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Test report

338023-1TRFWL

Date of issue: January 25, 2018

Applicant:

Communications Components, Inc.

Product:

2W SDAR ECHO Repeater

Model:

SER-2300-2W-EC

FCC ID:

NT3SER23002W

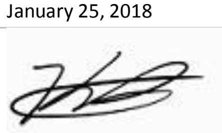
Specifications:

- FCC 47 CFR Part 25

  Satellite communications

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2040; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	January 25, 2018
Signature of reviewer	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Communications Components, Inc.
Address	89 Leuning Street 2nd Floor
City	South Hackensack
Province/State	NJ
Postal/Zip code	07606
Country	USA

1.2 Test specifications

FCC 47 CFR Part 25	Satellite communications

1.3 Test methods

ANSI C63.10 v 2013	American National Standard for Procedures for Compliance Testing of Unsilenced Wireless Devices
935210 D05 Indus Booster Basic Meas v01r02 October 27, 2017	Measurements guidance for industrial and non-consumer signal booster, repeater, and amplifier devices.

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 25 test results

Part 25	Part 2	Test description	Verdict
25.214(d)[1]	2.1046	Average RF Power Output	Pass
25.144(e)(7)(ii)	2.1046	Peak-to-Average Power Ratio (PAPR)	Pass
–	2.1049	Occupied bandwidth	Pass
25.202(h)(2)	2.1051	Spurious emissions at the antenna terminal for operating at power levels ≤ 2 W	Pass
25.202(h)(1)	2.1051	Spurious emissions at the antenna terminal for operating at power levels > 2 W	Pass
25.202(h)(2)	2.1053	Field strength of spurious emissions for operating at power levels ≤ 2 W	Pass
25.202(h)(1)	2.1053	Field strength of spurious emissions for operating at power levels > 2 W	Pass
25.202(d)[2]	2.1055	Frequency tolerance, earth stations	Not applicable[2]

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2] Up-conversion and down-conversion are performed by a common PLL, thus the frequency drift will always be 0%. The EUT is a repeater and does not contain frequency determining components to derive the transmit frequencies, therefore this test was deemed not applicable.

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 28, 2017
Nemko sample ID number	1, 2

3.2 EUT information

Product name	2W SDAR ECHO Repeater
Model	SER-2300-2W-EC
Serial number	PROV6001

3.3 Technical information

Frequency bands	2324.244–2328.256 MHz, 2336.225–2341.285 MHz
Frequency Min (MHz)	2326.250
Frequency Max (MHz)	2338.755
RF power Max (W)	2
Bandwidth	Low band ±2.006 MHz; High band ±2.53 MHz
Type of modulation	COFDM DAB
Transmitter spurious, Units @ distance	46.94 dBμV/m @ 3 m at 2345 MHz
Power requirements	48 V_{DC}
Antenna information	External Small Cell Sector antenna, SCA65F-A2A, 13 dBi gain. The EUT is professionally installed.

3.4 Product description and theory of operation

The Echo SDAR terrestrial repeater was designed to receive, filter and amplify the two terrestrial bands within the SXM broadcast network. It was designed to help overcome some of the interference issues which may arise in the immediate area of a WCS base station.
The repeater receives a sample from the existing SXM network using a carefully positioned 2300 MHz donor antenna. The repeater output can utilize a dedicated 2300 MHz service antenna or share a WCS sector antenna by utilizing an SDAR-WCS Duplexer.

3.5 EUT exercise details

The SDAR ECHO Repeater uses the down-conversion/up-conversion scheme. The dual band SXM terrestrial input signal received from the donor antenna is sent through a series of SDAR specific Band Pass filters and LNA circuits in addition to an Automatic Level -Control (ALC) circuit in order to maintain the maximum output power at 2-Watt composite. The signal is then divided into SXM low band and high band frequencies before the down-converting mixers. At IF band, signals are independently filtered, amplified and up converted back to the combined, dual band SXM terrestrial output signal. The driver amplifier and power amplifier make up the final gain stages and an SDAR cavity band pass filter added to suppress both out of band emissions and harmonics.
The repeater has a nominal gain of 93 dB for both SXM bands but each has independent Manual Gain Control via USB port. A control algorithm continuously monitors and detects power levels at various stages within the repeater amplifier system. The unit condition is reported via status LEDs and RS232 communication port.
Two test signals with COFDM DAB modulations were supplied at the input of the repeater using the RF combiner:
Signal 1: for "Low band" at the frequency of 2326.25 MHz with ±2.006 MHz bandwidth;
Signal 2: for "High band" at the frequency of 2338.755 MHz with ±2.53 MHz bandwidth.

