PHOENIX TESTLAB

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# TEST REPORT

**on**

**IEC 62287-1 Edition 2**

**Maritime navigation and radiocommunication equipment and systems**
**Class B shipborne equipment of the automatic identification system (AIS)**
**Part 1: Carrier sense time division multiple access (CSTDMA) techniques**

**Test Report Reference: F130840E1**

**Equipment under Test:**

**CAMINO-108 / CAMINO-108W**

**Serial Number: -**

**Applicant: Alltek Marine Electronics Corp.**

**Manufacturer: Alltek Marine Electronics Corp.**

# 1 IDENTIFICATION

## 1.1 APPLICANT

| | |
|---|---|
| Name: | Alltek Marine Electronics Corp. |
| Address: | 7F, No. 605, Ruei Guang Rd., Neihu<br>11492 Taipei |
| Country: | Taiwan |
| Name for contact purposes: | Mr. Leslie Yang |
| Tel: | +886-2-2627-1599 |
| Fax: | +886-2-2627-1600 |
| e-mail address: | leslieyang@alltekmarine.com |

## 1.2 MANUFACTURER

| | |
|---|---|
| Name: | Alltek Marine Electronics Corp. |
| Address: | 7F, No. 605, Ruei Guang Rd., Neihu<br>11492 Taipei |
| Country: | Taiwan |
| Name for contact purposes: | Mr. Leslie Yang |
| Tel: | +886-2-2627-1599 |
| Fax: | +886-2-2627-1600 |
| e-mail address: | leslieyang@alltekmarine.com |

## 1.3 DATES

| | |
|---|---|
| Date of Receipt of Test Sample: | 28 February 2013 |
| Start of test: | 28 February 2013 |
| Finish of test: | 23 August 2013 |

## 1.4 TEST LABORATORY

The tests were carried out at: **PHOENIX TESTLAB GmbH**
**Königswinkel 10**
**D-32825 Blomberg** **Tel: +49 (0) 52 35 / 95 00-0**
**Germany** **Fax: +49 (0) 52 35 / 95 00-10**

| | Name | Signature | Date |
|---|---|---|---|
| Test engineer: | Raimund BLASK |  | 13 Sept. 2013 |
| Authorized reviewer: | Bernd STEINER |  | 16 Sept. 2013 |

## 1.5 RESERVATION

This test report is only valid in the original form.

Any reproduction of it's contents without written permission of the accredited test laboratory PHOENIX TEST-LAB GmbH is prohibited.

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

## 1.6 REFERENCES

[1] IEC 62287-1 Edition 2
Maritime navigation and radiocommunication equipment and systems
Class B shipborne equipment of the automatic identification system (AIS)
Part 1: Carrier sense time division multiple access (CSTDMA) techniques

# 2 TECHNICAL DATA OF EQUIPMENT

| | |
|---|---|
| Type: | AIS Class B Transponder |
| Type designation: | CAMINO-108 / CAMINO-108W<br>(where “W” is the option for “Wi-Fi”-Version as declared by the applicant) |
| Serial No.: | - |
| Alignment range: | 156.025 to 162.025 MHz |
| Switching range: | 156.025 to 162.025 MHz |
| Channel separation: | 25 kHz |
| Rated RF output power: | 2 W / 33 dBm |
| 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-B108MBV1 |
| Software: | V1.2.6 |

Ports/Connectors

| Identification | Connector | | Length |
|---|---|---|---|
| | EUT | Ancillary | |
| DC-power-supply | DC-Plug | none | 1 m |
| GPS-antenna | TNC | - | 3 m |
| VHF-antenna | SO-239 | N-Connector | 3 m |
| NMEA0183 | 12-PIN-Connector | D-Sub | 3 m |
| USB | Mini-USB | USB | 1 m |

**Test Report History:**

| Test Report Number: | Date of issue: | Report Status: |
|---|---|---|
| F130840E1 | 10 September 2013 | First issue |
| - | - | - |

# 3 ADDITIONAL INFORMATION

**General:**
Full tests were carried out at 156.025 MHz and 162.025 MHz.
The EUT was powered by an external DC-Power-Supply.

**Wanted signal:**

**AIS-Mode:**
The Test-Signals were generated by the AIS-Simulator “Attingimus”.
For the Receiver-Tests the Output-Signal 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 Test-Signals 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: | Mode: | Bit pattern: |
|---|---|---|
| 1 | DSC | 010101 (dotting pattern, refer to ITU-R M.825-3 |
| 2 | AIS | 01010101 (defined in part 8.3.2) |
| 3 | AIS | 00001111 (defined in part 8.3.3) |
| 4 | AIS | Pseudo Random Bit Sequence (defined in part 8.3.4) |
| 5 | AIS | Pseudo Random Bit Sequence (defined in part 8.3.5) |

**Unwanted signal:**
All unwanted-signals were generated by the RF-Generators from Phoenix Test-Lab.

# 4 TEST OVERVIEW

| Part 11 | PHYSICAL TESTS | | |
|---|---|---|---|
| **11.1** | **TDMA Transmitter** | | |
| 11.1.1 | Frequency error | Applicable | passed |
| 11.1.2 | Carrier power | Applicable | passed |
| 11.1.3 | Transmission spectrum | Applicable | passed |
| 11.1.4 | Modulation accuracy | Applicable | passed |
| 11.1.5 | Transmitter output power versus time function | Applicable | passed |
| **11.2** | **TDMA Receiver** | | |
| 11.2.1 | Sensitivity | Applicable | passed |
| 11.2.2 | Error behaviour at high input level | Applicable | passed |
| 11.2.3 | Co-channel rejection | Applicable | passed |
| 11.2.4 | Adjacent channel selectivity | Applicable | passed |
| 11.2.5 | Spurious response rejection | Applicable | passed |
| 11.2.6 | Intermodulation response rejection | Applicable | passed |
| 11.2.7 | Blocking and desensitisation | Applicable | passed |
| 11.3 | Conducted spurious emissions | | |
| 11.3.1 | Spurious emissions from the receiver | Applicable | passed |
| 11.3.2 | Spurious emissions from the transmitter | Applicable | passed |
| **C.4** | **DSC Receiver Tests** | | |
| C.4.2 | Maximum sensitivity | Applicable | passed |
| C.4.3 | Error behaviour at high input levels | Applicable | passed |
| C.4.4 | Co-channel rejection | Applicable | passed |
| C.4.5 | Adjacent channel selectivity | Applicable | passed |
| C.4.6 | Spurious response rejection | Applicable | passed |
| C.4.7 | Intermodulation response rejection | Applicable | passed |
| C.4.8 | Blocking and desensitisation | Applicable | passed |

# 5 TRANSMITTER REQUIREMENTS

## 5.1 FREQUENCY ERROR SUBCLAUSE 11.1.1

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Continuous transmission without modulation, f = 156.025 MHz

| TEST CONDITIONS | | FREQUENCY | FREQUENCY ERROR |
|---|---|---|---|
| Temperature | Voltage | | |
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 156.025112 MHz | +112 Hz |
| $T_{min}$ (-15°C) | $U_{min}$ (9.6 V DC) | 156.024680 MHz | -320 Hz |
| | $U_{max}$ (31.2 V DC) | 156.024683 MHz | -317 Hz |
| $T_{max}$ (+55°C) | $U_{min}$ (9.6 V DC) | 156.025320 MHz | +320 Hz |
| | $U_{max}$ (31.2 V DC) | 156.025323 MHz | +323 Hz |
| Maximum frequency error | | -320 Hz / +323 Hz | |
| Measurement uncertainty | | ± 10 Hz | |

Operation mode: Continuous transmission without modulation, f = 162.025 MHz

| TEST CONDITIONS | | FREQUENCY | FREQUENCY ERROR |
|---|---|---|---|
| Temperature | Voltage | | |
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 162.025368 MHz | +368 Hz |
| $T_{min}$ (-15°C) | $U_{min}$ (9.6 V DC) | 162.025840 MHz | +840 Hz |
| | $U_{max}$ (31.2 V DC) | 162.025845 MHz | +845 Hz |
| $T_{max}$ (+55°C) | $U_{min}$ (9.6 V DC) | 162.025480 MHz | +480 Hz |
| | $U_{max}$ (31.2 V DC) | 162.025487 MHz | +487 Hz |
| Maximum frequency error | | -0 Hz / +845 Hz | |
| Measurement uncertainty | | ± 10 Hz | |

LIMITS: SUBCLAUSE 1.1.1.3

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

TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 51, 82, 86 |

## 5.2 CARRIER POWER (CONDUCTED) SUBCLAUSE 11.1.2

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Continuous transmission without modulation, f = 156.025 MHz

| Test conditions | | Carrier power (Conducted) |
|---|---|---|
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 33.7 dBm |
| $T_{min}$ (-15°C) | $U_{min}$ (9.6 V DC) | 31.5 dBm |
| | $U_{max}$ (31.2 V DC) | 33.6 dBm |
| $T_{max}$ (+55°C) | $U_{min}$ (9.6 V DC) | 30.6 dBm |
| | $U_{max}$ (31.2 V DC) | 32.7 dBm |
| Measurement uncertainty | | + 0.66 dB / - 0.72 dB |

