 %
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Operation mode: Receive on 156.525 MHz (-107 dBm (normal) / -101 dBm (extreme) conditions)
 Wanted signal: Test-signal 1 (0101010...)

Temperature	Voltage	DSC-Frequency	Bit Error Rate
T _{nom} (+20 °C)	U _{nom} (12.0 V DC)	156.523500 MHz	0.0 %
		156.525000 MHz	0.0 %
		156.526500 MHz	0.0 %
T _{min} (-15 °C)	U _{min} (9.6 V DC)	156.525000 MHz	0.0 %
	U _{max} (31.2 V DC)	156.525000 MHz	0.0 %
T _{max} (55 °C)	U _{min} (9.6 V DC)	156.525000 MHz	0.0 %
	U _{max} (31.2 V DC)	156.525000 MHz	0.0 %
Measurement uncertainty		+ 0.66 dB / - 0.72 dB	

Limits: Subclause A 5.2.3

The BER shall not exceed 1 % in all cases.
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Test equipment used (please refer clause 7 for details)

2, 7, 16, 17

6.11 DSC receiver error behaviour at high input levels

Subclause A 5.3

Ambient temperature	22 °C
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Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz

Wanted signal: Test-signal 1 (0101010...)

RF-input signal level	Bit Error Rate
-7 dBm	0.0 %

Limits: Subclause A 5.3.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2, 7, 16, 17

6.12 DSC receiver co-channel rejection

Subclause A 5.4

Ambient temperature	22 °C
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Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz
 Wanted signal A: Test-signal 1 (0101010...), P = -104 dBm
 Unwanted signal B: Modulated with 400 Hz / 3 kHz deviation

Unwanted signal frequency	Unwanted signal level	Signal ratio	Bit Error Rate
156.522 MHz	-114 dBm	-10 dB	0.0 %
156.525 MHz	-114 dBm	-10 dB	0.0 %
156.528 MHz	-114 dBm	-10 dB	0.0 %
Measurement uncertainty		+ 0.8 dB / - 0.9 dB	

Limits: Subclause A 5.4.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2, 3, 5, 7, 16, 17

6.13 DSC receiver adjacent channel sensitivity

Subclause A 5.5

Ambient temperature	22 °C	Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz
 Wanted signal A: Test-signal 1, P = - 104 dBm
 Unwanted signal B: f = 156.500 MHz, modulated with 400 Hz and a deviation of 3 kHz.

Temperature	Voltage	Unwanted signal level	Bit Error Rate
T _{nom} (+ 20 °C)	U _{nom} (12.0 V DC)	-34 dBm	0.0 %
Measurement uncertainty		±0.1%	

Operation mode: Receive in DSC-mode on 156.525 MHz
 Wanted signal A: Test-signal 1, P = - 104 dBm
 Unwanted signal B: f = 156.550 MHz, modulated with 400 Hz and a deviation of 3 kHz.

Temperature	Voltage	Unwanted signal level	Bit Error Rate
T _{nom} (+ 20 °C)	U _{nom} (12.0 V DC)	-34 dBm	0.0 %
Measurement uncertainty		±0.1%	

Limits: Subclause A 5.5.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2, 3, 5, 7, 16, 17

6.14 DSC receiver spurious response rejection

Subclause A 5.6

Ambient temperature	22 °C	Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz (1st LO-Freq. = 135.125 MHz)

Wanted signal A: Test-signal 1, P = -104 dBm

Unwanted signal B: Unmodulated, P = -34 dBm

Definition	Unwanted frequency	Bit Error Rate
1 st IF (Receiver A)	21.400 MHz	0.0 %
1 st LO-Freq. - IF	113.725 MHz	0.0 %
2 x 1 st LO-Freq. - IF	248.850 MHz	0.0 %
2 x 1 st LO-Freq. + IF	291.650 MHz	0.0 %
3 x 1 st LO-Freq. - IF	383.975 MHz	0.0 %
3 x 1 st LO-Freq. + IF	426.775 MHz	0.0 %
4 x 1 st LO-Freq. - IF	519.100 MHz	0.0 %
4 x 1 st LO-Freq. + IF	561.900 MHz	0.0 %
-	No other spurious response rejection frequencies found.	
-		
Measurement uncertainty		±0.1%

Remark:

An additional frequency sweep of the unwanted signal generator was carried out to make sure that there are no other unwanted frequencies not calculated according to the table above.