3.6 EUT setup diagram

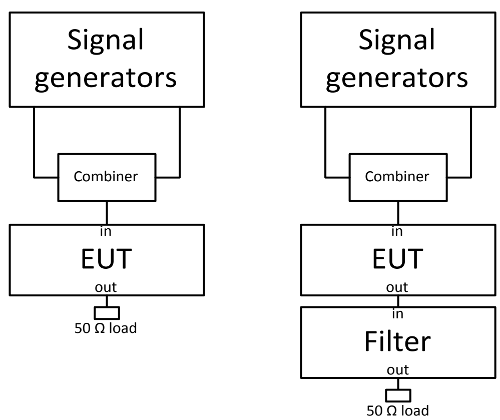


Figure 3.6-1: *Setup diagrams*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Repeater	CCI	SER-2300-2W-EC	PROV6001
Filter	CCI	CCI DPO-2323-SS2	AT2617NJOH

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 1/17
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 31/18
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jul. 18/18
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	June 27/18
Horn with Preamp	ETS-Lindgren	3117-PA	FA002840	1 year	Nov. 11/17
Signal generator	Rohde & Schwarz	SMB100A	FA002174	1 year	May 12/18
Power meter	Agilent	E4418B	FA001678	1 year	May 15/18
Power sensor	HP	8482A	FA001944	1 year	May 12/18
DFS and Adaptivity system	Aeroflex	PXI 30xx	FA002628	1 year	Aug 26/18

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 2.1049 Occupied bandwidth

8.1.1 Definitions and limits

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

8.1.2 Test summary

Test date	September 14, 2017	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	33 %

8.1.3 Observations, settings and special notes

As per KDB 935210 D05 out-of-band rejection requirements EUT output −20 dB BW was verified as follows: for 2326.250 MHz is 4.11 MHz, for 2338.755 MHz is 5.23 MHz.
Spectrum analyser settings:

Resolution bandwidth:	100 kHz
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-1: *99 % bandwidth results*

Frequency, MHz	99 % occupied bandwidth at the input, MHz	99 % occupied bandwidth at the output, MHz
2326.250	4.15	4.10
2338.755	5.23	5.21