Operation mode: Continuous transmission without modulation, f = 162.025 MHz

| Test conditions | | Carrier power (Conducted) |
|---|---|---|
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 33.8 dBm |
| $T_{min}$ (-15°C) | $U_{min}$ (9.6 V DC) | 31.6 dBm |
| | $U_{max}$ (31.2 V DC) | 33.8 dBm |
| $T_{max}$ (+55°C) | $U_{min}$ (9.6 V DC) | 30.7 dBm |
| | $U_{max}$ (31.2 V DC) | 32.9 dBm |
| Measurement uncertainty | | + 0.66 dB / - 0.72 dB |

LIMITS: SUBCLAUSE 11.1.2.3

| |
|---|
| The carrier output power (conducted) shall be 33 dBm ± 1.5 dB under normal test conditions and 33 dBm ± 3 dB under extreme test conditions. |

TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 51, 82, 86 |

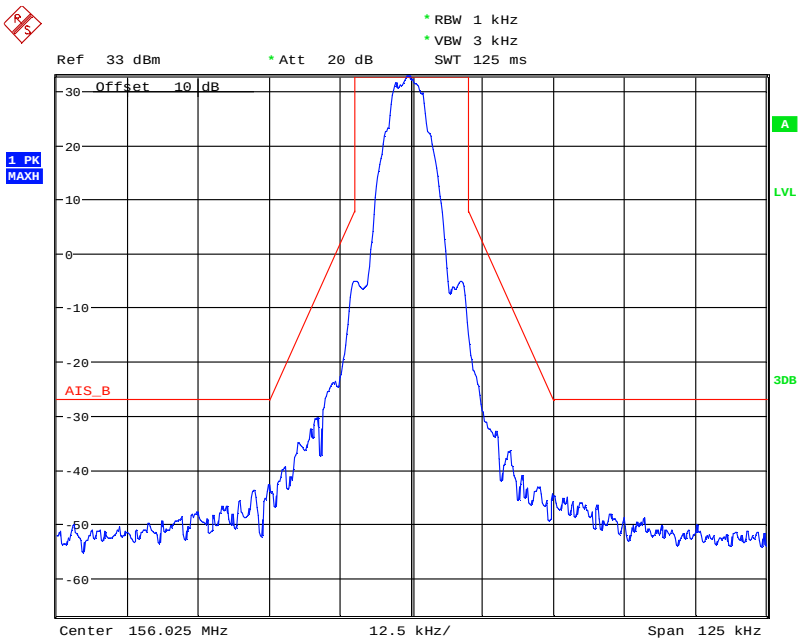
## 5.3 MODULATION SPECTRUM

## SUBCLAUSE 11.1.3

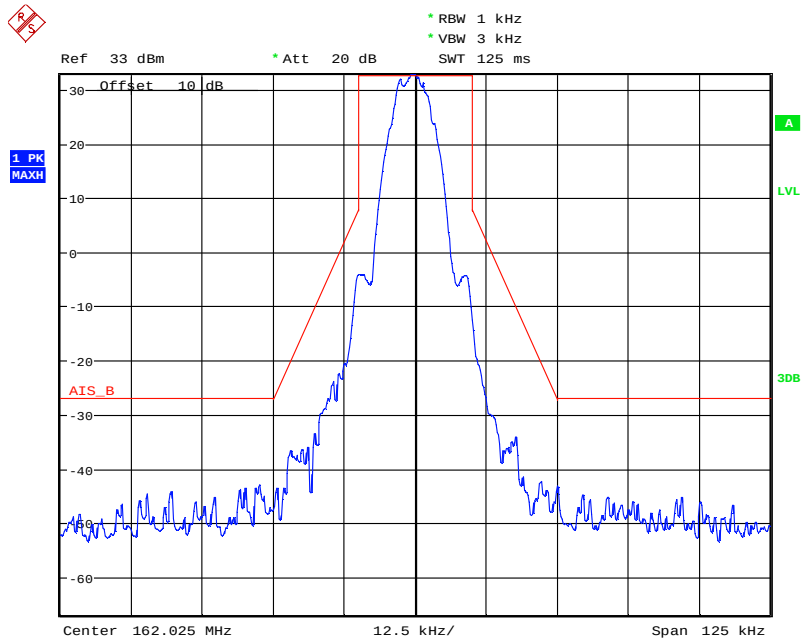
| Ambient temperature | 20 °C |
|---|---|

| Relative humidity | 45 % |
|---|---|

Operation mode: Transmit in AIS-mode (test signal number 3)




130840spec156: Transmit 156.025 MHz




130840spec162: Transmit 162.025 MHz

LIMITS: SUBCLAUSE 11.1.3.3

| |
|---|
| At ± 10 kHz removed from the carrier, the modulation sideband is below - 25 dBc.<br>At ± 25 kHz removed from the carrier, the modulation sideband is below - 60 dBc or -30 dBm.<br>In the region ± 10 kHz and ± 25 kHz removed from the carrier, the modulation sideband is below a line specified between these two points. |

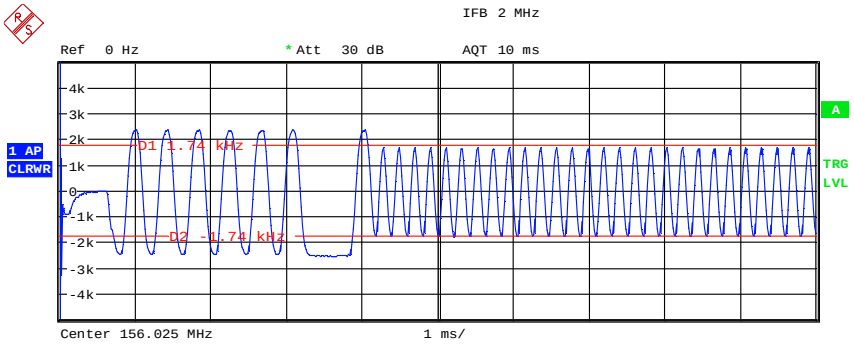
TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 82, 86 |

## 5.4 TRANSMITTER TEST SEQUENCE AND MODULATION ACCURACY SUBCLAUSE 11.1.4

| Ambient temperature | 20 °C | Relative humidity | 55 % |
|---|---|---|---|

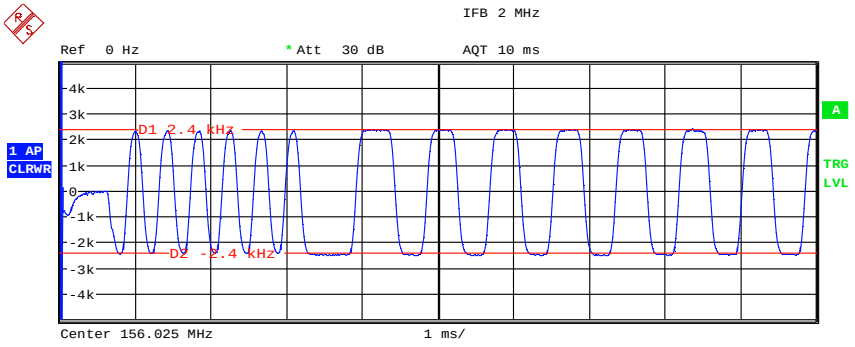
Operation mode: Transmit at 156.025 MHz




**Frequency Modulation Summary**

| | | | | |
|---|---|---|---|---|
| Coupling | DC | | Carrier Offset | -267.41 Hz |
| Deviation | +peak | 187.9 kHz | Carrier Power | 33.76 dBm |
| | -peak | -11.68 kHz | Modulation Frequency | --- Hz |
| | ⇧peak/2 | 99.80 kHz | Sampling Rate | 250 kHz |
| | RMS | 4.132 kHz | Record Length | 2501 |
| | | | Demod Bandwidth | 200 kHz |

156mod2: 156.025 MHz, Test-Signal 2

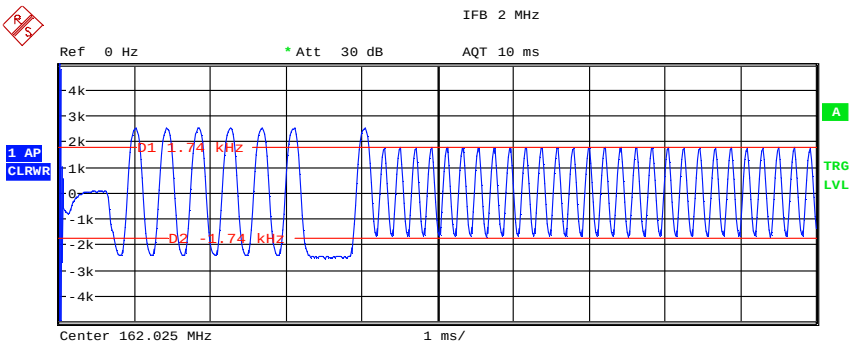



**Frequency Modulation Summary**

| | | | | |
|---|---|---|---|---|
| Coupling | DC | | Carrier Offset | -183.36 Hz |
| Deviation | +peak | 72.98 kHz | Carrier Power | 33.75 dBm |
| | -peak | -159.3 kHz | Modulation Frequency | --- Hz |
| | ⇧peak/2 | 116.1 kHz | Sampling Rate | 250 kHz |
| | RMS | 4.385 kHz | Record Length | 2501 |
| | | | Demod Bandwidth | 200 kHz |