Limits: Subclause A 5.6.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2, 3, 5, 7, 16, 17

6.15 DSC receiver intermodulation response rejection

Subclause A 5.7

Ambient temperature	22 °C	Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz
 Wanted signal A: P = -104 dBm
 Unwanted signal B: Unmodulated, P = -39 dBm
 Unwanted signal C: Modulated with 400 Hz / 3 kHz-deviation, P = -39 dBm

Frequencies of the signals			Bit Error Rate
Generator A	Generator B	Generator C	
156.525 MHz	156.475 MHz	156.425 MHz	0.0 %
	156.575 MHz	156.625 MHz	0.0 %
Measurement uncertainty			±0.1 %

Limits: Subclause A 5.7.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2 - 7, 13 - 16, 17

6.16 DSC receiver blocking or desensitisation

Subclause A 5.8

Ambient temperature	22 °C
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Relative humidity	57 %
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Operation mode: Receive in DSC-mode on 156.525 MHz
 Wanted signal A: P = -104 dBm
 Unwanted signal B: Unmodulated, P = -20 dBm

Frequencies of the unwanted signal		Bit Error Rate
-10 MHz	146.525 MHz	0.0 %
-5 MHz	151.525 MHz	0.0 %
-2 MHz	154.525 MHz	0.0 %
-1 MHz	155.525 MHz	0.0 %
+1 MHz	157.525 MHz	0.0 %
+2 MHz	158.525 MHz	0.0 %
+5 MHz	161.525 MHz	0.77 %
+10 MHz	166.525 MHz	0.0 %
Measurement uncertainty		±0.1 %

Limits: Subclause A 5.8.3

The BER shall not exceed 1 %.

Test equipment used (please refer clause 7 for details)

2, 3, 5, 7, 16, 17

7 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Spectrum analyser	FSU 46	Rohde & Schwarz	200125	480956	17.02.2016	02.2017
2	Signal generator	SMHU 58	Rohde & Schwarz	844170/017	480266	19.02.2016	02.2018
3	Signal generator	CMTA 54	Rohde & Schwarz	841904/011	480169	05.01.2016	01.2018
4	Signal generator	SMBV100A	Rohde & Schwarz	255092	481326	10.03.2015	03.2017
5	Combiner	ZFSC-2-11	Mini Circuits	-	410089	Annual verification	
6	Combiner	ZFSC-2-11	Mini Circuits	-	410090	Annual verification	
7	Power supply	TOE8852	Toellner	51712	480233	Not necessary	
8	Climatic chamber	MK 240	Binder	05-79022	480462	19.08.2015	02.2017
9	Tunable notch filter	WTRCD5-150-165-0.05-0.61-40EEK	Wainwright Instruments	1	481810	Weekly verification	
10	High pass filter	WHJ9-167-200-2000-60EF	Wainwright Instruments	1	481811	Annual verification	
11	Attenuator / 10 dB / 10 W	WA8 / 18-20-34	Weinschel	-	481451	Annual verification	
12	Attenuator / 20 dB / 10 W	WA8 / 18-20-34	Weinschel	-	481450	Annual verification	
13	Zirkulator	156-162MHz	DFE	-	410162	Annual verification	
14	Zirkulator	156-162MHz	DFE	-	410164	Annual verification	
15	Zirkulator	156-162MHz	DFE	-	410165	Annual verification	
16	Multimeter	971A	Hewlett Packard	JP39009358	480721	19.01.2016	01.2017
17	Function generator	AFG320	Tektronix	J313349	480405	12.06.2015	06.2017
18	AIS Test Unit	MK II	Attingimus	AA06PA	481422	18.01.2016	01.2018

8 Report history

Report Number	Date	Comment
F161141E1	22.07.2016	Document created

9 List of annexes

Annex A Photographs 19 pages

Test setup photographs

161141_a.jpg: WideLink B600, test setup temperature chamber

External photographs of the test sample

161141_1.jpg: WideLink B600, 3D-view 1

161141_2.jpg: WideLink B600, 3D-view 2

161141_3.jpg: WideLink B600, connector view 1

161141_4.jpg: WideLink B600, connector view 2

161141_6.jpg: WideLink B600, type plate view

Internal photographs of the test sample

161141_7.jpg: WideLink B600, internal view

161141_8.jpg: WideLink B600, internal view, PCB 1 removed

161141_12.jpg: WideLink B600, PCB 1, top view

161141_13.jpg: WideLink B600, PCB 1, bottom view

161141_9.jpg: WideLink B600, internal view, PCB 2 removed

161141_14.jpg: WideLink B600, PCB 2, top view

161141_15.jpg: WideLink B600, PCB 1, bottom view

161141_11.jpg: WideLink B600, internal view, shielding removed

161141_16.jpg: WideLink B600, PCB 3, top view

161141_17.jpg: WideLink B600, PCB 3, bottom view

161141_18.jpg: WideLink B600, PCB 3, top view

161141_19.jpg: WideLink B600, PCB 3, bottom view

161141_10.jpg: WideLink B600, detail view to WIFI antenna

Annex B Measurement results 26 pages

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