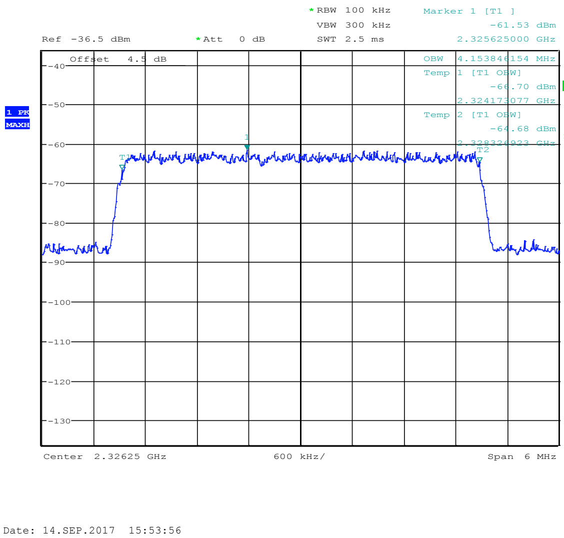


Figure 8.1-1: *99 % bandwidth on low band, input*

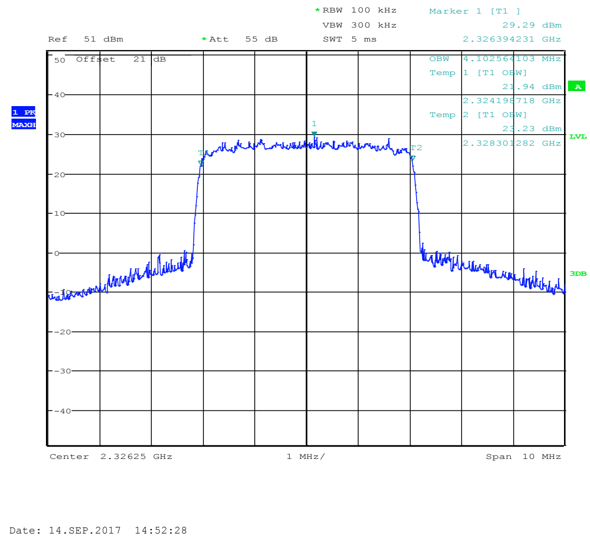


Figure 8.1-2: *99 % bandwidth on low band, output*

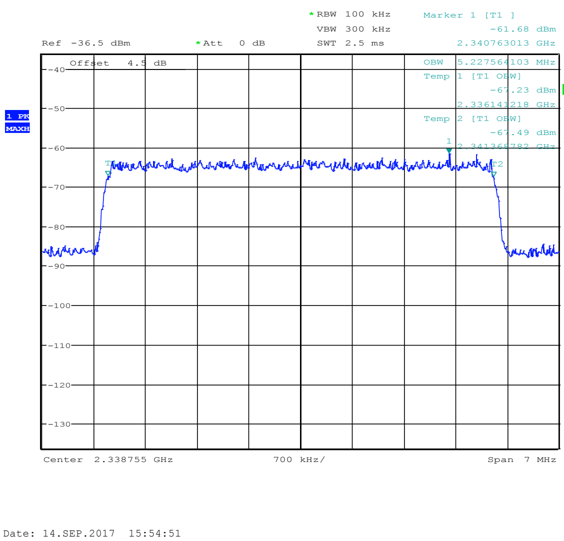


Figure 8.1-3: *99 % bandwidth on high band, input*

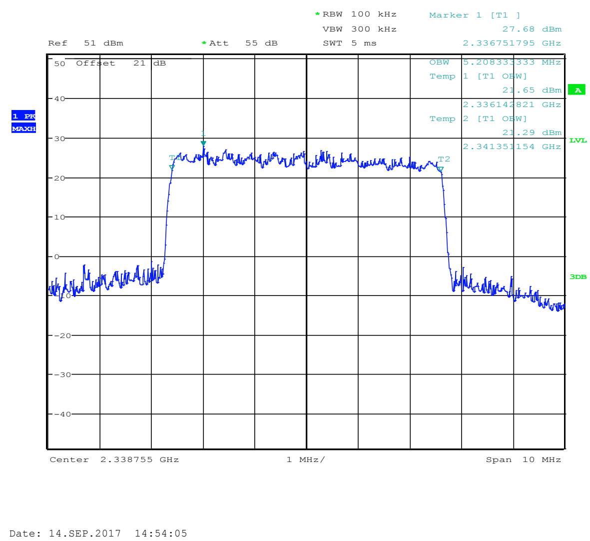


Figure 8.1-4: *99 % bandwidth on high band, output*

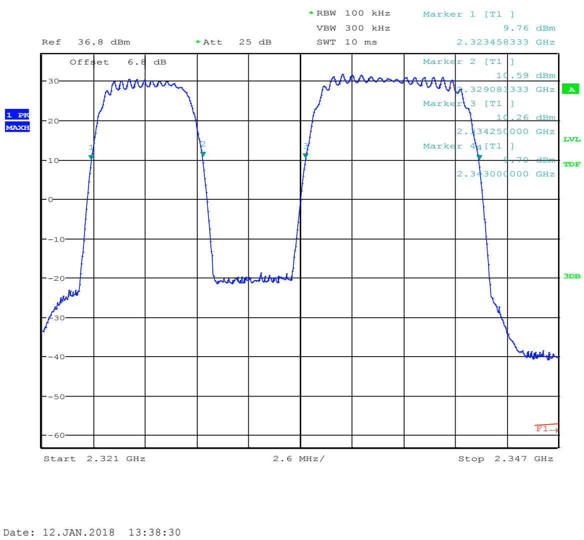


Figure 8.1-5: *Out-of-band rejection, at the output antenna port without external filter*