156mod3: 156.025 MHz, Test-Signal 3

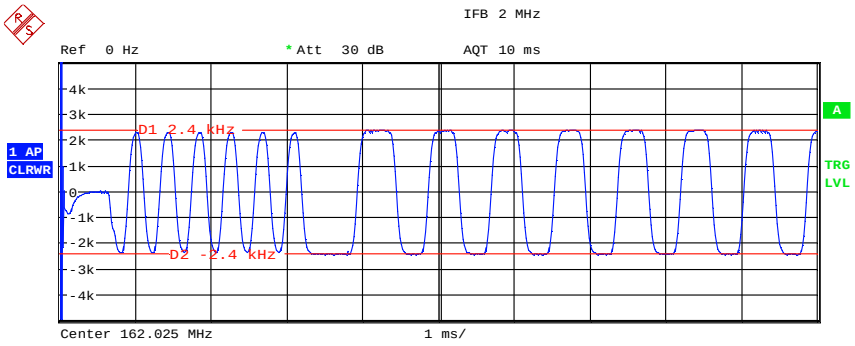
Operation mode: Transmit at 162.025 MHz




**Frequency Modulation Summary**

| | | | | |
|---|---|---|---|---|
| Coupling | DC | | Carrier Offset | -182.83 Hz |
| Deviation | +peak | 98.47 kHz | Carrier Power | 34.28 dBm |
| | -peak | -27.79 kHz | Modulation Frequency | --- Hz |
| | ⇧peak/2 | 63.13 kHz | Sampling Rate | 250 kHz |
| | RMS | 2.884 kHz | Record Length | 2501 |
| | | | Demod Bandwidth | 200 kHz |

162mod2: 162.025 MHz, Test-Signal 2




**Frequency Modulation Summary**

| | | | | |
|---|---|---|---|---|
| Coupling | DC | | Carrier Offset | -159.19 Hz |
| Deviation | +peak | 109.1 kHz | Carrier Power | 34.55 dBm |
| | -peak | -48.94 kHz | Modulation Frequency | --- Hz |
| | ⇧peak/2 | 79.01 kHz | Sampling Rate | 250 kHz |
| | RMS | 3.177 kHz | Record Length | 2501 |
| | | | Demod Bandwidth | 200 kHz |

162mod3: 162.025 MHz, Test-Signal 3

Additional Information:

Due to the fact that the measurement results under extreme test conditions are equal to the results under normal test-conditions the additional plots from the measurement under extreme conditions are not documented in this test-report.

LIMITS: SUBCLAUSE 11.1.4.3

| |
|---|
| See table 22. |

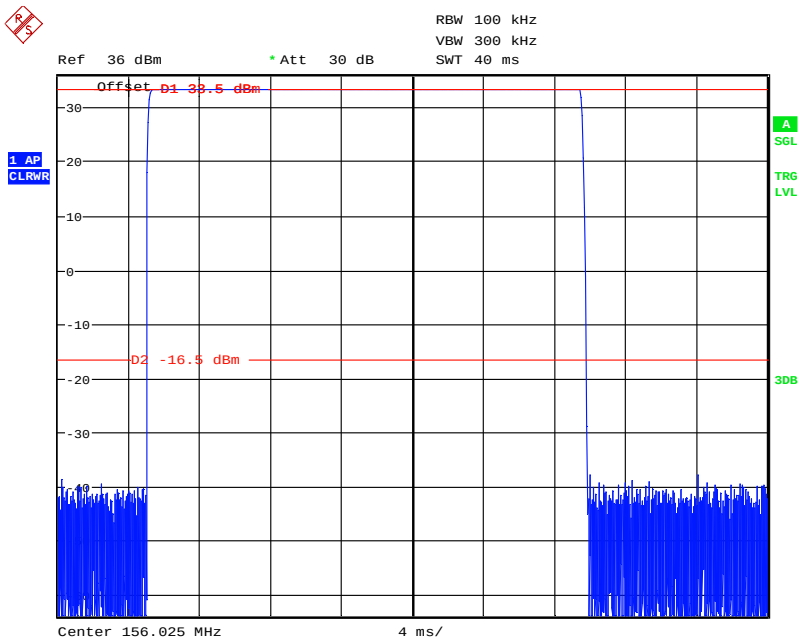
TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 82, 86 |

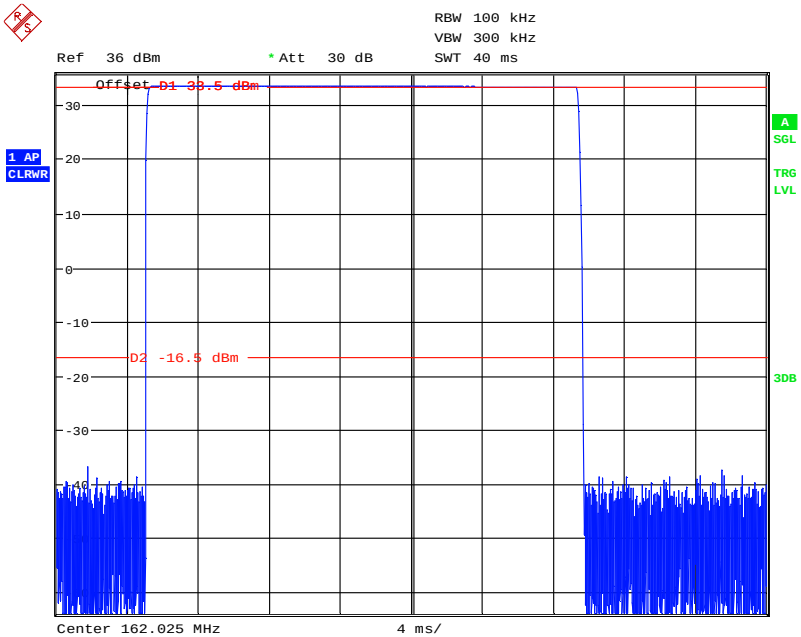
## 5.5 TRANSMITTER OUTPUT POWER VERSUS TIME FUNCTION SUBCLAUSE 11.1.5

| Ambient temperature | 20 °C | Relative humidity | 55 % |
|---|---|---|---|

Operation mode: Transmit




130840_156burst: 156.025 MHz




130840_162burst: 162.025 MHz

LIMITS: SUBCLAUSE 11.1.5.3

| |
|---|
| See table 6 [1]. |

Result: Passed

TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 82, 86 |

# 6 RECEIVER REQUIREMENTS

## 6.1 TDMA-RECEIVER SENSITIVITY SUBCLAUSE 11.2.1

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive: f = 156.025 MHz (-107 dBm (normal) / -104 dBm (extreme) conditions)

| MEASUREMENT CONDITIONS | | MEASURED PACKET ERROR RATE PER | |
|---|---|---|---|
| TEMPERATURE | VOLTAGE | Frequency: | PER: |
| $T_{nom}$ (+ 20°C) | $U_{nom}$ (12.0 V DC) | 156.0245 MHz | 5.5% |
| | | 156.025 MHz | 3.5% |
| | | 156.0255 MHz | 6.5% |
| $T_{min}$ (-15°C/-20°C) | $U_{min}$ (9.6 V DC) | 156.025 MHz | 3.9% / 8.5% |
| | $U_{max}$ (31.2 V DC) | 156.025 MHz | 5.2% / 9.2% |
| $T_{max}$ (55°C/60°C) | $U_{min}$ (9.6 V DC) | 156.025 MHz | 8.5% / 9.5% |
| | $U_{max}$ (31.2 V DC) | 156.025 MHz | 10.0% / 8.2% |
| Limit | | < 20% | |
| Measurement uncertainty | | + 0.9 dB / - 1.0 dB | |

Operation mode: Receive: f = 162.025 MHz (-107 dBm (normal) / -104 dBm (extreme) conditions)

| MEASUREMENT CONDITIONS | | MEASURED PACKET ERROR RATE PER | |
|---|---|---|---|
| TEMPERATURE | VOLTAGE | Frequency: | PER: |
| $T_{nom}$ (+ 20°C) | $U_{nom}$ (12.0 V DC) | 162.0245 MHz | 3.5% |
| | | 162.025 MHz | 2.8% |
| | | 162.0255 MHz | 4.5% |
| $T_{min}$ (-15°C/-20°C) | $U_{min}$ (9.6 V DC) | 162.025 MHz | 0.1% / 1.1% |
| | $U_{max}$ (31.2 V DC) | 162.025 MHz | 0.1% / 1.8% |
| $T_{max}$ (55°C/60°C) | $U_{min}$ (9.6 V DC) | 162.025 MHz | 0.5% / 0.1% |
| | $U_{max}$ (31.2 V DC) | 162.025 MHz | 0.1% / 0.1% |
| Limit | | < 20% | |
| Measurement uncertainty | | + 0.9 dB / - 1.0 dB | |

LIMITS: SUBCLAUSE 11.2.1.3

| |
|---|
| The PER shall not exceed 20%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 42, 51 |