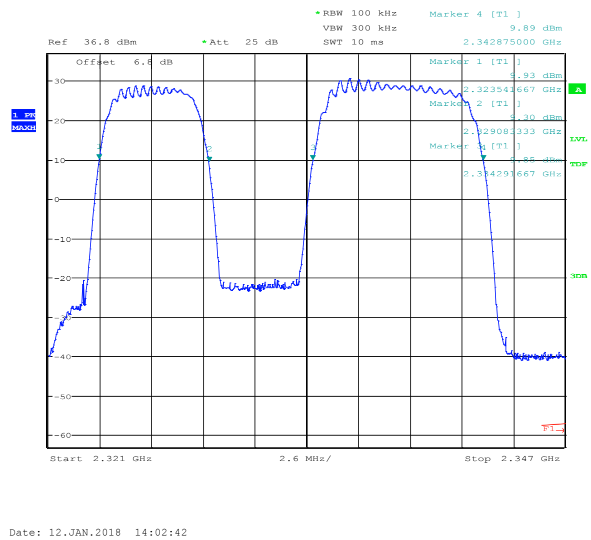


Figure 8.1-6: *Out-of-band rejection, at the output antenna port with external filter*

Note: signal generator was connected to the input of the EUT and CW tone was applied in sweep mode from 2.32 GHz to 2.35 GHz.

8.2 FCC 25.214(d) Transmitter output power

8.2.1 Definitions and limits

(d) Power limit for SDARS terrestrial repeaters. (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP

8.2.2 Test summary

Test date	September 14, 2017	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	33 %

8.2.3 Observations, settings and special notes

RMS composite output power was measured using average power meter. Both bands were transmitting simultaneously.
For the configuration with and without external filter, Lower band carrier was supplied with ±2.006 MHz COFDM DAB signal at −60.5 dBm power level, Higher band carrier was supplied with ±2.53 MHz COFDM DAB signal at −60.5 dBm power level.
As per KDB 935210 D05 input power level was used according to the AGC threshold level.

8.2.4 Test data

Table 8.2-1: *Output power measurement result without external filter*

Frequency, MHz	Output power, dBm	Antenna gain, dB	EIRP, dBm	EIRP limit, dBm	Margin, dB
2326.250 and 2338.755	32.96	13.00	45.96	70.79	24.83

Table 8.2-2: *Output power measurement result with external filter*

Frequency, MHz	Output power, dBm	Antenna gain, dB	EIRP, dBm	EIRP limit, dBm	Margin, dB
2326.250 and 2338.755	32.94	N/A	32.94	70.79	37.85

8.3 FCC 25.144(e)(7)(ii) Peak-to-Average Power Ratio (PAPR)

8.3.1 Definitions and limits

In addition to the procedures set forth in subpart J of part 2 of this chapter, power measurements for SDARS repeater transmitters may be made in accordance with a Commission-approved average power technique. Peak-to-average power ratio (PAPR) measurements for SDARS repeater transmitters should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that the PAPR will not exceed 13 dB for more than 0.1 percent of the time or another Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

§25.214 Technical requirements for space stations in the Satellite Digital Audio Radio Service and associated terrestrial repeaters.

(d) Power limit for SDARS terrestrial repeaters. (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP, with a maximum peak-to-average power ratio of 13 dB.

8.3.2 Test summary

Test date	September 1, 2017	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	33 %

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

Table 8.3-1: *Output power measurement result*

Frequency, MHz	PAPR, dB	Limit, dB	Margin, dB
2326.250	8.56	13.00	4.44
2338.755	10.10	13.00	2.90

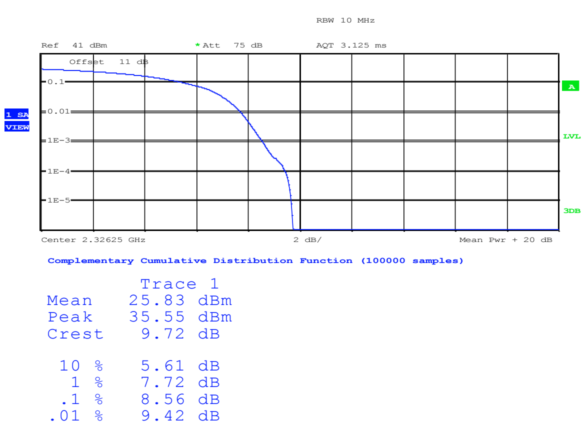


Figure 8.3-1: *PAPR on low band*

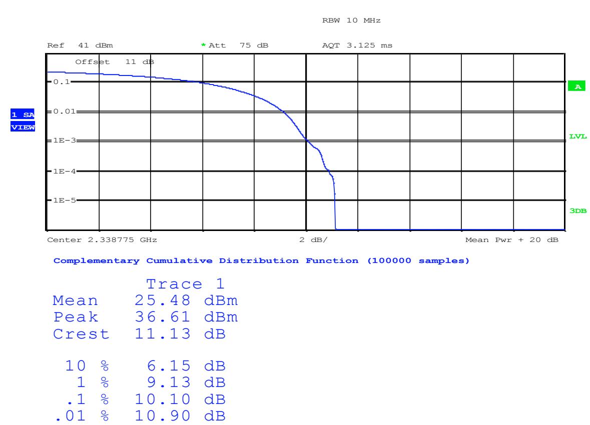


Figure 8.3-2: *PAPR on high band*

8.4 FCC 25.202(h) Spurious out-of-band emissions, conducted

8.4.1 Definitions and limits

(1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than 90 + 10 log (P) dB in a 1-megahertz bandwidth outside the 2320–2345 MHz band, where P is average transmitter output power in watts.
(2) Any SDARS terrestrial repeater operating at a power level equal to or less than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than 75 + 10 log (P) dB in a 1-megahertz bandwidth outside the 2320–2345 MHz band, where P is average transmitter output power in watts.

8.4.2 Test summary

Test date	September 1, 2017	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	33 %

8.4.3 Observations, settings and special notes

Configuration with the external filter was used to comply with the section FCC 25.202(h)(1).
Configuration without the external filter was used to comply with the section FCC 25.202(h)(2).
Since EUT cannot transmit at two adjacent frequencies simultaneously, intermodulation assessment is not applicable.
The spectrum was searched from 30 MHz to the 10th harmonic.
EUT without external filter operates with the power greater than 2 W average EIRP, therefore the applicable limit is 90 + 10 log (P) dB in a 1-megahertz bandwidth or −60 dBm/MHz.
EUT with external filter operates with the power equal or less than 2 W average EIRP, therefore the applicable limit is 75 + 10 log (P) dB in a 1-megahertz bandwidth or −45 dBm/MHz

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	RMS
Trace mode	Averaging

8.4.4 Test data

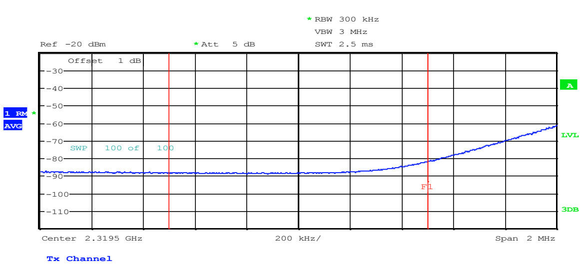


Figure 8.4-1: *Spurious emissions at the lower band edge at 2.32 GHz, configuration with external filter*

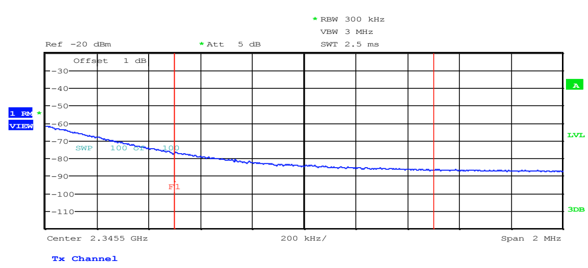


Figure 8.4-2: *Spurious emissions at the upper band edge at 2.345 GHz, configuration with external filter*