## 6.2 ERROR BEHAVIOUR AT HIGH INPUT LEVELS SUBCLAUSE 11.2.2

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in AIS-mode, f = 156.025 MHz

| RF-INPUT SIGNAL LEVEL | NUMBER OF MESSAGES NOT SUCCESSFULLY RECORDED |
|---|---|
| - 77 dBm | 0.0% |
| - 7 dBm | 5.2% |
| Measurement uncertainty | + 0.9 dB / - 1.0 dB |

Operation mode: Receive in AIS-mode, f = 162.025 MHz

| RF-INPUT SIGNAL LEVEL | NUMBER OF MESSAGES NOT SUCCESSFULLY RECORDED |
|---|---|
| - 77 dBm | 0.0% |
| - 7 dBm | 0.4% |
| 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:

| |
|---|
| 25, 42 |

## 6.3 CO-CHANNEL REJECTION SUBCLAUSE 11.2.3

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in AIS-mode, f = 156.025 MHz

| Unwanted signal frequency: | Unwanted signal level: | Signal ratio: | Packet error rate: |
|---|---|---|---|
| 156.024 MHz | -111 dBm | 10 dB | 9.9% |
| 156.025 MHz | -111 dBm | 10 dB | 9.6% |
| 156.026 MHz | -111 dBm | 10 dB | 10.0% |
| Measurement uncertainty | | + 0.8 dB / - 0.9 dB | |

Operation mode: Receive in AIS-mode, f = 162.025 MHz

| Unwanted signal frequency: | Unwanted signal level: | Signal ratio: | Packet error rate: |
|---|---|---|---|
| 162.024 MHz | -111 dBm | 10 dB | 0.4% |
| 162.025 MHz | -111 dBm | 10 dB | 0.5% |
| 162.026 MHz | -111 dBm | 10 dB | 0.1% |
| Measurement uncertainty | | + 0.8 dB / - 0.9 dB | |

LIMITS: SUBCLAUSE 11.2.3.3

| |
|---|
| The maximum PER shall not exceed 20%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 29, 33, 42 |

## 6.4 ADJACENT CHANNEL SELECTIVITY SUBCLAUSE 11.2.4

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

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

| TEMPERATURE | VOLTAGE | WANTED SIGNAL | UNWANTED SIGNAL | SIGNAL RATIO | PACKET ERROR RATE |
|---|---|---|---|---|---|
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 156.025 MHz | 156.000 MHz | 70 dB | 13.7% |
| | | | 156.050 MHz | 70 dB | 14.2% |
| | | 162.025 MHz | 162.000 MHz | 70 dB | 7.3% |
| | | | 162.050 MHz | 70 dB | 0.7% |
| Measurement uncertainty | | | | + 0.8 dB / - 0.9 dB | |

LIMITS: SUBCLAUSE 11.2.4.3

| |
|---|
| The maximum PER shall not exceed 20%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 29, 33, 42 |

## 6.5 SPURIOUS RESPONSE REJECTION SUBCLAUSE 11.2.5

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

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

| DEFINITION IF | UNWANTED FREQUENCY | MEASSURED PACKET ERROR RATE |
|---|---|---|
| 1st IF | 21.4 MHz | 0.7% |
| 1st LO-Freq. - IF | 113.225 MHz | 0.9% |
| 2 x 1st LO-Freq. – IF | 247.850 MHz | 0.1% |
| 2 x 1st LO-Freq. + IF | 290.650 MHz | 0.5% |
| 3 x 1st LO-Freq. – IF | 382.475 MHz | 0.7% |
| 3 x 1st LO-Freq. + IF | 425.275 MHz | 1.1% |
| 4 x 1st LO-Freq. – IF | 517.100 MHz | 0.2% |
| 4 x 1st LO-Freq. + IF | 599.900 MHz | 0.0% |
| - | 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, Channel B = 162.025 MHz (1st LO-Freq. = 140.625 MHz)
Wanted signal: P = -101 dBm
Unwanted signal: Modulated with 400 Hz / 3 kHz deviation, P = -27 dBm

| DEFINITION IF | UNWANTED FREQUENCY | MEASSURED PACKET ERROR RATE |
|---|---|---|
| 1st IF | 21.4 MHz | 1.4% |
| 1st LO-Freq. - IF | 119.225 MHz | 1.3% |
| 2 x 1st LO-Freq. – IF | 259.850 MHz | 1.4% |
| 2 x 1st LO-Freq. + IF | 302.650 MHz | 0.6% |
| 3 x 1st LO-Freq. – IF | 400.475 MHz | 1.2% |
| 3 x 1st LO-Freq. + IF | 443.275 MHz | 0.1% |
| 4 x 1st LO-Freq. – IF | 541.100 MHz | 0.2% |
| 4 x 1st LO-Freq. + IF | 583.900 MHz | 0.6% |
| - | 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:

| |
|---|
| 25, 29, 33, 42 |

## 6.6 INTERMODULATION RESPONSE REJECTION SUBCLAUSE 11.2.6

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

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 UNWANTED SIGNALS | | | PACKET ERROR RATE |
|---|---|---|---|
| Generator A | Generator B | Generator C | |
| 162.025 MHz | 162.075 MHz | 162.125 MHz | 1.0% |
| | 161.975 MHz | 161.925 MHz | 0.2% |
| Limit: | | | 20% |
| Measurement uncertainty: | | | + 0.8 dB / - 0.9 dB |

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 UNWANTED SIGNALS | | | PACKET ERROR RATE |
|---|---|---|---|
| Generator A | Generator B | Generator C | |
| 156.025 MHz | 156.075 MHz | 156.125 MHz | 9.9% |
| | 155.975 MHz | 155.925 MHz | 9.0% |
| Limit: | | | 20% |
| Measurement uncertainty: | | | + 0.8 dB / - 0.9 dB |

LIMITS: SUBCLAUSE 11.2.6.3

| |
|---|
| The PER shall not exceed 20 %. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 27, 29, 33, 34, 42 |

## 6.7 BLOCKING OR DESENSITISATION SUBCLAUSE 11.2.7

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in AIS-mode: f = 156.025 MHz
Wanted signal A: P = -101 dBm
Unwanted signal B: Unmodulated, P = -23 dBm / -15 dBm*

| FREQUENCIES OF THE UNWANTED SIGNALS | | PACKET ERROR RATE PER |
|---|---|---|
| -10 MHz | 146.025 MHz* | 0.7% |
| -5 MHz | 151.025 MHz* | 2.8% |
| -2 MHz | 154.025 MHz | 0.9% |
| -1 MHz | 155.025 MHz | 0.2% |
| -500 kHz | 155.525 MHz | 0.9% |
| +500 kHz | 156.525 MHz | 3.4% |
| +1 MHz | 157.025 MHz | 0.2% |
| +2 MHz | 158.025 MHz | 0.6% |
| +5 MHz | 161.025 MHz* | 1.7% |
| +10 MHz | 166.025 MHz* | 0.3% |
| Limit: | | 20% |
| Measurement uncertainty | | + 0.8 dB / - 0.9 dB |

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

| FREQUENCIES OF THE UNWANTED SIGNALS | | PACKET ERROR RATE PER |
|---|---|---|
| -10 MHz | 152.025 MHz* | 0.3% |
| -5 MHz | 157.025 MHz* | 2.8% |
| -2 MHz | 160.025 MHz | 0.1% |
| -1 MHz | 161.025 MHz | 0.1% |
| -500 kHz | 161.525 MHz | 5.5% |
| +500 kHz | 162.525 MHz | 5.4% |
| +1 MHz | 163.025 MHz | 0.6% |
| +2 MHz | 164.025 MHz | 1.7% |
| +5 MHz | 167.025 MHz* | 0.1% |
| +10 MHz | 172.025 MHz* | 0.1% |
| Limit: | | 20% |
| Measurement uncertainty | | + 0.8 dB / - 0.9 dB |

LIMITS: SUBCLAUSE 11.2.7.3

| The PER shall not exceed 20%. |
|---|

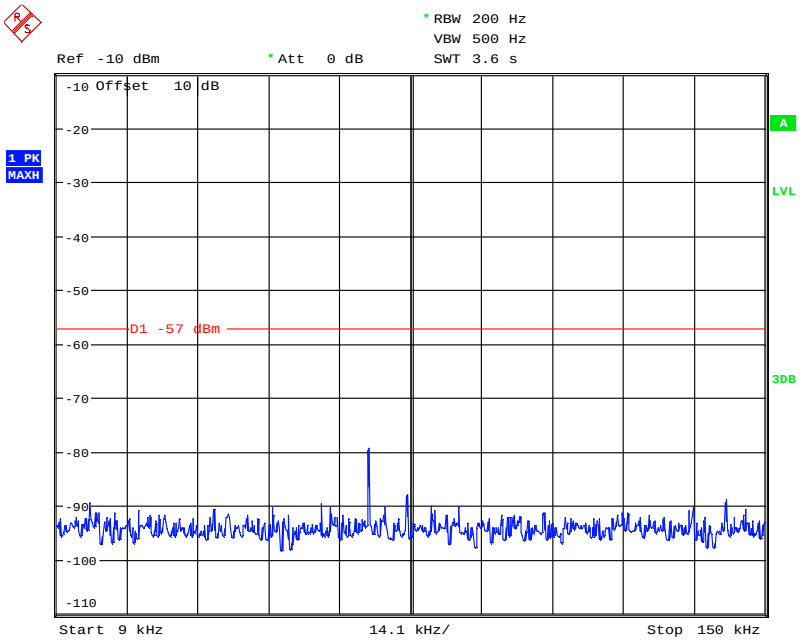
TEST EQUIPMENT USED:

| 25, 29, 33, 42 |
|---|

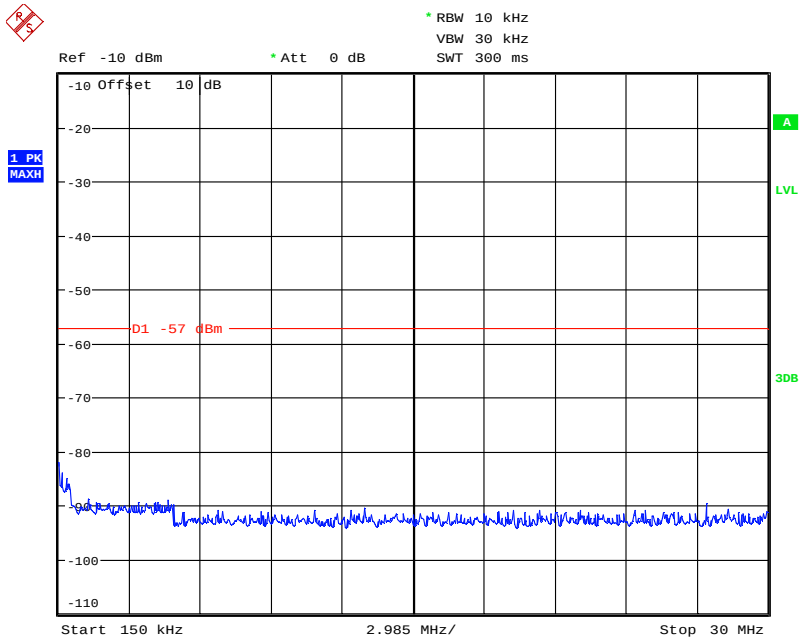
## 6.8 SPURIOUS EMISSIONS FROM THE RECEIVER SUBCLAUSE 11.3.1

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

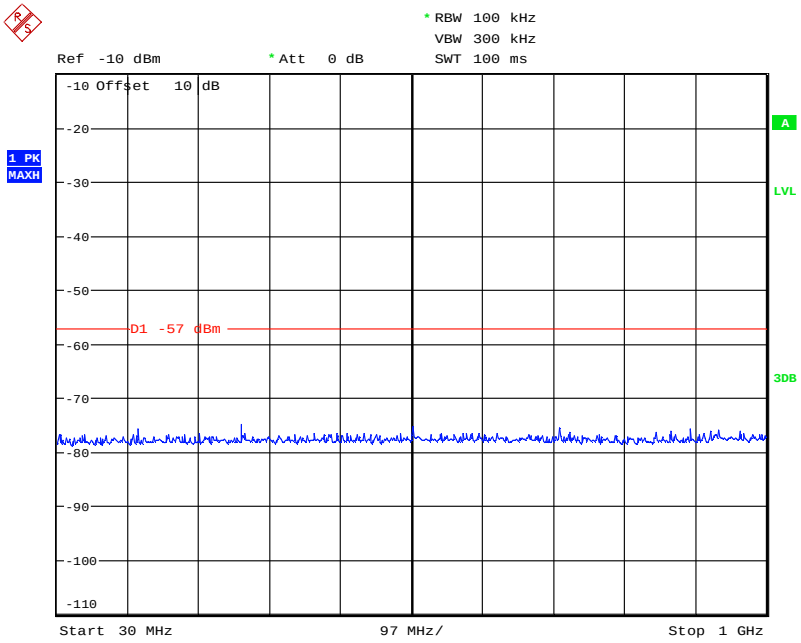
Operation mode: Receiver 1: f = 156.025 MHz, AIS-mode
Receiver 2: f = 162.025 MHz, AIS-mode



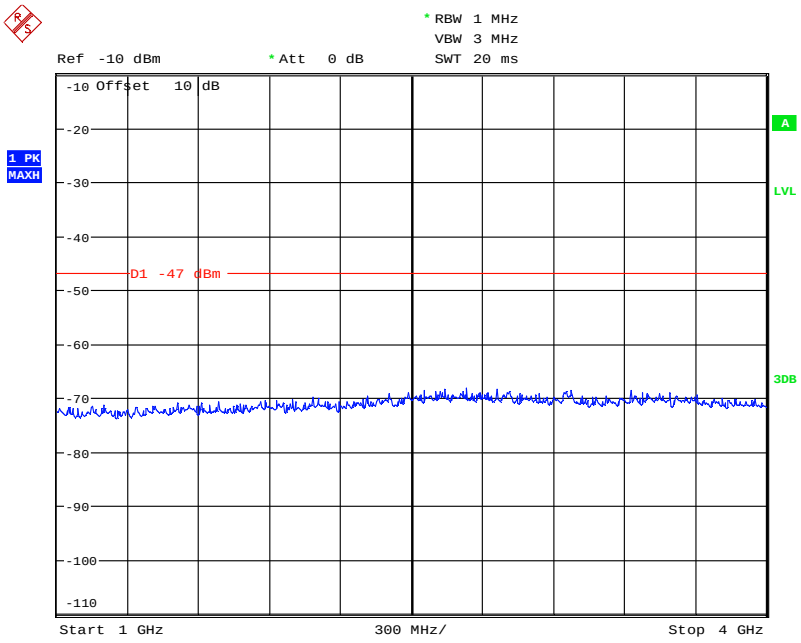

130840emi_rx1: 9 kHz to 150 kHz




130840emi_rx2: 150 kHz to 30 MHz




130840emi_rx3: 30 MHz to 1 GHz




130840emi_rx4: 1 GHz to 4 GHz

| SPURIOUS EMISSIONS LEVEL | | | |
|---|---|---|---|
| Frequency: | Measured level: | Limit: | Margin: |
| - | - | - | - |
| - | No significant spurious emissions found. | | - |
| - | - | - | - |
| Measurement uncertainty | +0.66 dB / -0.72 dB | | |

LIMITS: SUBCLAUSE 11.3.1.3

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

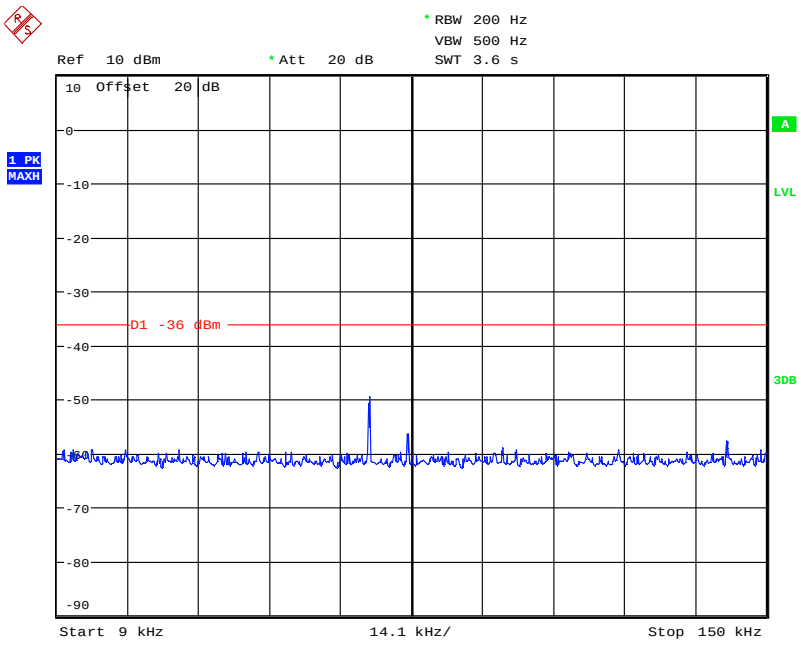
TEST EQUIPMENT USED:

| |
|---|
| 06, 42, 76 |

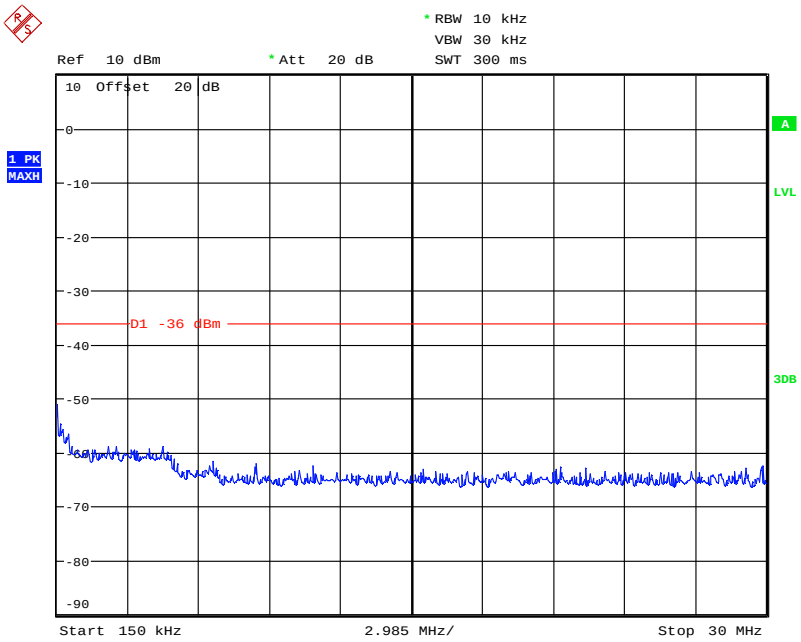
## 6.9 SPURIOUS EMISSIONS FROM THE TRANSMITTER SUBCLAUSE 11.3.2

| Ambient temperature | 20 °C | Relative humidity | 45 % |
|---|---|---|---|

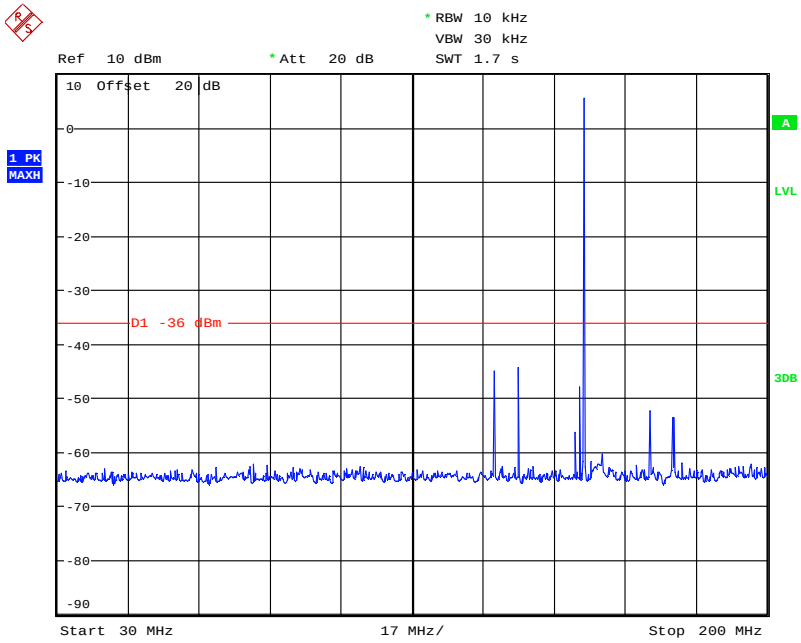
Operation mode: Continuous transmission, f = 156.025 MHz



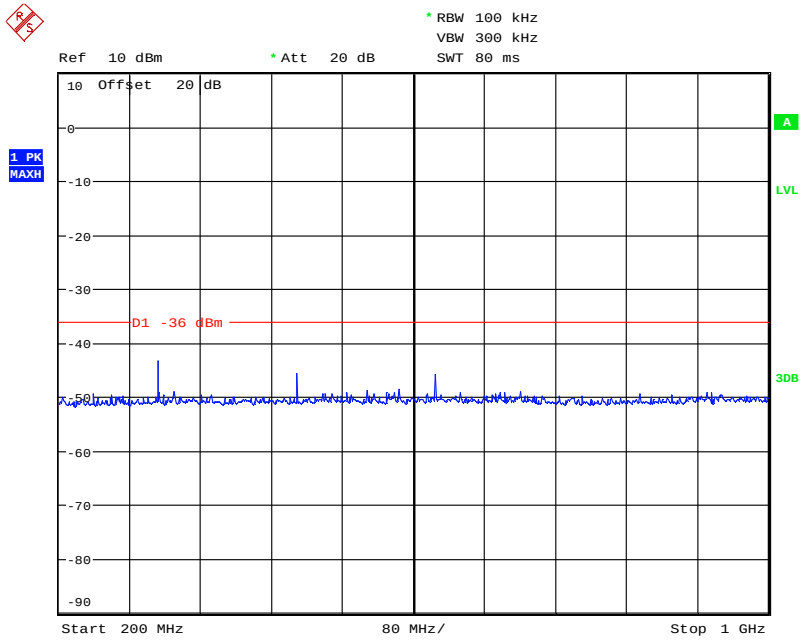

130840tx156_1: 9 kHz to 150 kHz



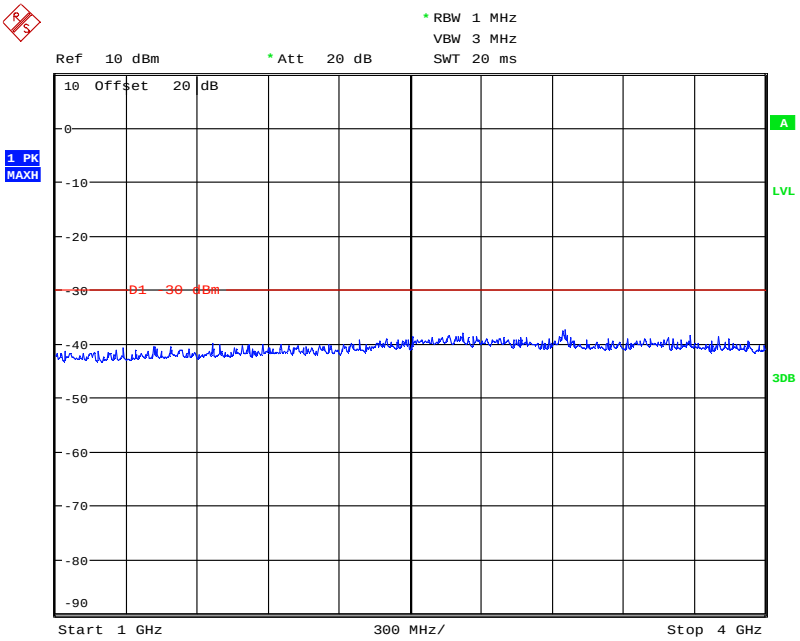

130840tx156_2: 150 kHz to 30 MHz




130840tx156_3: 30 MHz to 200 MHz



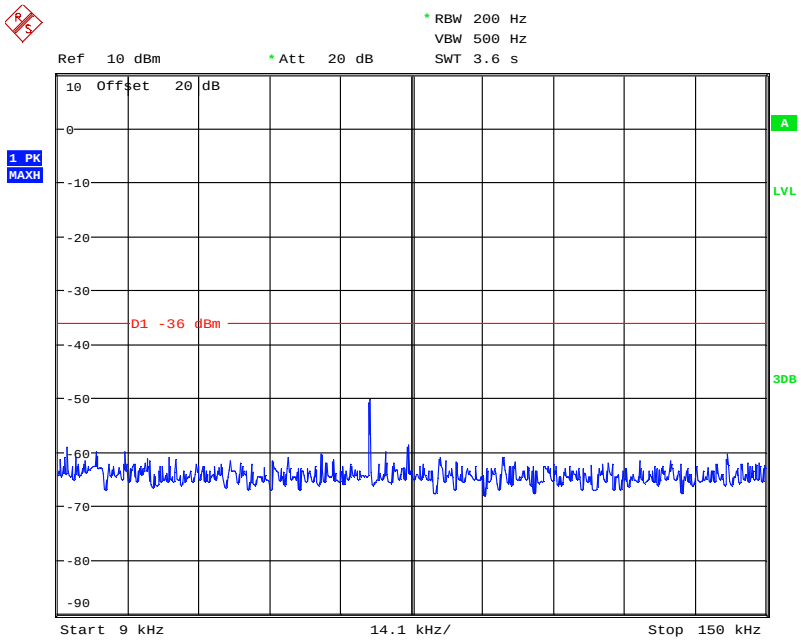

130840tx156_4: 200 MHz to 1 GHz



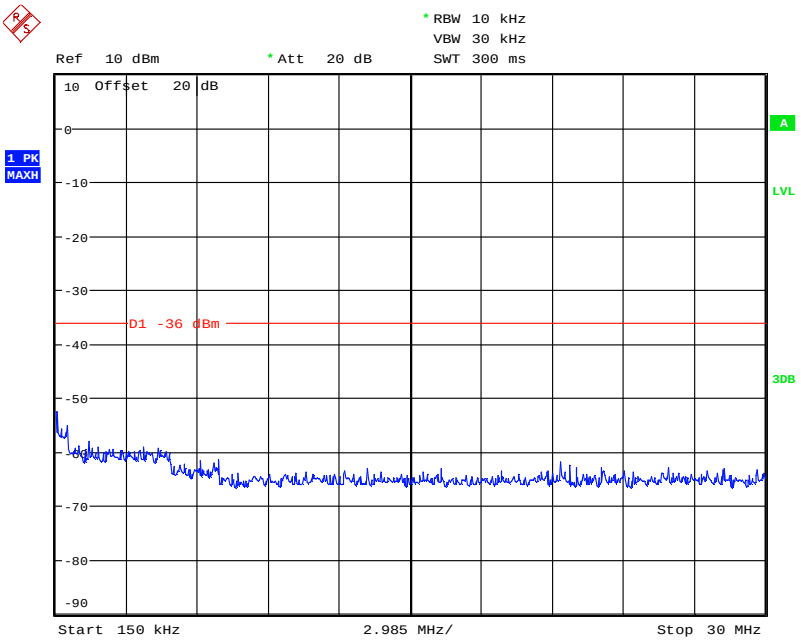

130840tx156_5: 1 GHz to 4 GHz

| SPURIOUS EMISSIONS LEVEL (CONDUCTED) | | | | | |
|---|---|---|---|---|---|
| f | Level | Bandwidth | Limit | Margin | Result |
| 134.615 MHz | -44.5 dBm | 100 kHz | -36 dBm | 8.5 dB | Passed |
| 312.025 MHz | -43.5 dBm | 100 kHz | -36 dBm | 7.5 dB | Passed |
| 468.075 MHz | -46.0 dBm | 100 kHz | -36 dBm | 10.0 dB | Passed |
| 780.125 MHz | -46.5 dBm | 100 kHz | -36 dBm | 10.5 dB | Passed |
| Measurement uncertainty | | + 0.66 dB / - 0.72 dB | | | |

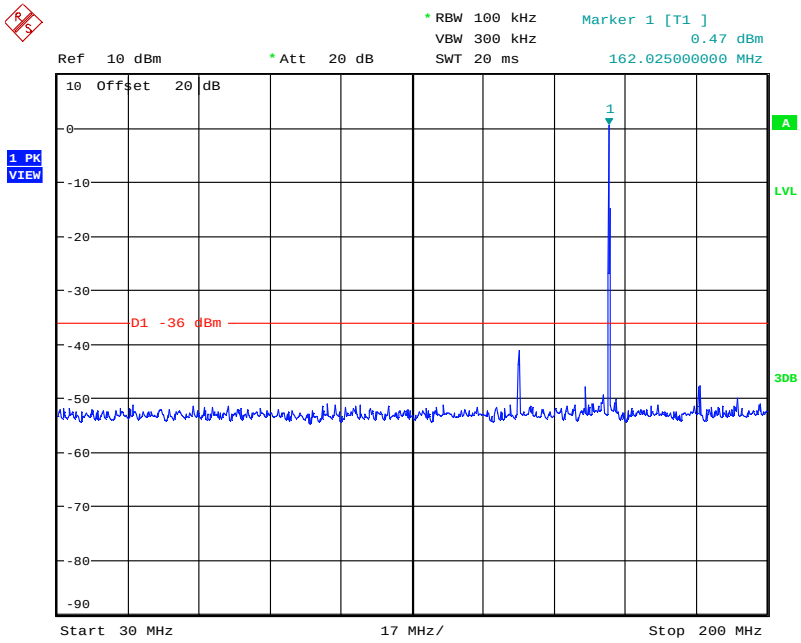
Operation mode: Continuous transmission, f = 162.025 MHz



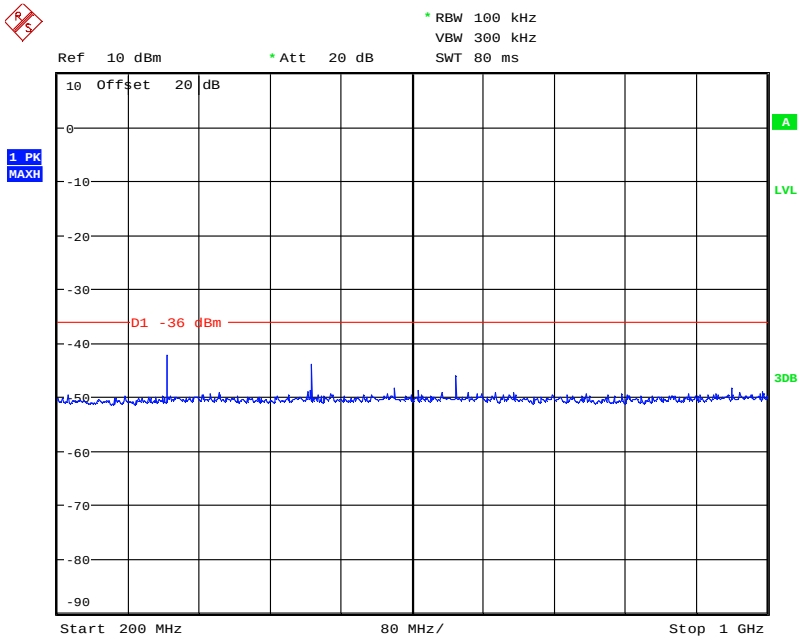

130840tx162_1: 9 kHz to 150 kHz



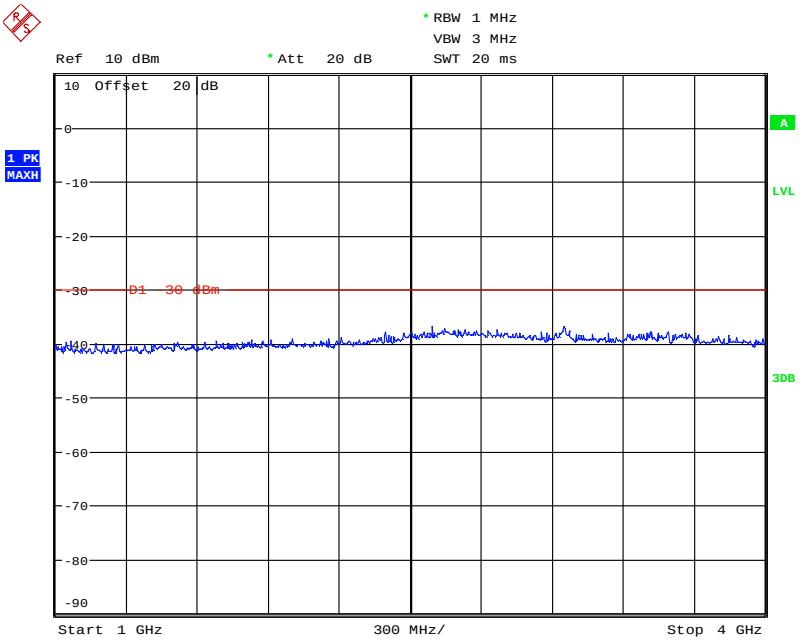

130840tx162_2: 150 kHz to 30 MHz




130840tx162_3: 30 MHz to 200 MHz




130840tx162_4: 200 MHz to 1000 MHz




130840tx162_5: 1 GHz to 4 GHz

| SPURIOUS EMISSIONS LEVEL (CONDUCTED) | | | | | |
|---|---|---|---|---|---|
| f | Level | Bandwidth | Limit | Margin | Result |
| 140.500 MHz | -41.0 dBm | 100 kHz | -36 dBm | 5.0 dB | Passed |
| 324.050 MHz | -42.0 dBm | 100 kHz | -36 dBm | 6.0 dB | Passed |
| 486.075 MHz | -43.5 dBm | 100 kHz | -36 dBm | 7.5 dB | Passed |
| 810.125 MHz | -45.5 dBm | 100 kHz | -36 dBm | 9.5 dB | Passed |
| Measurement uncertainty | | + 0.66 dB / - 0.72 dB | | | |

LIMITS: SUBCLAUSE 11.3.2.3

Conducted emissions:

| 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:

| |
|---|
| 06, 07, 42, 63, 82, 86 |

## 6.10 MAXIMUM SENSITIVITY

**SUBCLAUSE C.4**

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1 (0101010…)

| TEMPERATURE | VOLTAGE | DSC-FREQUENCY | RECEIVER SENSITIVITY |
|---|---|---|---|
| $T_{nom}$ (+20°C) | $U_{nom}$ (12.0 V DC) | 156.523500 MHz<br>156.525000 MHz<br>156.526500 MHz | 0%<br>0%<br>0% |
| $T_{min}$ (-15°C/-20°C) | $U_{min}$ (9.6 V DC) | 156.523500 MHz<br>156.525000 MHz<br>156.526500 MHz | 0% / 0%<br>0% / 0%<br>0% / 0% |
| | $U_{max}$ (31.2 V DC) | 156.523500 MHz<br>156.525000 MHz<br>156.526500 MHz | 0% / 0%<br>0% / 0%<br>0% / 0% |
| $T_{max}$ (55°C/60°C) | $U_{min}$ (9.6 V DC) | 156.523500 MHz<br>156.525000 MHz<br>156.526500 MHz | 0% / 0%<br>0% / 0%<br>0% / 0% |
| | $U_{max}$ (31.2 V DC) | 156.523500 MHz<br>156.525000 MHz<br>156.526500 MHz | 0% / 0%<br>0% / 0%<br>0% / 0% |
| Measurement uncertainty | | + 0.66 dB / - 0.72 dB | |

LIMITS: SUBCLAUSE C.4.1

The maximum usable sensitivity shall not be less sensitive than - 107 dBm under normal test conditions, and - 101 dBm under extreme test conditions. The test shall be repeated at the nominal carrier frequency (156.525 MHz) ± 1.5 kHz.

TEST EQUIPMENT USED:

29, 42, 51

## 6.11 ERROR BEHAVIOUR AT HIGH INPUT LEVELS SUBCLAUSE C.4.2

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1 (0101010…)

| RF-INPUT SIGNAL LEVEL | NUMBER OF MESSAGES NOT SUCCESSFULLY RECORDED |
|---|---|
| - 7 dBm | 0% |

LIMITS: SUBCLAUSE C.4.2

| |
|---|
| The BER shall not exceed 1%. |

TEST EQUIPMENT USED:

| |
|---|
| 29, 42 |

## 6.12 CO-CHANNEL REJECTION SUBCLAUSE C.4.3

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1 (0101010…), P = -104 dBm
Unwanted signal: 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% |
| 156.525 MHz | -114 dBm | -10 dB | 0% |
| 156.528 MHz | -114 dBm | -10 dB | 0% |
| Measurement uncertainty | | ±0.1% | |

LIMITS: SUBCLAUSE C.4.3

| |
|---|
| The BER shall not exceed 1%. |

TEST EQUIPMENT USED:

| |
|---|
| 29, 42 |

## 6.13 ADJACENT CHANNEL SENSITIVITY SUBCLAUSE C.4.4

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1, P = - 104 dBm
Unwanted signal: 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% |
| $T_{min}$ (-15°C/-20°C) | $U_{min}$ (9.6 V DC) | -44 dBm | 0% |
| | $U_{max}$ (31.2 V DC) | | 0% |
| $T_{max}$ (55°C/60°C) | $U_{min}$ (9.6 V DC) | -44 dBm | 0% |
| | $U_{max}$ (31.2 V DC) | | 0% |
| Measurement uncertainty | | ±0.1% | |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1, P = - 104 dBm
Unwanted signal: 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% |
| $T_{min}$ (-15°C/-20°C) | $U_{min}$ (9.6 V DC) | -44 dBm | 0% |
| | $U_{max}$ (31.2 V DC) | | 0% |
| $T_{max}$ (55°C/60°C) | $U_{min}$ (9.6 V DC) | -44 dBm | 0% |
| | $U_{max}$ (31.2 V DC) | | 0% |
| Measurement uncertainty | | ±0.1% | |

LIMITS: SUBCLAUSE C.4.4

| | |
|---|---|
| Normal test conditions: | 70 dB |
| Extreme test conditions: | 60 dB |
| The BER shall not exceed 1%. | |

TEST EQUIPMENT USED:

| |
|---|
| 25, 29, 33, 42, 51 |

## 6.14 SPURIOUS RESPONSE REJECTION SUBCLAUSE C.4.5

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Operation mode: Receive in DSC-mode, f = 156.525 MHz
Wanted signal: Test-signal 1, P = -104 dBm
Unwanted signal: Unmodulated, P = -34 dBm

| DEFINITION | UNWANTED FREQUENCY | MEASURED BIT EROR RATE BER |
|---|---|---|
| 1st IF (Receiver A) | 21.400 MHz | 0% |
| 1st LO-Freq. - IF | 113.725 MHz | 0% |
| 2 x 1st LO-Freq. – IF | 248.850 MHz | 0% |
| 2 x 1st LO-Freq. + IF | 291.650 MHz | 0% |
| 3 x 1st LO-Freq. – IF | 383.975 MHz | 0% |
| 3 x 1st LO-Freq. + IF | 426.775 MHz | 0% |
| 4 x 1st LO-Freq. – IF | 519.100 MHz | 0% |
| 4 x 1st LO-Freq. + IF | 561.900 MHz | 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 C.4.5

| |
|---|
| The BER shall not exceed 1%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 29, 33, 42 |

## 6.15 INTERMODULATION RESPONSE REJECTION SUBCLAUSE C.4.6

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

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 UNWANTED SIGNALS | | | MEASSURED BIT EROR RATE BER |
|---|---|---|---|
| Generator A | Generator B | Generator C | |
| 156.525 MHz | 156.475 MHz | 156.425 MHz | 0.2% |
| | 156.575 MHz | 156.625 MHz | 0.1% |
| Limit: | | | 1% |
| Measurement uncertainty: | | | ±0.1% |

LIMITS: SUBCLAUSE C.4.6

| |
|---|
| The BER shall not exceed 1%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 27, 29, 33, 34, 42 |

## 6.16 BLOCKING OR DESENSITISATION SUBCLAUSE C.4.7

| | | | |
|---|---|---|---|
| Ambient temperature | 20 °C | Relative humidity | 45 % |

Wanted signal A: P = -104 dBm
Unwanted signal B: Unmodulated, P = -20 dBm

| FREQUENCIES OF THE UNWANTED SIGNALS | | MEASSURED BIT EROR RATE BER |
|---|---|---|
| -10 MHz | 146.525 MHz | 0% |
| -5 MHz | 151.525 MHz | 0% |
| -2 MHz | 154.525 MHz | 0% |
| -1 MHz | 155.525 MHz | 0% |
| +1 MHz | 157.525 MHz | 0% |
| +2 MHz | 158.525 MHz | 0% |
| +5 MHz | 161.525 MHz | 0% |
| +10 MHz | 166.525 MHz | 0% |
| Limit: | | 1% |
| Measurement uncertainty | | ±0.1% |

LIMITS: SUBCLAUSE C.4.7

| |
|---|
| The PER shall not exceed 1%. |

TEST EQUIPMENT USED:

| |
|---|
| 25, 29, 33, 42 |

# 7 TEST EQUIPMENT

| No. | Test equipment | Type | Manufacturer | Serial No. | PM-No |
|---|---|---|---|---|---|
| 01 | Spectrum Analyser | FSU | Rohde & Schwarz | 200125 | 480956 |
| 02 | Measuring Receiver | ESI 40 | Rohde & Schwarz | 837808/007 | 480335 |
| 03 | Power amplifier | 25A250A | AR | 18647 | 480154 |
| 04 | Signal generator | SMHU | Rohde & Schwarz | 844170/017 | 480266 |
| 05 | Signal generator | SMG | Rohde & Schwarz | 8334497/030 | 480013 |
| 06 | Signal generator | 83650L | Agilent | 3844A00554 | 480333 |
| 07 | Radio communication analyser | CMTA 54 | Rohde & Schwarz | 841904/011 | 480169 |
| 08 | Combiner | ZFSC-2-11 | Mini Circuits | - | 410089 |
| 09 | Combiner | ZFSC-2-11 | Mini Circuits | - | 410090 |
| 10 | Regulating transformer | BR1000 | Block | - | 480341 |
| 11 | Power supply | TOE 8872 | Toellner | 61005 | 480833 |
| 12 | Power supply | TOE 8852 | Toellner | 51712 | 480233 |
| 13 | Climatic chamber | - | Binder | - | 480462 |
| 14 | Directional coupler | DC3510 | AR | 312259 | 480470 |
| 15 | Notch Filter | TTR 190-3EE | TELONIC Berkeley | 97284-6 | 480331 |
| 16 | Variable Attenuator / 0-11 dB | 8494B | Hewlett Packard | 3308A38264 | 480264 |
| 17 | Variable Attenuator<br>0 - 110 dB | 8496B | Hewlett Packard | 3308A71365 | 480265 |
| 18 | Attenuator / 10 dB / 5 W | WA2-10 | Weinschel | 8259 | 410121 |
| 19 | Attenuator / 10 dB / 5 W | WA2-10 | Weinschel | 8260 | 410122 |
| 20 | Attenuator / 10 dB / 5 W | WA2-10 | Weinschel | 8261 | 410123 |
| 21 | Attenuator / 10 dB / 10 W | WA8-10 | Weinschel | 7538 | 410112 |
| 22 | Attenuator / 10 dB / 25 W | 33-10-34 | Weinschel | BH 4878 | 410129 |
| 23 | Attenuator / 10 dB / 25 W | 33-10-34 | Weinschel | BH 4856 | 410130 |
| 24 | RF-cable No. 1 | RTK 081 | Rosenberger | - | 410093 |
| 25 | RF-cable No. 2 | RTK 081 | Rosenberger | - | 410094 |
| 26 | RF-cable No. 7 | Sucoflex | Huber + Suhner | - | 410099 |
| 27 | RF-cable No. 8 | RG223 | Phoenix-Test-Lab | - | 410100 |
| 28 | RF-cable No. 9 | RG223 | Phoenix-Test-Lab | - | 410101 |
| 29 | Zirkulator | 156-162MHz | DFE | - | 410162 |
| 30 | Zirkulator | 156-162MHz | DFE | - | 410163 |
| 31 | Zirkulator | 156-162MHz | DFE | - | 410164 |
| 32 | Zirkulator | 156-162MHz | DFE | - | 410165 |

# 8 LIST OF ANNEXES

| | | |
|---|---|---|
| ANNEX A | PHOTOGRAPHS | 9 pages |
| | EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE | |
| | EUT, 3D-view | 130840eut1.jpg |
| | EUT, front-view | 130840eut2.jpg |
| | EUT, 3D-rear view | 130840eut3.jpg |
| | EUT, rear-view | 130840eut4.jpg |
| | INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE | |
| | EUT, internal-view | 130840eut5.jpg |
| | RF-PCB, front-view | 130840eut6.jpg |
| | RF-PCB, rear-view | 130840eut7.jpg |
| | Main-PCB, front-view | 130840eut8.jpg |
| | Main-PCB, rear-view | 130840eut9.jpg |