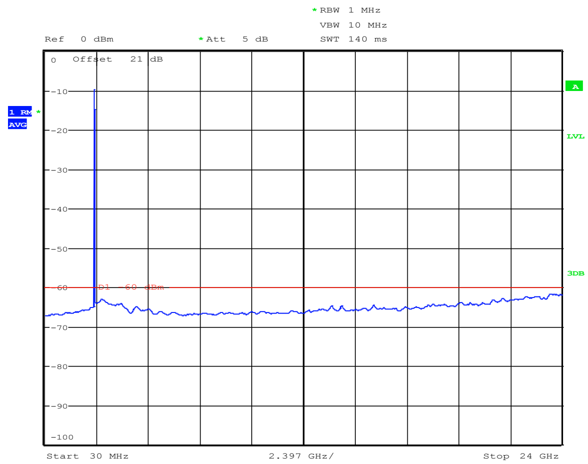


Figure 8.4-3: *Spurious emissions, configuration with external filter*

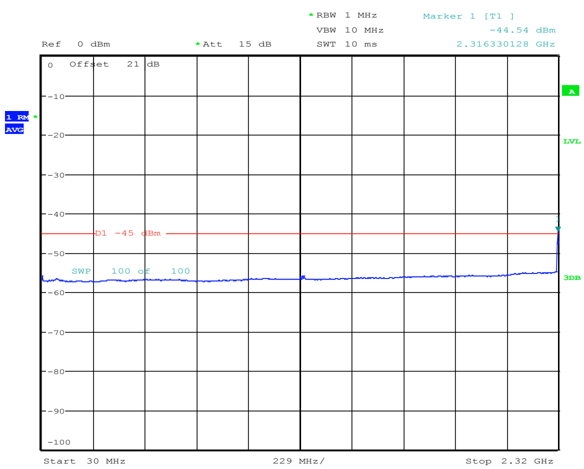


Figure 8.4-4: *Spurious emissions below 2.320 GHz, configuration without external filter*

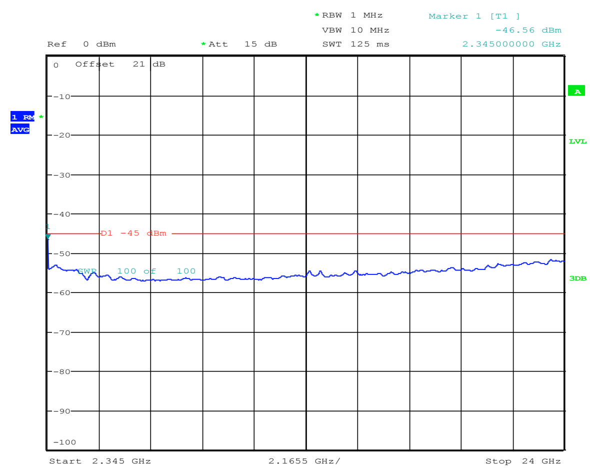


Figure 8.4-5: *Spurious emissions above 2.345 GHz, configuration without external filter*

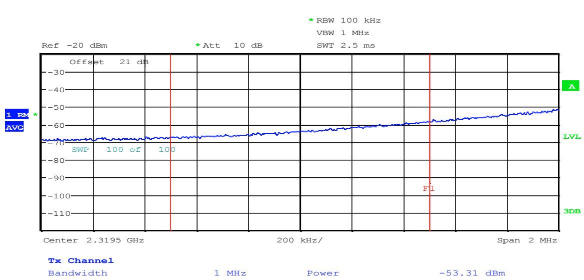


Figure 8.4-6: *Spurious emissions at the lower band edge at 2.32 GHz, configuration without external filter*

Figure 8.4-7: *Spurious emissions at the upper band edge at 2.345 GHz, configuration without external filter*

8.5 FCC 25.202(h) Spurious out-of-band emissions, radiated

8.5.1 Definitions and limits

(1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than 90 + 10 log (P) dB in a 1-megahertz bandwidth outside the 2320–2345 MHz band, where P is average transmitter output power in watts.
(2) Any SDARS terrestrial repeater operating at a power level equal to or less than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than 75 + 10 log (P) dB in a 1-megahertz bandwidth outside the 2320–2345 MHz band, where P is average transmitter output power in watts.

8.5.2 Test summary

Test date	September 5, 2017	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	37 %

8.5.3 Observations, settings and special notes

EUT was scanned in two configurations:
Configuration with the external filter was used to comply with the section FCC 25.202(h)(1).
Configuration without the external filter was used to comply with the section FCC 25.202(h)(2).
In both cases output port to the antenna was terminated with the 50-Ohm load.
The spectrum was searched from 30 MHz to the 10^{th} harmonic.
EUT without external filter operates with the power greater than 2 W average EIRP, therefore the applicable limit is 90 + 10 log (P) dB in a 1-megahertz bandwidth or −60 dBm/MHz.
EUT with external filter operates with the power equal or less than 2 W average EIRP, therefore the applicable limit is 75 + 10 log (P) dB in a 1-megahertz bandwidth or −45 dBm/MHz

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	RMS
Trace mode	Averaging

8.5.4 Test data

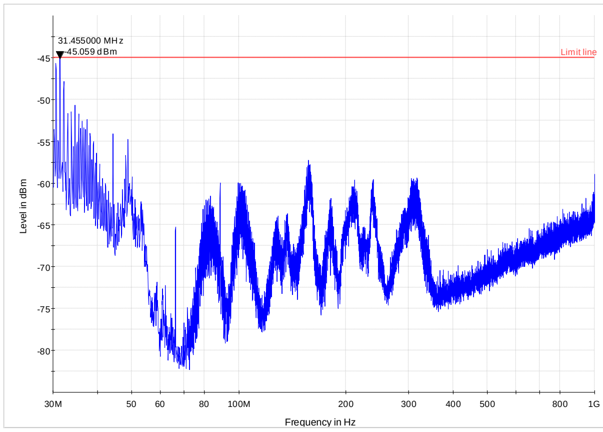


Figure 8.5-1: *Spurious emissions below 1 GHz, low range, configuration without external filter*

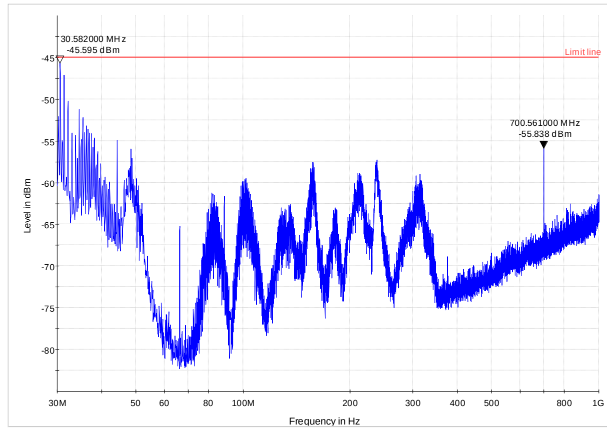


Figure 8.5-2: *Spurious emissions below 1 GHz, high range, configuration without external filter*

Note: configuration with external filter was scanned as well. No RF related emissions were detected within 10 dB below the limits.

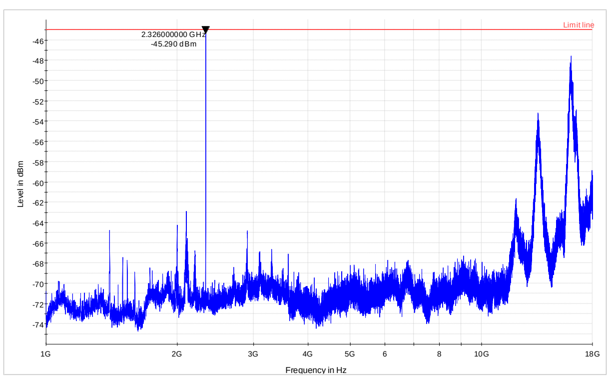


Figure 8.5-3: *Spurious emissions within 1–18 GHz, low range, configuration without external filter*

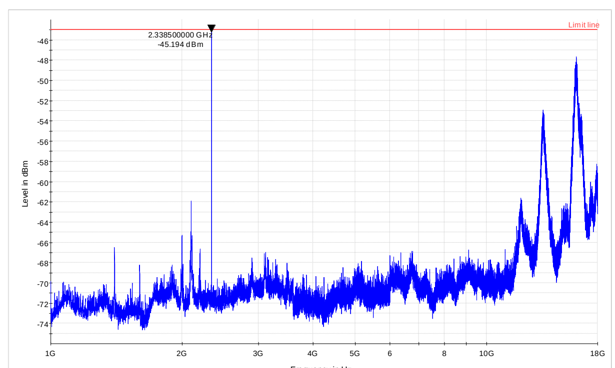
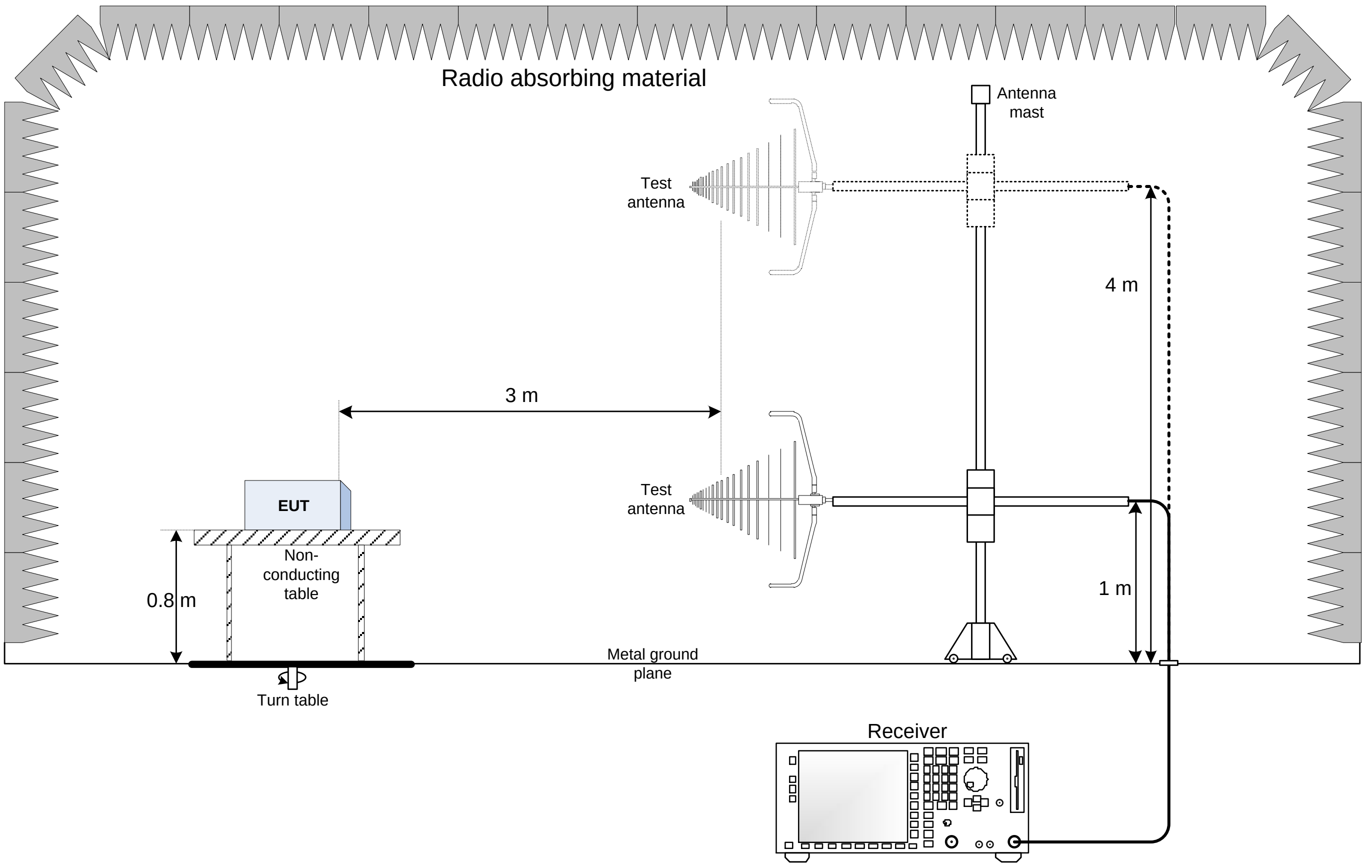


Figure 8.5-4: *Spurious emissions within 1–18 GHz, high range, configuration without external filter*

Note: configuration with external filter was scanned as well. No RF related emissions were detected within 10 dB below the limits.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz