



WIRELESS TEST REPORT – 381042-1TRWL

Applicant:

Satcube AB

Product:

Portable satellite terminal

Model:

Satcube Ku

FCC ID:

2AUV4SATCUBEKU

Specifications:

FCC 47 CFR Part 25

Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

Date of issue: **November 1, 2019**

David Duchesne, Senior EMC/Wireless Specialist

Tested by

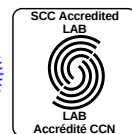
Signature

Andrey Adelberg, Senior Wireless/EMC Specialist

Reviewed by

Signature

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada.
The tests included in this report are within the scope of this accreditation



Lab locations

Company name	Nemko Canada Inc.			
Facilities	Ottawa site:	Montréal site:	Cambridge site:	Almonte site:
	303 River Road	292 Labrosse Avenue	1-130 Saltsman Drive	1500 Peter Robinson Road
	Ottawa, Ontario	Pointe-Claire, Québec	Cambridge, Ontario	West Carleton, Ontario
	Canada	Canada	Canada	Canada
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	Fax: +1 613 737 9691	Fax: +1 514 694 3528		Fax: +1 613 256-8848
Test site registration	Organization	Recognition numbers and location		
	FCC/ISED	CA2040 (Ottawa/Almonte); CA2041 (Montreal); CA0101 (Cambridge)		
Website	www.nemko.com			

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 contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 25

Satellite communications

1.2 Exclusions

None

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.2 above. 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.

1.4 Test report revision history

Table 1.4-1: Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	October 17, 2019	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

None

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	30 % – 60 %
Air pressure	86 kPa (860 mbar) – 106 kPa (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.

3.2 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 $\pm 5\%$, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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

Table 4.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13

Section 5 Summary of test results

5.1 Testing location

Test location (s)	Ottawa
-------------------	--------

5.2 Testing period

Test start date	October 3, 2019
Test end date	October 8, 2019

5.3 Sample information

Receipt date	September 23, 2019
Nemko sample ID number	Item # 1

5.4 Test results

Table 5.4-1: Result summary

Part	Test description	Verdict
2.1049	Occupied bandwidth*	Pass
25.203 (c)(2)(ix) and 25.204(a)	Power Spectral Density and Total Tx power	Pass
25.202(d)	Frequencies tolerance	Pass
25.202(f)	Emission limits	Pass

Notes: * No limits apply.

5.5 Technical information

All used IC test site(s) Reg. number	2040A-4
Frequency range, GHz	Transmit: 13.75 14.5, Receive: 10.95 to 12.75
Test frequencies, GHz	Low channel: 13.75, Mid channel: 14.25, High channel: 14.5
Types of modulation	QPSK ¼, 8PSK ¼ and 16APSK ¼
Channel bandwidth	10, 7.5, 5 and 2.5
RF power Max (W)	20 (43 dBm)
Measured BW (MHz) (99 %)	9
Calculated BW (kHz), as per TRC-43	N/A
Transmitter spurious, Units @ distance	75.9 dBuV/m @ 14 GHz
Power requirements	24 V _{DC} (Via AC/DC adapter 100 – 240 V _{AC} , 47 – 63 Hz, 150 W)
Antenna information	Tx antenna gain = 31.2 dBi @ 13.75 GHz, 32 dBi @ 14.25 GHz, and 31.9 dBi @ 14.5 GHz

Section 6 Information provided by the applicant

6.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

6.2 Applicant

Company name	Satcube AB
Address	Box 7111 SE-40232 Gothenburg, Sweden

6.3 Manufacturer

Company name	Satcube AB
Address	Anders Carlssons gata 7, SE-41755 Gothenburg, Sweden

6.4 EUT information

Serial number	000021
Description/theory of operation	The EUT is a portable satellite terminal that provides broadband connectivity.
HW version	1.0.0
SW version	0.4.24

6.5 EUT setup details

6.5.1 EUT test configuration

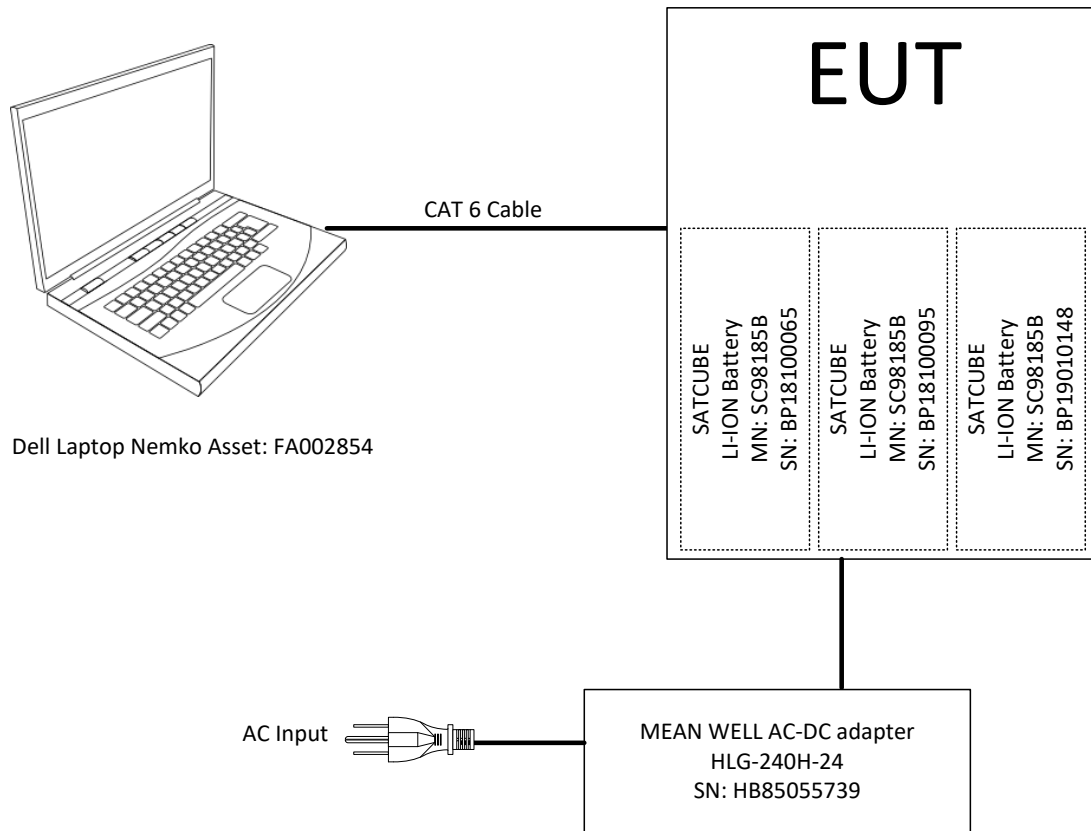


Figure 6.5-1: block diagram

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	January 24, 2020
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 3, 2020
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	November 7, 2019
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	October 9, 2019
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
50 Ω coax cable	C.C.A.	None	FA002556	1 year	April 18, 2020
50 Ω coax cable	Huber + Suhner	None	FA003099	1 year	May 10, 2020
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	October 26, 2019
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 years	July 29, 2022
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322a	3 years	July 29, 2022
60–90 GHz Harmonic mixer	OML	WR12 M12HWD	FA001524	3 years	July 29, 2022
60–90 GHz Standard gain horn	Millitech	U SGH-12	FA001524a	3 years	July 29, 2022
Temperature chamber	Espec	EPX-4H	FA002735	1 year	September 11, 2020

Note: NCR - no calibration required, VOU - verify on use

Section 8 Testing data

8.1 FCC 2.1049 Occupied bandwidth

8.1.1 Definitions and limits

§2.1049

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.

Test limit N/A

8.1.2 Test summary

Verdict	Pass		
Tested by	David Duchesne	Test date	October 3, 2019

8.1.3 Observations, settings and special notes

- **Test Method:** KDB 971168 D01 Power Meas License Digital Systems v03r01
- **Test procedure used:** ANSI C63.26-2015 – Section 5.4.4

Spectrum analyser settings:

Resolution bandwidth:	1 % to 5% of the OBW
Video bandwidth:	$\geq 3 \times \text{RBW}$
Detector mode:	Peak
Trace mode:	Max Hold
Sweep	Auto couple

8.1.5 Test data

Table 8.1-1: 99 % bandwidth results

Modulation	Channel bandwidth, MHz	Test Freq., GHz	99 % occupied bandwidth, MHz
QPSK $\frac{3}{4}$	10	14.25	9.0
8PSK $\frac{3}{4}$	10	14.25	9.0
16APSK $\frac{3}{4}$	10	14.25	9.0
QPSK $\frac{3}{4}$	7.5	14.25	7.0
8PSK $\frac{3}{4}$	7.5	14.25	6.8
16APSK $\frac{3}{4}$	7.5	14.25	7.0
QPSK $\frac{3}{4}$	5	14.25	4.5
8PSK $\frac{3}{4}$	5	14.25	4.4
16APSK $\frac{3}{4}$	5	14.25	4.5
QPSK $\frac{3}{4}$	2.5	14.25	2.2
8PSK $\frac{3}{4}$	2.5	14.25	2.2
16APSK $\frac{3}{4}$	2.5	14.25	2.2

Notes: None

8.1.5 Test data, continued

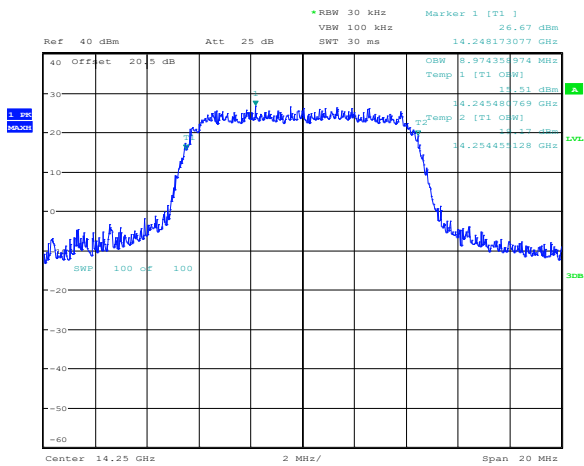


Figure 8.1-1: Sample plot 99 % bandwidth, QPSK ¼ with 10 MHz Bandwidth

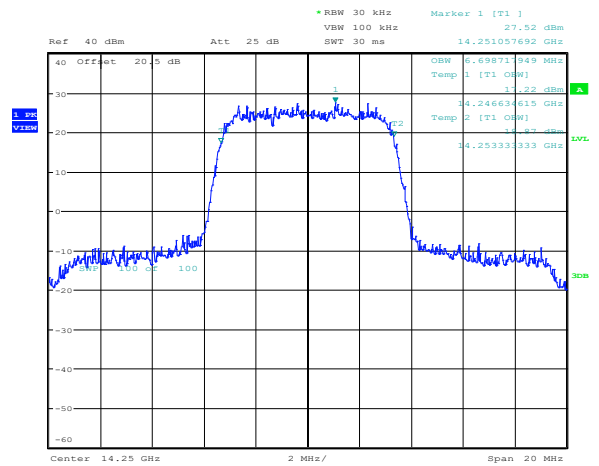


Figure 8.1-2: Sample plot 99 % bandwidth, QPSK ¼ with 7.5 MHz Bandwidth

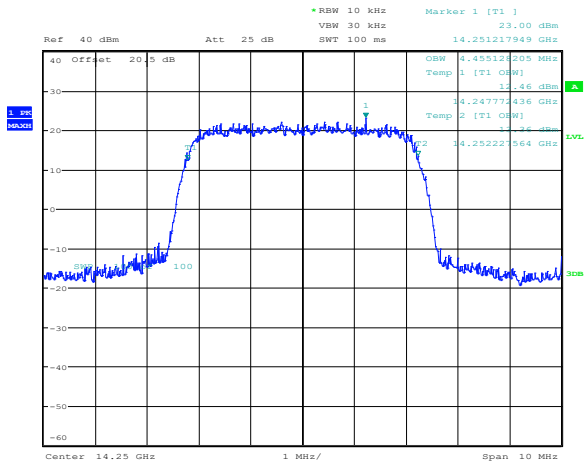


Figure 8.1-3: Sample plot 99 % bandwidth, QPSK ¼ with 5 MHz Bandwidth

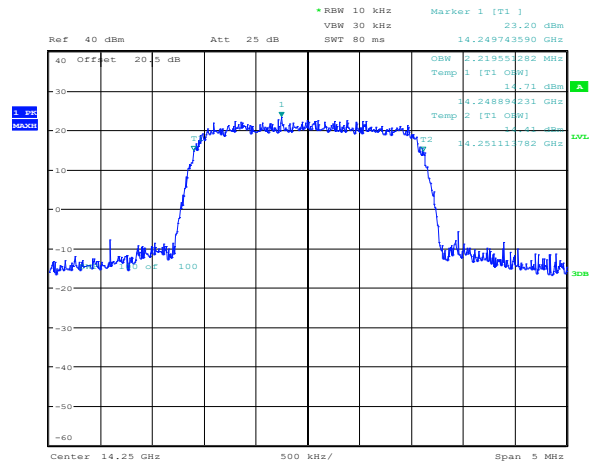


Figure 8.1-4: Sample plot 99 % bandwidth, QPSK ¼ with 2.5 MHz Bandwidth

8.2 FCC 25.203(c)(2)(ix) and 25.204 (a) Power Spectral Density and Total Tx power

8.2.1 Definitions and limits

§25.203 (c)(2)(ix)

Maximum equivalent isotropically radiated power (e.i.r.p.) density in the main beam in any 4 kHz band, (dBW/4 kHz) for frequency bands below 15 GHz or in any 1 MHz band (dBW/MHz) for frequency band above 15 GHz

§25.204

- (a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) below:
- +40 dBW (70 dBm) in any 4 kHz band for $\Theta \leq 0^\circ$
 - +40 + 3 Θ dBW in any 4 kHz band for $0^\circ < \Theta \leq 5^\circ$

where Θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

8.2.2 Test summary

Verdict	Pass		
Tested by	David Duchesne	Test date	October 3, 2019

8.2.3 Observations, settings and special notes

- **Test Method:** KDB 971168 D01 Power Meas License Digital Systems v03r01
- **Test procedure used:** ANSI C63.26-2015-Section 5.2.4.5 (Density)
- **Test procedure used:** ANSI C63.26-2015-Section 5.2.4.4 (Total power)

Spectrum analyser settings:

Span:	2 to 3 times OBW
Resolution bandwidth:	3 kHz (PSD); 1–3 % (Total Power)
Video bandwidth:	$\geq 3 \times \text{RBW}$
Measurement points:	$\geq 2 \times \text{span} / \text{RBW}$
Detector mode:	Power averaging (RMS)
Trace mode:	Trace average
Integration (for Total Power):	Over the OBW

8.2.4 Test data

Table 8.2-1: Power Spectral Density result

Modulation	Chan. bandwidth, MHz	Configured modem output power ¹ , dBm	Test Freq., GHz	Avg. PSD, dBm/3kHz	RBW Cor. ³ , dB	Antenna gain ⁴ , dBi	Final Avg. PSD ³ , dBm/4kHz	Limit, dBm/4kHz	Margin, dB
QPSK %	10	-4.0	13.75	9.7	1.3	31.2	42.2	70	27.8
QPSK %	10	-5.3	14.25	7.1	1.3	32.0	40.3	70	29.7
QPSK %	10	-3.5	14.5	7.5	1.3	31.9	40.6	70	29.4
8PSK %	10	-5.3	14.25	7.3	1.3	32.0	40.6	70	29.5
16APSK %	10	-5.3	14.25	6.9	1.3	32.0	40.2	70	29.8
QPSK %	7.5	-5.2	13.75	11.0	1.3	31.2	43.5	70	26.5
QPSK %	7.5	-6.5	14.25	7.4	1.3	32.0	40.7	70	29.3
QPSK %	7.5	-4.7	14.5	8.6	1.3	31.9	41.7	70	28.3
8PSK %	7.5	-6.5	14.25	7.6	1.3	32.0	40.8	70	29.2
16APSK %	7.5	-6.5	14.25	7.3	1.3	32.0	40.5	70	29.5
QPSK %	5	-7.0	13.75	12.1	1.3	31.2	44.6	70	25.4
QPSK %	5	-8.3	14.25	8.1	1.3	32.0	41.4	70	28.6
QPSK %	5	-6.5	14.5	9.6	1.3	31.9	42.8	70	27.2
8PSK %	5	-8.3	14.25	8.2	1.3	32.0	41.4	70	28.6
16APSK %	5	-8.3	14.25	8.0	1.3	32.0	41.3	70	28.7
QPSK %	2.5	-10.0	13.75	13.6	1.3	31.2	46.1	70	23.9
QPSK %	2.5	-11.3	14.25	8.7	1.3	32.0	42.0	70	28.0
QPSK %	2.5	-9.5	14.5	10.1	1.3	31.9	43.2	70	26.8
8PSK %	2.5	-11.3	14.25	8.6	1.3	32.0	41.8	70	28.2
16APSK %	2.5	-11.3	14.25	8.5	1.3	32.0	41.78	70	28.2

Notes:

¹Configured modem output power (dBm) = 1 dB compression – Power Back off (dB)

– 1 dB compression @ 13.75 GHz = -4 dBm, 1 dB compression @ 14.25 GHz = -5.3 dBm, 1 dB compression @ 14.50 GHz = -3.5 dBm

– Channel Bandwidth Power back off @ 10 MHz = 0 dB, Channel Bandwidth Power back off @ 7.5 MHz = 1.2 dB, Channel Bandwidth Power back off @ 5MHz = 3 dB, Channel Bandwidth Power back off @ 2.5 MHz = 6 dB

²RBW correction factor = $10 \cdot \log(4\text{kHz}/3\text{kHz}) = 1.3 \text{ dB}$
³Final Power Spectral Density (dBm/4kHz) = Average Power Spectral Density (dBm/3kHz) + RBW correction factor + Antenna Gain (dBi)

⁴Tx antenna gain = 31.2 dBi @ 13.75 GHz, 32 dBi @ 14.25 GHz, and 31.9 dBi @ 14.5 GHz

8.2.4 Test data, continued

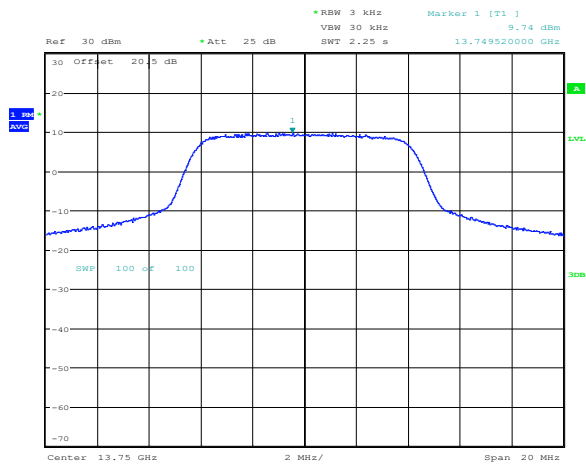


Figure 8.2-1: Sample plot Power Spectral Density, QPSK ¼ with 10 MHz Bandwidth

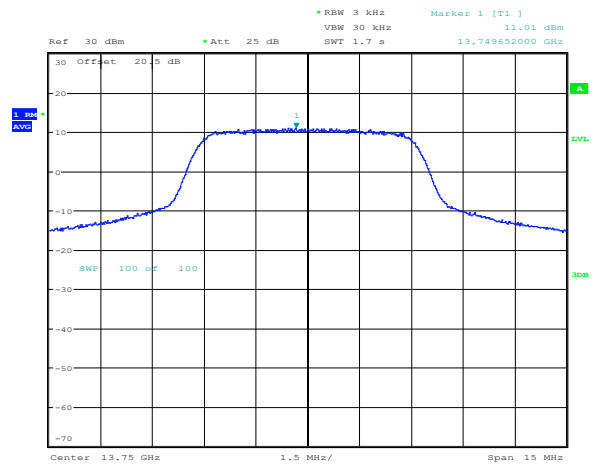


Figure 8.2-2: Sample plot Power Spectral Density, QPSK ¼ with 7.5 MHz Bandwidth

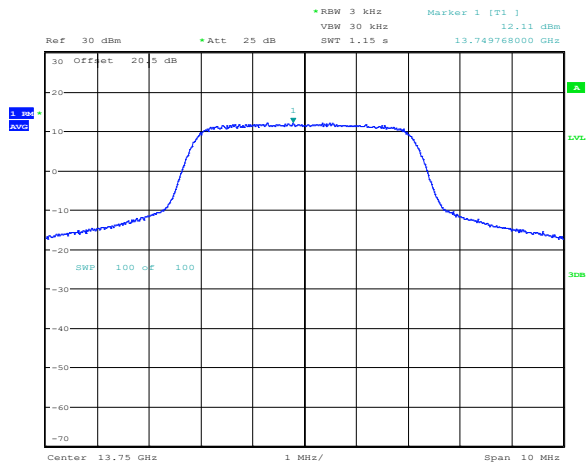


Figure 8.2-3: Sample plot Power Spectral Density, QPSK ¼ with 5 MHz Bandwidth

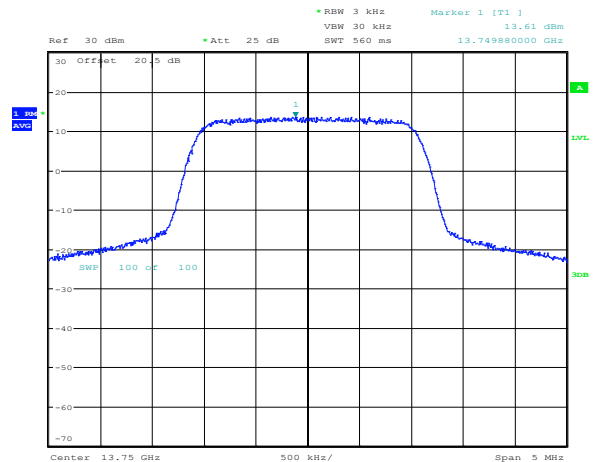


Figure 8.2-4: Sample plot Power Spectral Density, QPSK ¼ with 2 MHz Bandwidth

8.2.4 Test data, continued

Table 8.2-2: Total Tx power result

Modulation	Chan. bandwidth, MHz	Configured modem output power ¹ , dBm	Test Freq., GHz	Total power, dBm
QPSK ¼	10	-4.0	13.75	43.0
QPSK ¼	10	-5.3	14.25	40.2
QPSK ¼	10	-3.5	14.5	41.2
8PSK ¼	10	-5.3	14.25	40.2
16APSK ¼	10	-5.3	14.25	40.0
QPSK ¼	7.5	-5.2	13.75	42.7
QPSK ¼	7.5	-6.5	14.25	39.4
QPSK ¼	7.5	-4.7	14.5	40.6
8PSK ¼	7.5	-6.5	14.25	39.5
16APSK ¼	7.5	-6.5	14.25	39.3
QPSK ¼	5	-7.0	13.75	42.1
QPSK ¼	5	-8.3	14.25	38.1
QPSK ¼	5	-6.5	14.5	39.6
8PSK ¼	5	-8.3	14.25	38.2
16APSK ¼	5	-8.3	14.25	38.2
QPSK ¼	2.5	-10.0	13.75	40.1
QPSK ¼	2.5	-11.3	14.25	35.5
QPSK ¼	2.5	-9.5	14.5	37.5
8PSK ¼	2.5	-11.3	14.25	35.5
16APSK ¼	2.5	-11.3	14.25	35.5

Notes:

¹Configured modem output power (dBm) = 1 dB compression – Power Back off (dB)

- 1 dB compression @ 13.75 GHz = -4 dBm, 1 dB compression @ 14.25 GHz = -5.3 dBm, 1 dB compression @ 14.50 GHz = -3.5 dBm
- Channel Bandwidth Power back off @ 10 MHz = 0 dB, Channel Bandwidth Power back off @ 7.5 MHz = 1.2 dB, Channel Bandwidth Power back off @ 5MHz = 3 dB, Channel Bandwidth Power back off @ 2.5 MHz = 6 dB

8.2.4 Test data, continued

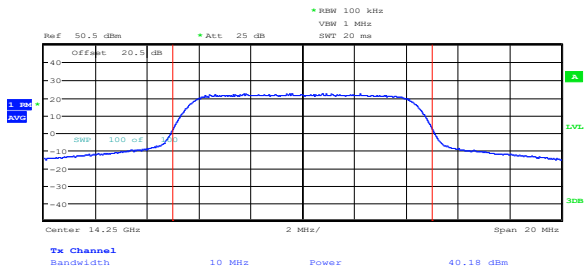


Figure 8.2-5: Sample plot Total Tx power, QPSK ¼ with 10 MHz Bandwidth

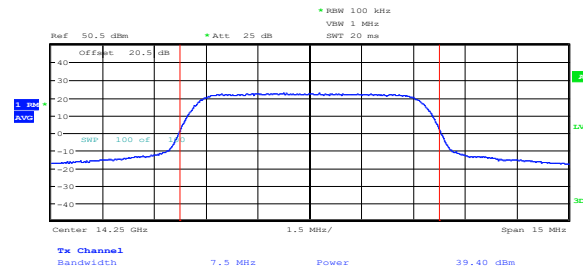


Figure 8.2-6: Sample plot Total Tx power, QPSK ¼ with 7.5 MHz Bandwidth

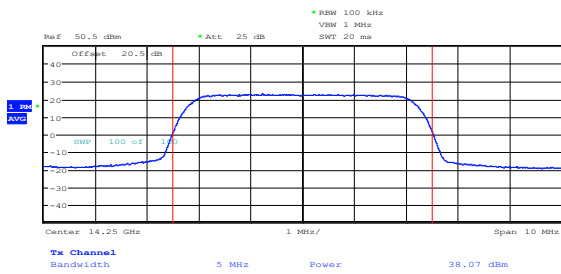


Figure 8.2-7: Sample plot Total Tx power, QPSK ¼ with 5 MHz Bandwidth

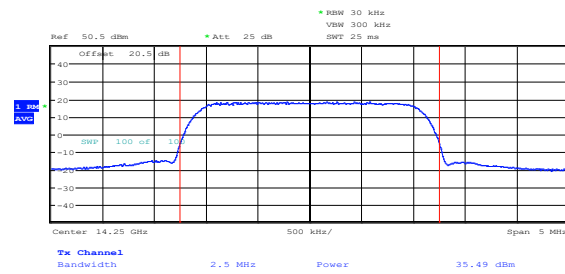


Figure 8.2-8: Sample plot Total Tx power, QPSK ¼ with 2 MHz Bandwidth

8.3 FCC 15.202(f) Emission limits

8.3.1 Definitions and limits

§25.202

(f) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section.

- (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
- (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
- (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts (–13 dBm fixed);

8.3.2 Test summary

Verdict	Pass		
Tested by	David Duchesne	Test date	October 3-10, 2010

8.3.3 Observations, settings and special notes

- **Test Method:** KDB 971168 D01 Power Meas License Digital Systems v03r01
- **Test procedure used:** ANSI C63.26-2015-Section 5.7
- Spurious emissions at antenna terminal was scanned from 30 MHz to 90 GHz.
- Spurious radiation (enclosure) was scanned from 30 MHz to 90 GHz. (Antenna port was terminated).
- Modulations QPSK $\frac{1}{4}$, 8PSK $\frac{1}{4}$, and 16APSK $\frac{1}{4}$ and channel BW 10, 7.5, 5 and 2.5 MHz were assessed.

Spectrum analyser settings (Assigned frequency up to and including 250 percent of the authorized bandwidth)

Resolution bandwidth:	3 kHz,
Video bandwidth:	$\geq 3 \times \text{RBW}$
Detector mode:	Power averaging (RMS)
Sweep time:	Auto couple
Trace mode:	Trace average
Notes:	– Analyzer center frequency was set to the frequency of the radiated spurious emission of interest. – $10 \cdot \log(4\text{kHz}/3\text{kHz}) = 1.25\text{dB}$ was added to the reference offset to correct the result relative to any 4kHz band as per the requirement in 25.202(f) (1).

Spectrum analyser settings: (Beyond 250 percent of the authorized bandwidth)

Resolution bandwidth:	100kHz for below 1GHz or 1MHz for above 1GHz
Video bandwidth:	$\geq 3 \times \text{RBW}$
Detector mode:	Power averaging (RMS)
Sweep time:	Auto couple
Trace mode:	Trace average
Notes:	If emissions were detected within 10 dB of limit, measurements were rechecked with resolution bandwidth of 3 kHz and video bandwidth $\geq 3 \times \text{RBW}$. $10 \cdot \log(4\text{kHz}/3\text{kHz}) = 1.25\text{dB}$ was added to the reference offset to correct the result relative to any 4kHz band as per the requirement in 25.202(f) (1).

8.3.4 Test data

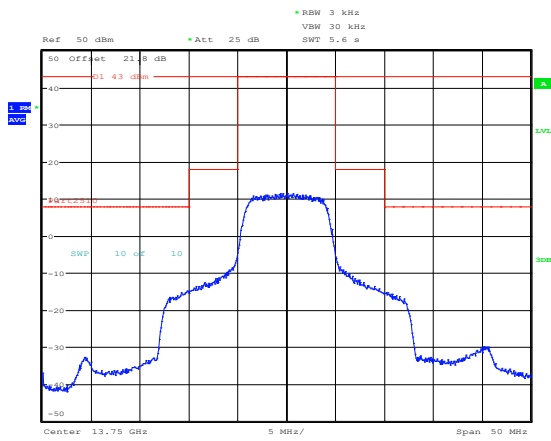


Figure 8.3-1: In-Band, QPSK ¼ with 10 MHz Bandwidth Tx 13.75 GHz

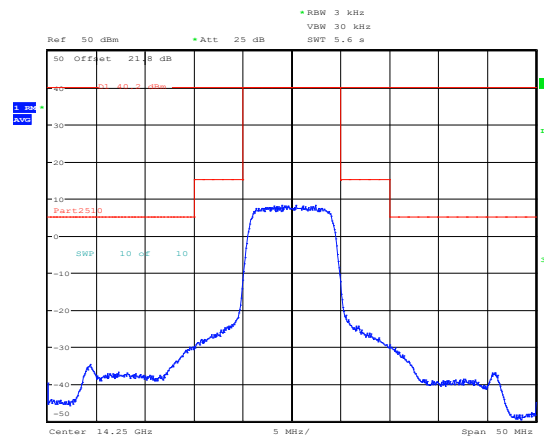


Figure 8.3-2: In-Band, QPSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

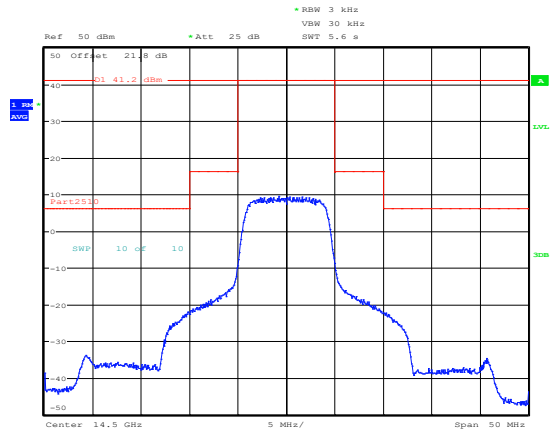


Figure 8.3-3: In-Band, QPSK ¼ with 10 MHz Bandwidth Tx 14.5 GHz

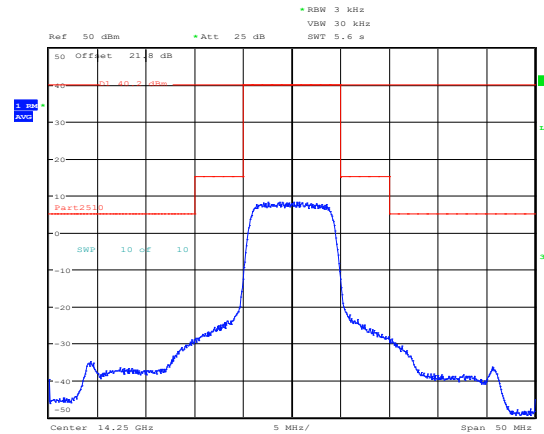


Figure 8.3-4: In-Band, 8PSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

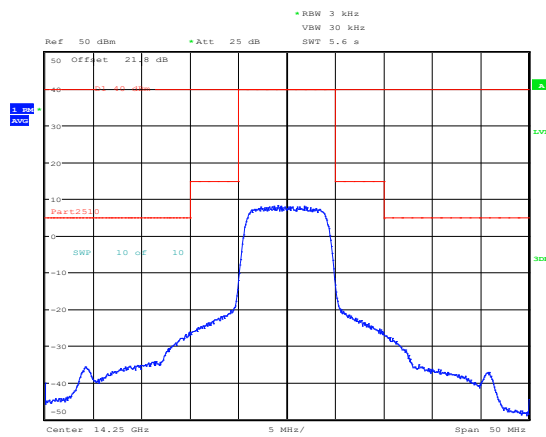


Figure 8.3-5: In-Band, 16APSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

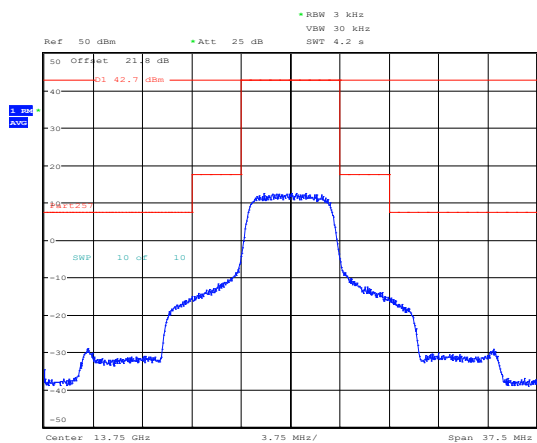


Figure 8.3-6: In-Band, QPSK ¼ with 7.5 MHz Bandwidth Tx 13.75 GHz

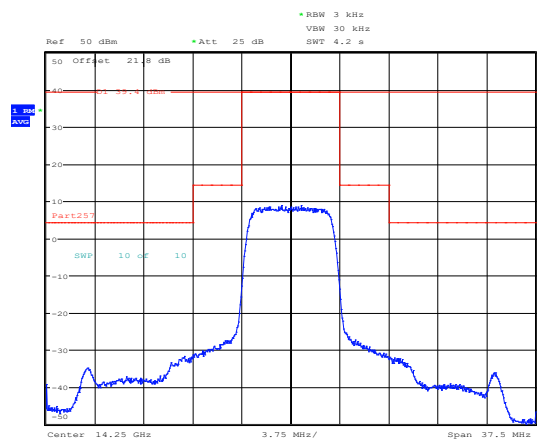


Figure 8.3-7: In-Band, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

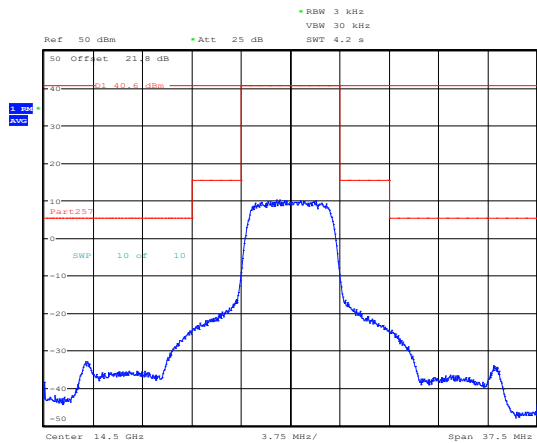


Figure 8.3-8: In-Band, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.5 GHz

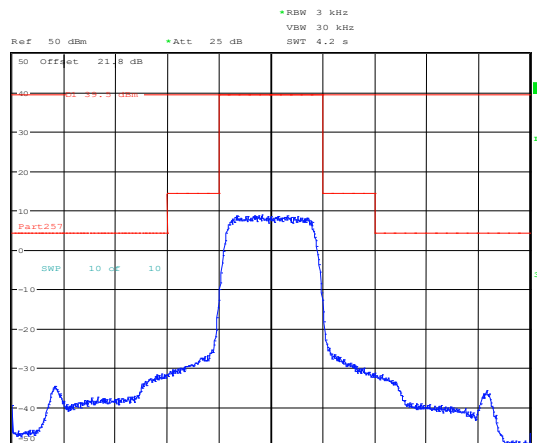


Figure 8.3-9: In-Band, 8PSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

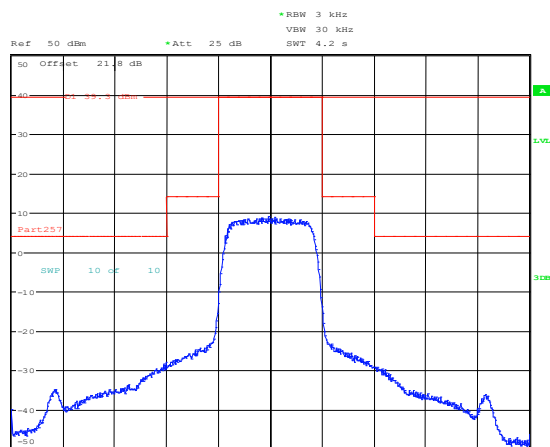


Figure 8.3-10: In-Band, 16APSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

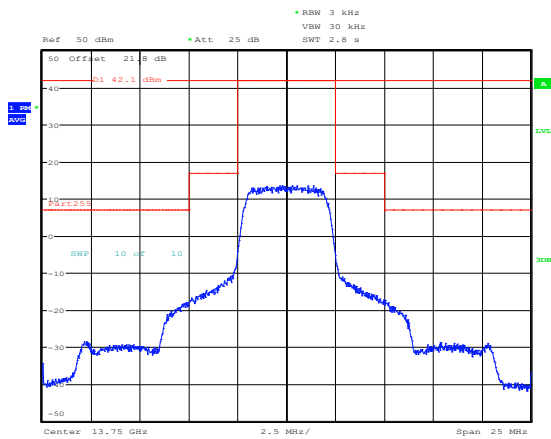


Figure 8.3-11: In-Band, QPSK ¼ with 5 MHz Bandwidth Tx 13.75 GHz

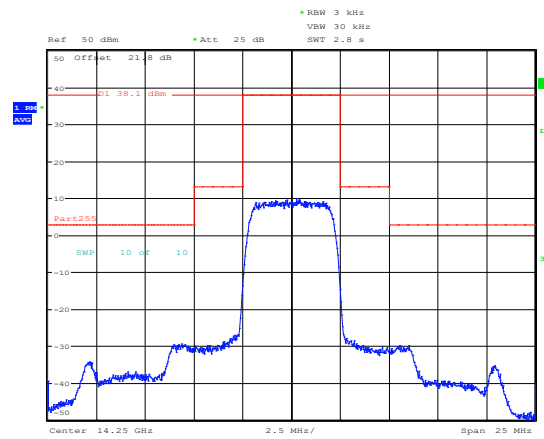


Figure 8.3-12: In-Band, QPSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

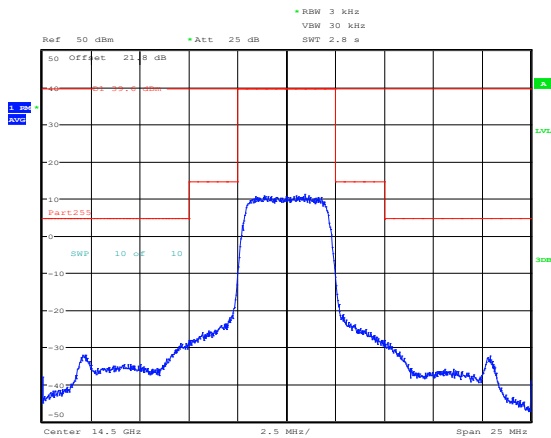


Figure 8.3-13: In-Band, QPSK ¼ with 5 MHz Bandwidth Tx 14.5 GHz

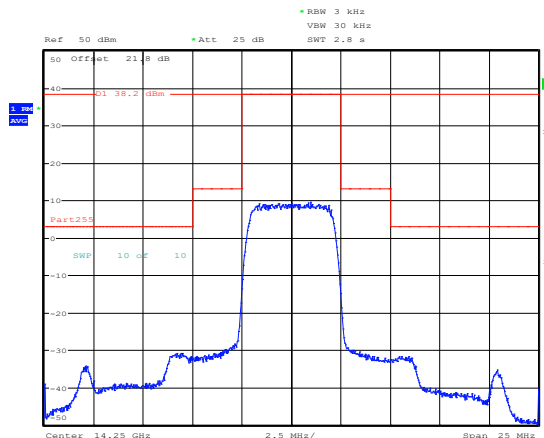


Figure 8.3-14: In-Band, 8PSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

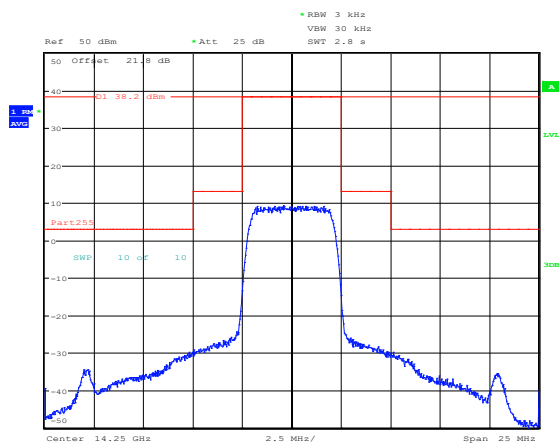


Figure 8.3-15: In-Band, 16APSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

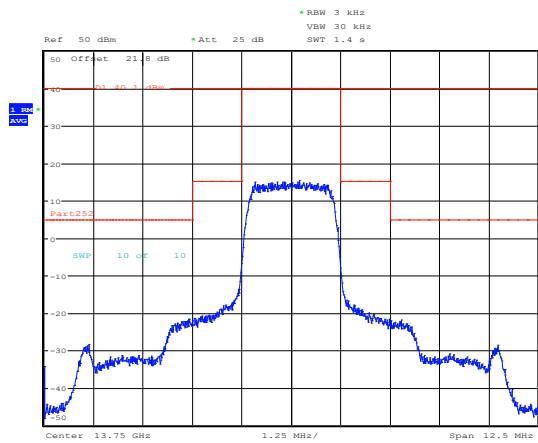


Figure 8.3-16: In-Band, QPSK ¼ with 2.5 MHz Bandwidth Tx 13.75 GHz

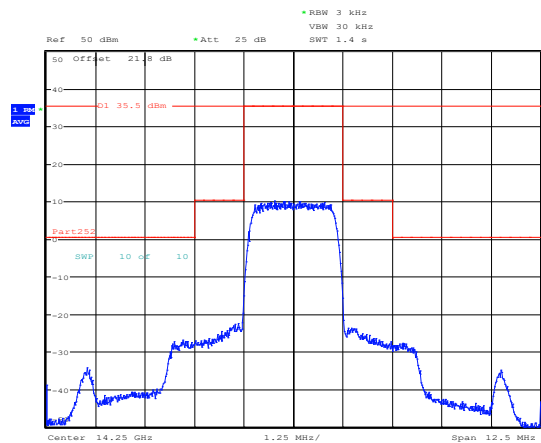


Figure 8.3-17: In-Band, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

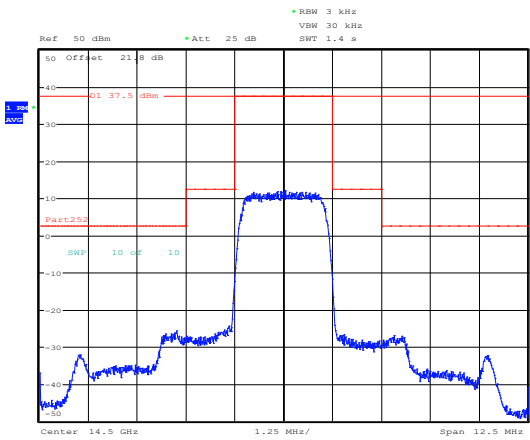


Figure 8.3-18: In-Band, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.5 GHz

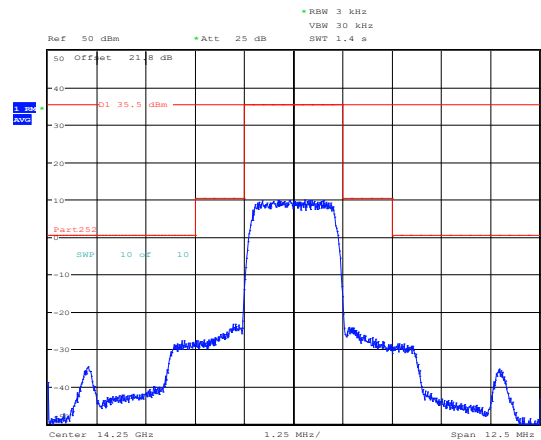


Figure 8.3-19: In-Band, 8PSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

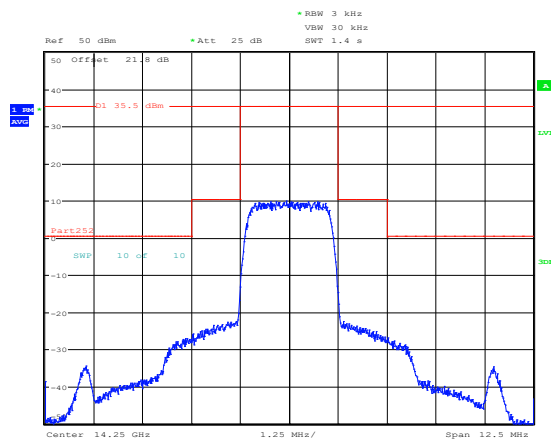


Figure 8.3-20: In-Band, 16APSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

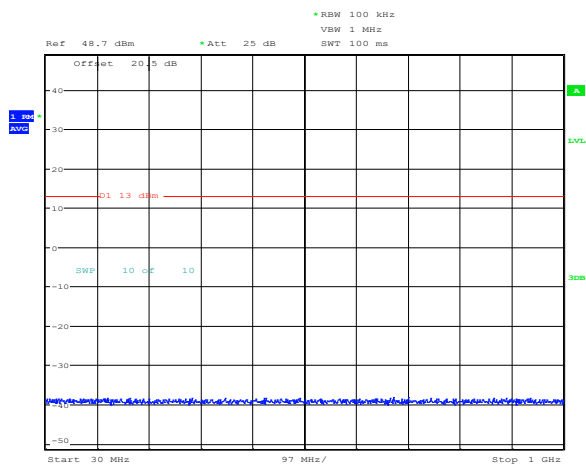


Figure 8.3-21: 30 to 1000 MHz, QPSK ¼ with 10 MHz Bandwidth Tx 13.75 GHz

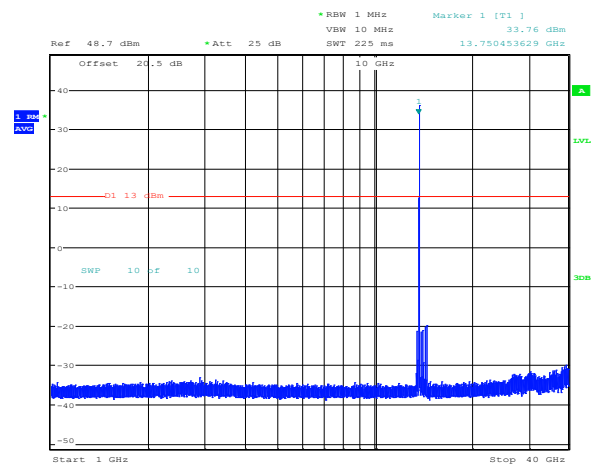


Figure 8.3-22: 1 to 40 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 13.75 GHz

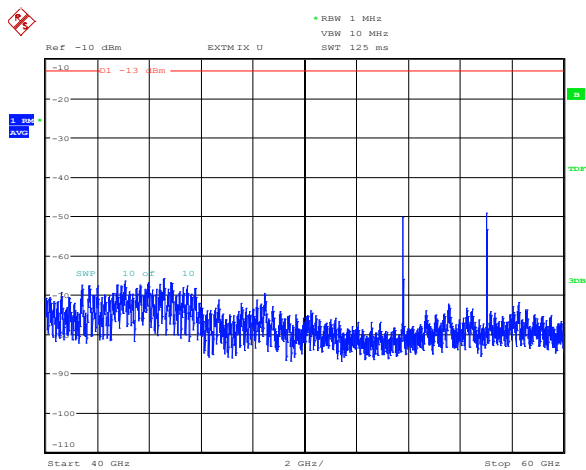


Figure 8.3-23: 40 to 60 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 13.75 GHz

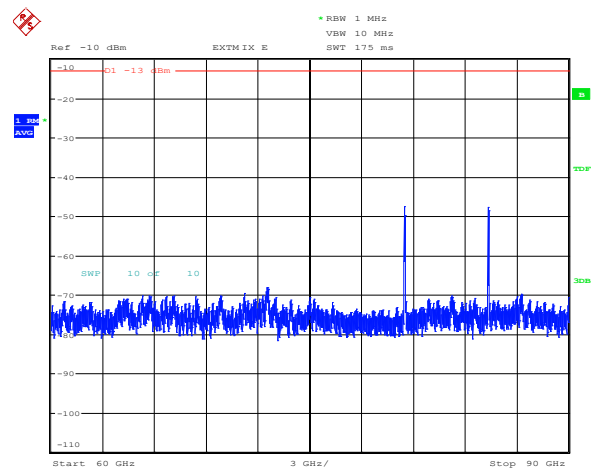


Figure 8.3-24: 60 to 80 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 13.75 GHz

8.3.4 Test data, continued

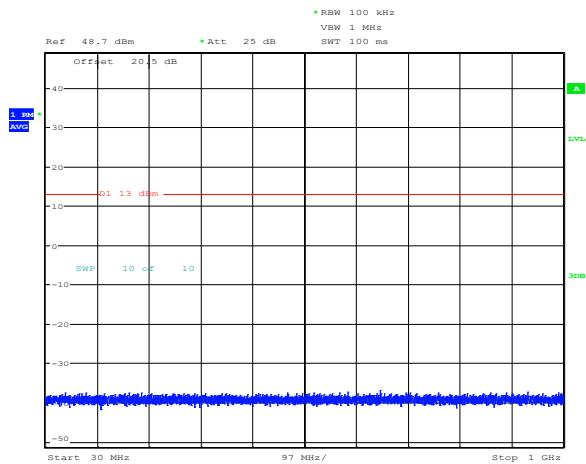


Figure 8.3-25: 30 to 1000 MHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

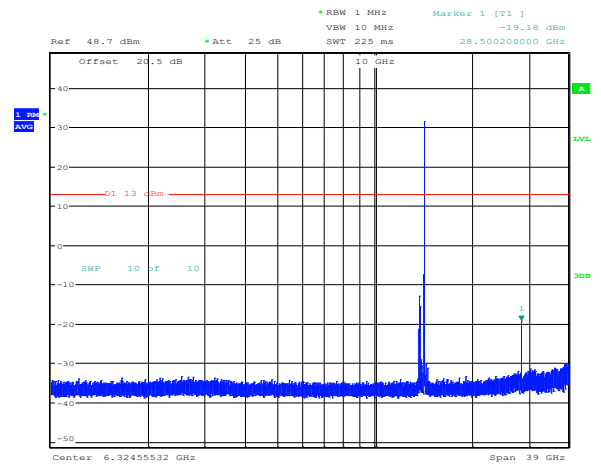


Figure 8.3-26: 1 to 40 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

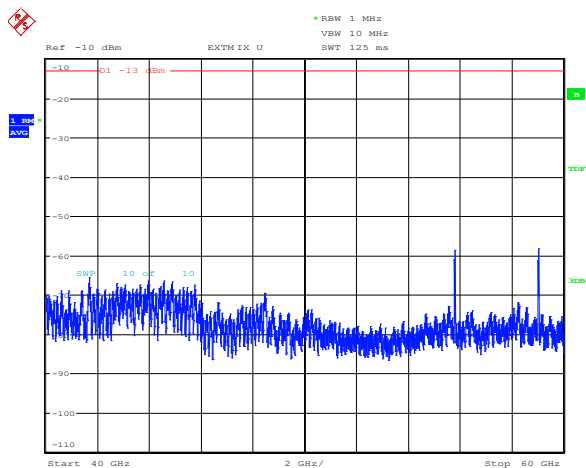


Figure 8.3-27: 40 to 60 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

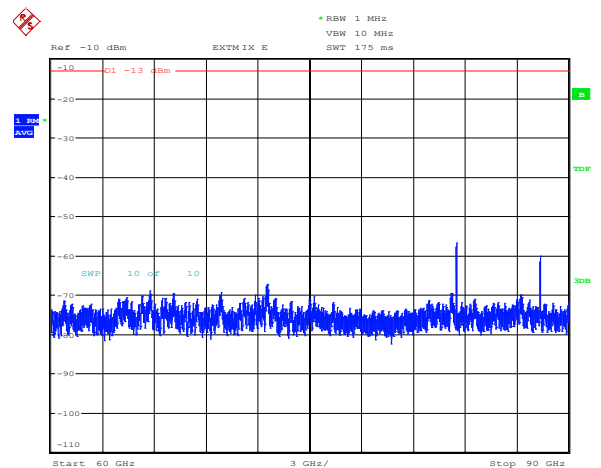


Figure 8.3-28: 60 to 80 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

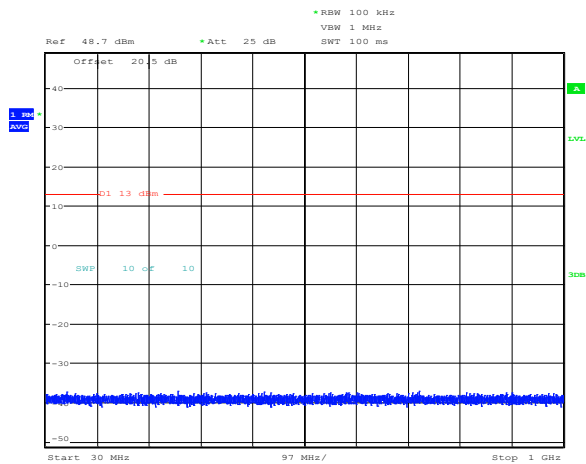


Figure 8.3-29: 30 to 1000 MHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.5 GHz

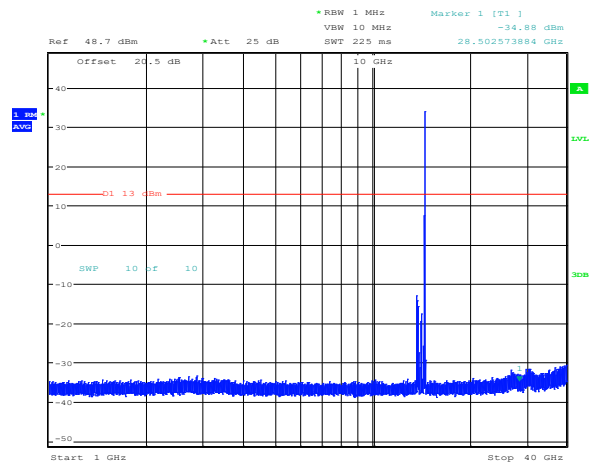


Figure 8.3-30: 1 to 40 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.5 GHz

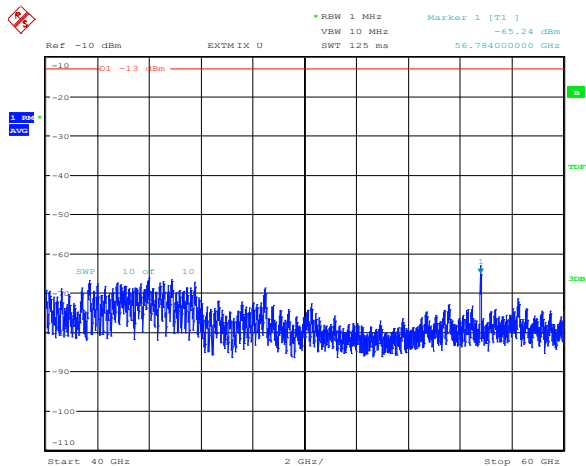


Figure 8.3-31: 40 to 60 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.5 GHz

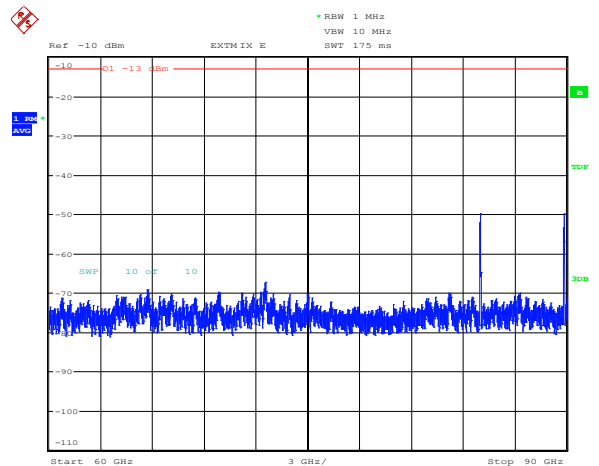


Figure 8.3-32: 40 to 90 GHz, QPSK ¼ with 10 MHz Bandwidth Tx 14.5 GHz

8.3.4 Test data, continued

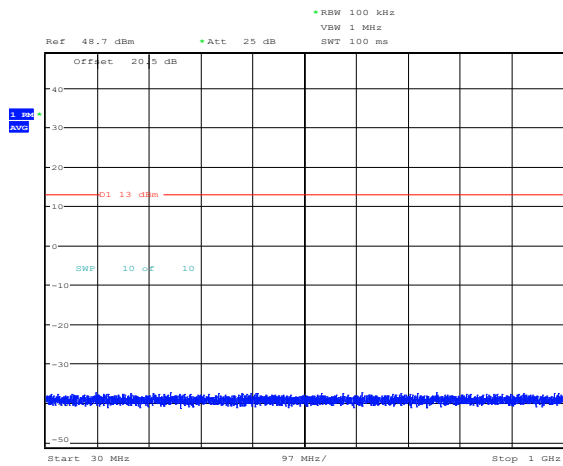


Figure 8.3-33: 30 to 1000 MHz, 8PSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

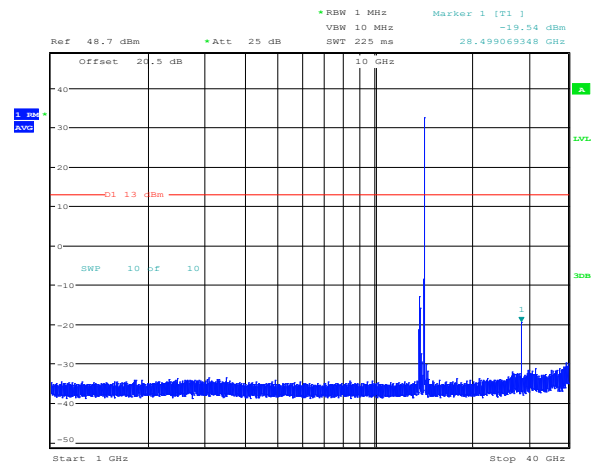


Figure 8.3-34: 1 to 40 GHz, 8PSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

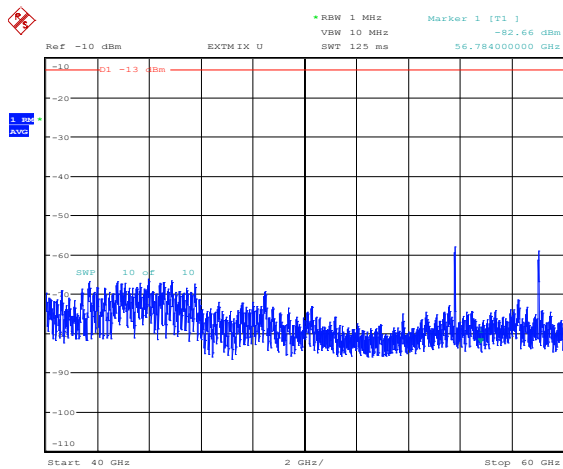


Figure 8.3-35: 40 to 60 GHz, 8PSK ¼ with 10 MHz Bandwidth Tx 14.25

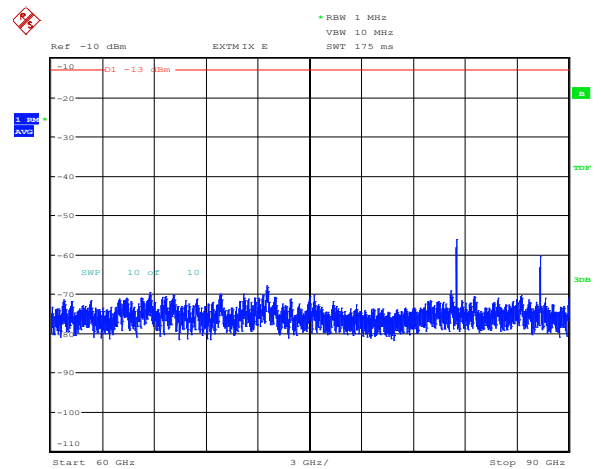


Figure 8.3-36: 60 to 90 GHz, 8PSK ¼ with 10 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

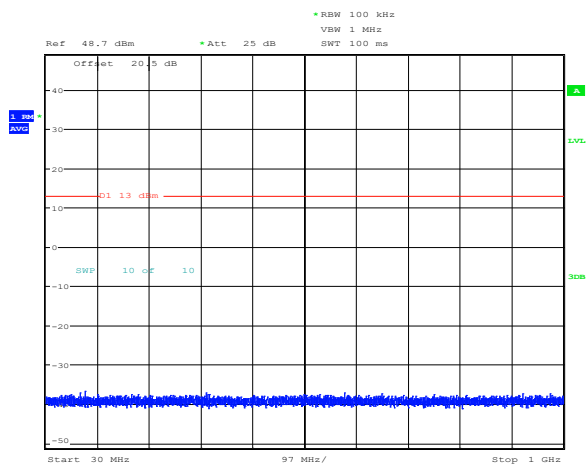


Figure 8.3-37: 30 to 1000 MHz, 16APSK $\frac{3}{4}$ with 10 MHz Bandwidth Tx 14.25 GHz

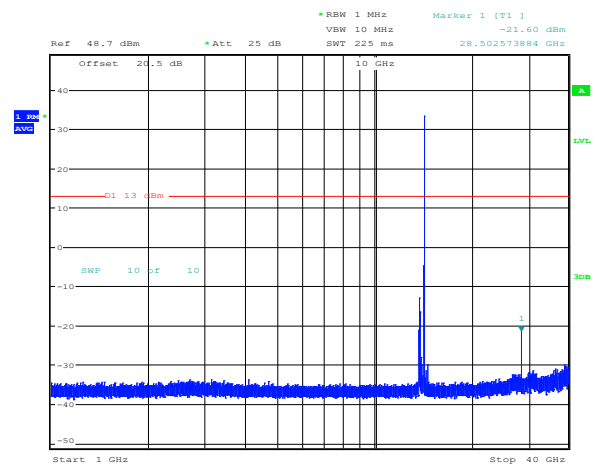


Figure 8.3-38: 1 to 40 GHz, 16APSK $\frac{3}{4}$ with 10 MHz Bandwidth Tx 14.25 GHz

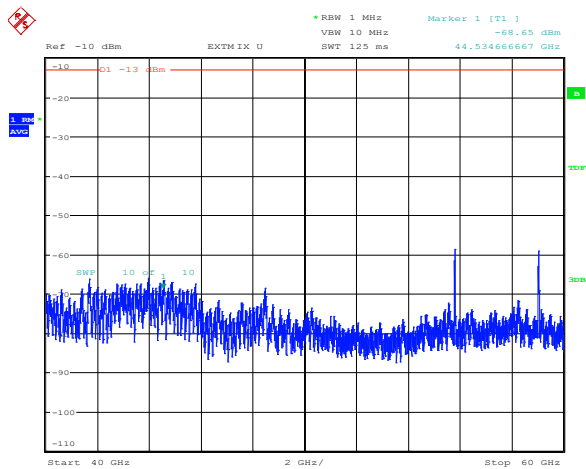


Figure 8.3-39: 40 to 60 GHz, 16APSK $\frac{3}{4}$ with 10 MHz Bandwidth Tx 14.25 GHz

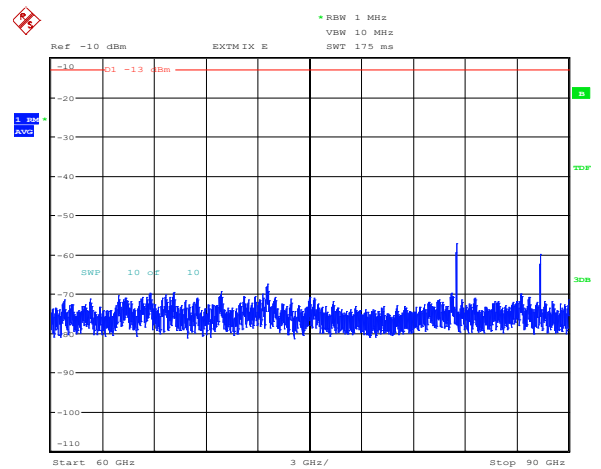


Figure 8.3-40: 60 to 90 GHz, 16APSK $\frac{3}{4}$ with 10 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

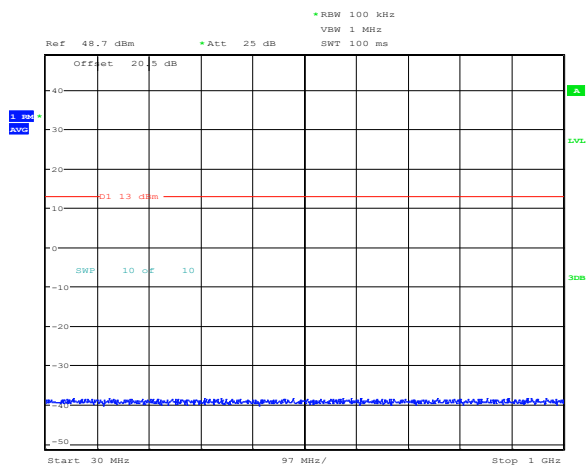


Figure 8.3-41: 30 to 1000 MHz, QPSK $\frac{3}{4}$ with 7.5 MHz Bandwidth Tx 13.75 GHz

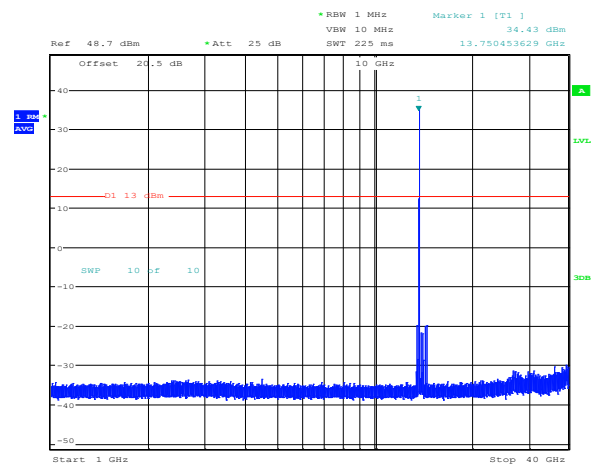


Figure 8.3-42: 1 to 40 GHz, QPSK $\frac{3}{4}$ with 7.5 MHz Bandwidth Tx 13.75 GHz

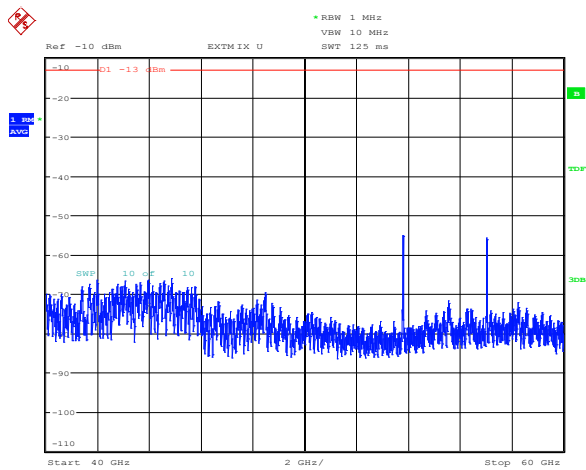


Figure 8.3-43: 40 to 60 GHz, QPSK $\frac{3}{4}$ with 7.5 MHz Bandwidth Tx 13.75 GHz

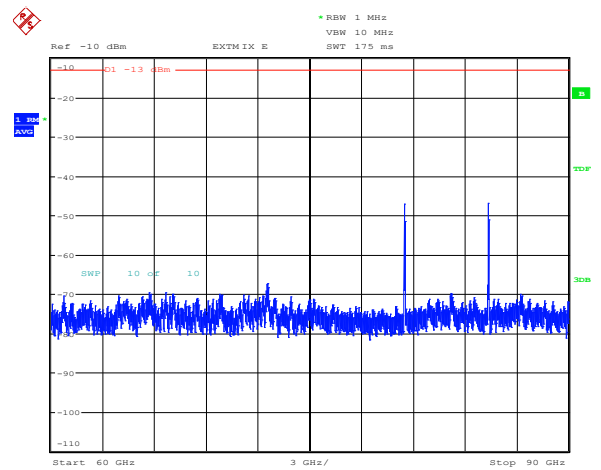


Figure 8.3-44: 60 to 90 GHz, QPSK $\frac{3}{4}$ with 7.5 MHz Bandwidth Tx 13.75 GHz

8.3.4 Test data, continued

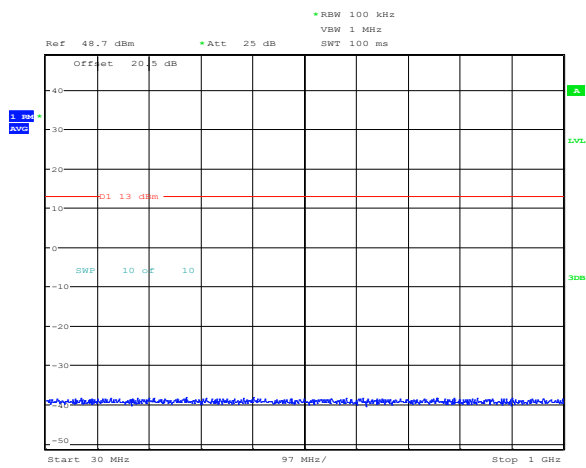


Figure 8.3-45: 30 to 1000 MHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

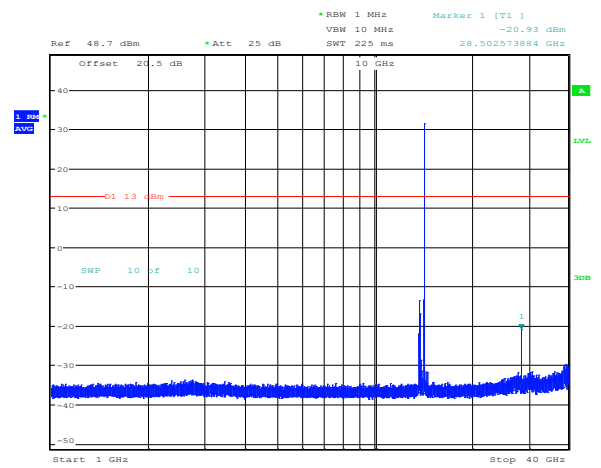


Figure 8.3-46: 1 to 40 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

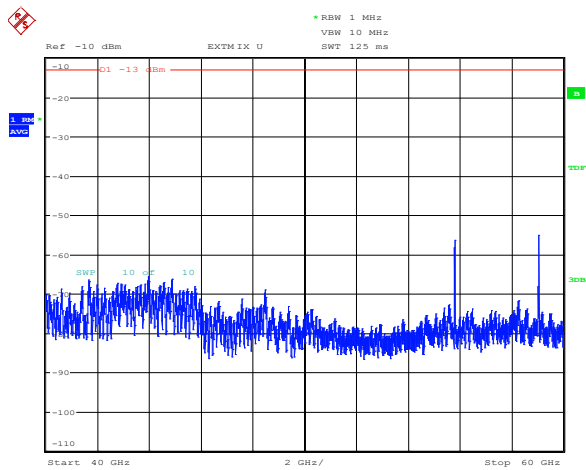


Figure 8.3-47: 40 to 60 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

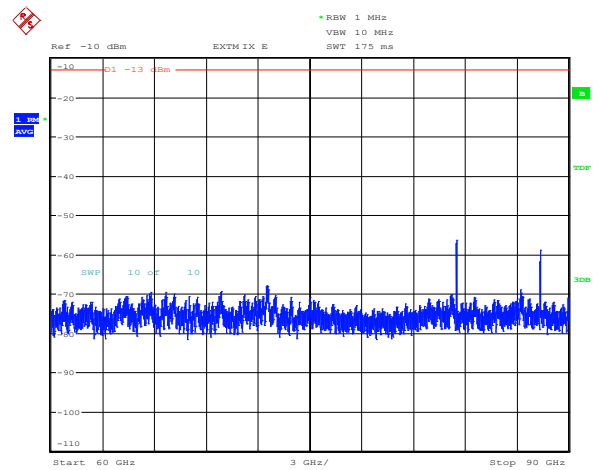


Figure 8.3-48: 60 to 80 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

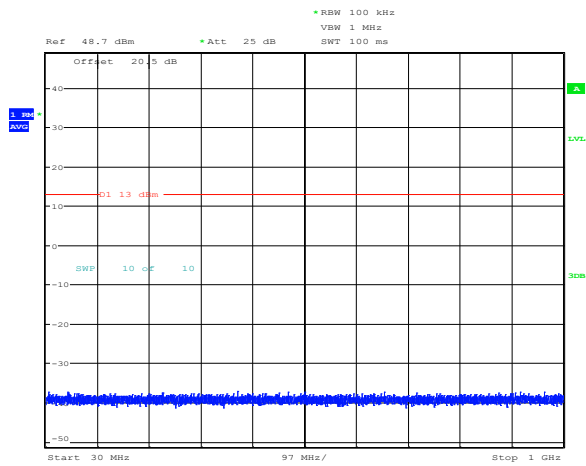


Figure 8.3-49: 30 to 1000 MHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.5 GHz

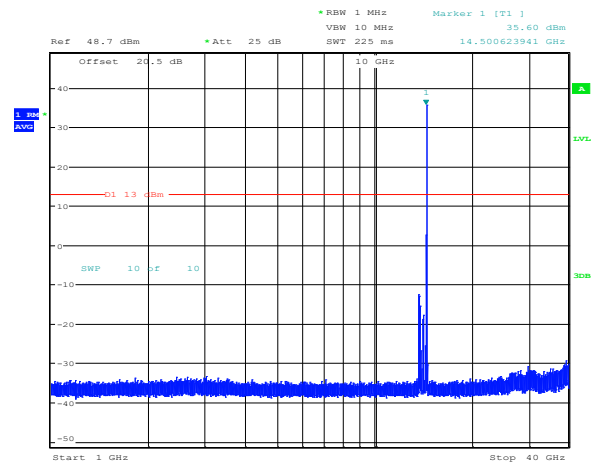


Figure 8.3-50: 1 to 40 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.5 GHz

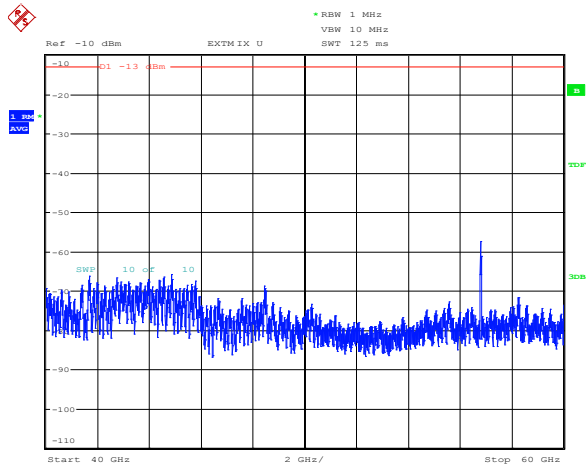


Figure 8.3-51: 40 to 60 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.5 GHz

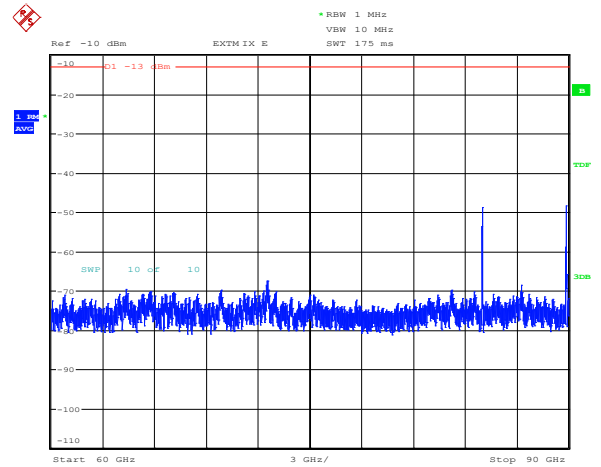


Figure 8.3-52: 60 to 80 GHz, QPSK ¼ with 7.5 MHz Bandwidth Tx 14.5 GHz

8.3.4 Test data, continued

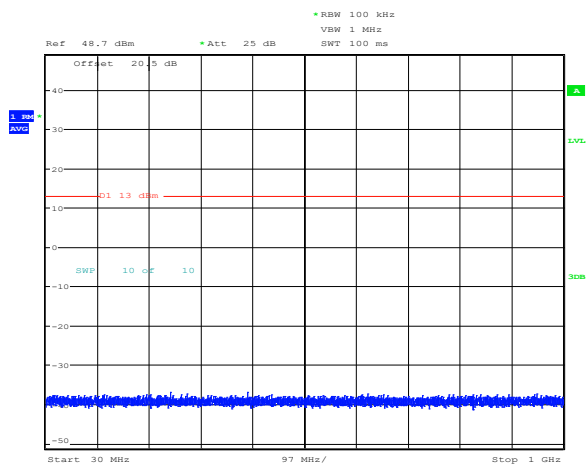


Figure 8.3-53: 30 to 1000 MHz, 8PSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

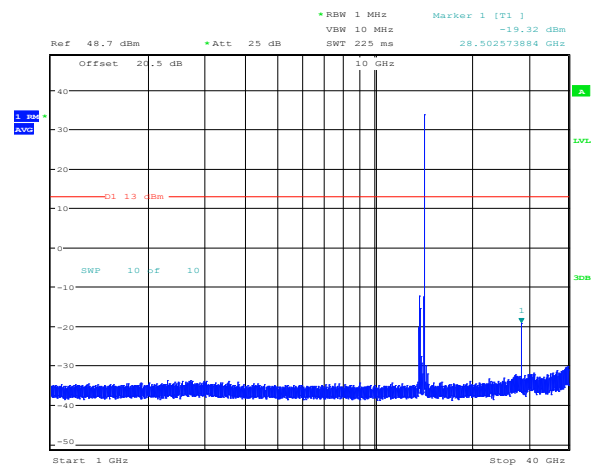


Figure 8.3-54: 1 to 40 GHz, 8PSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

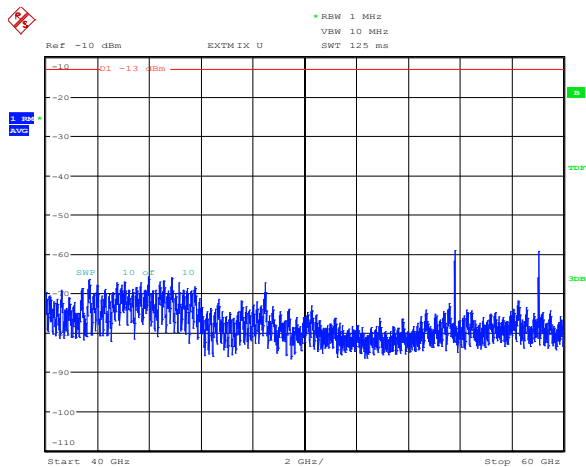


Figure 8.3-55: 40 to 60 GHz, 8PSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

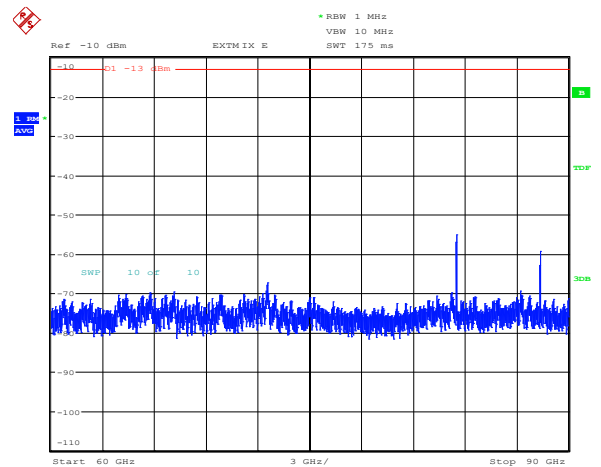


Figure 8.3-56: 60 to 80 GHz, 8PSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

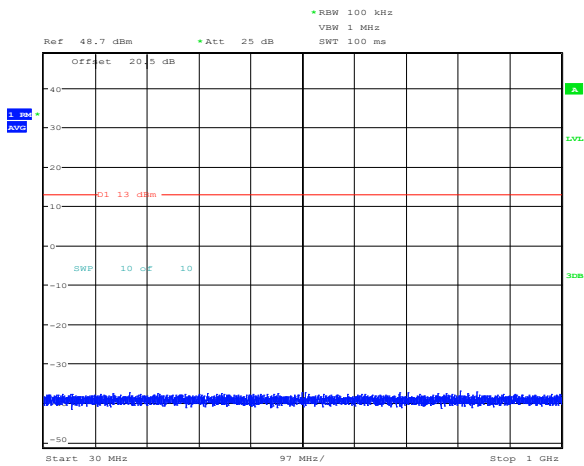


Figure 8.3-57: 30 to 1000 MHz, 16APSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

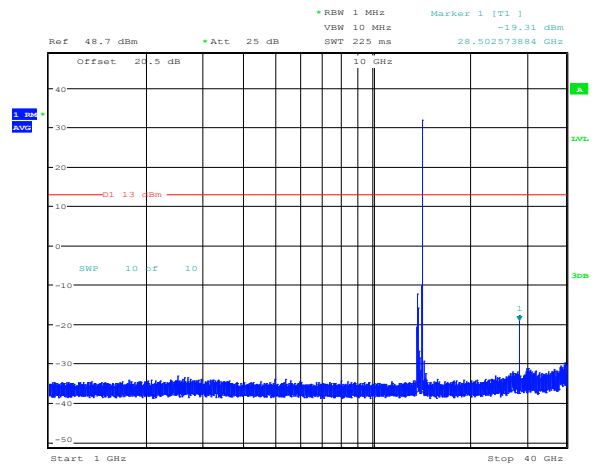


Figure 8.3-58: 1 to 40 GHz, 16APSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

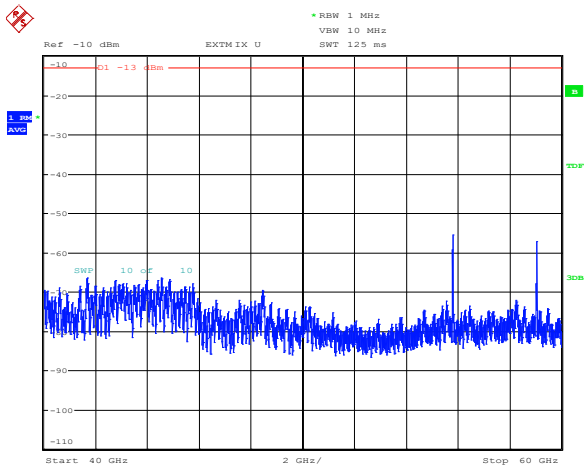


Figure 8.3-59: 40 to 60 GHz, 16APSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

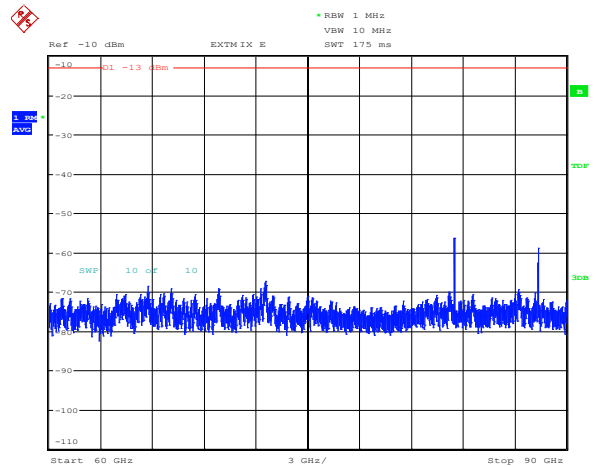


Figure 8.3-60: 60 to 80 GHz, 16APSK ¼ with 7.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

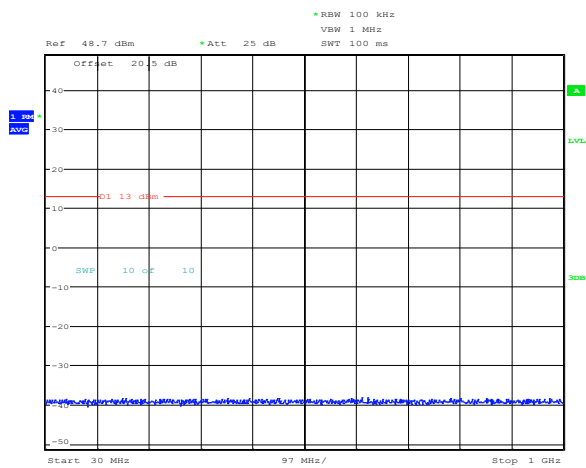


Figure 8.3-61: 30 to 1000 MHz, QPSK ¼ with 5 MHz Bandwidth Tx 13.75 GHz

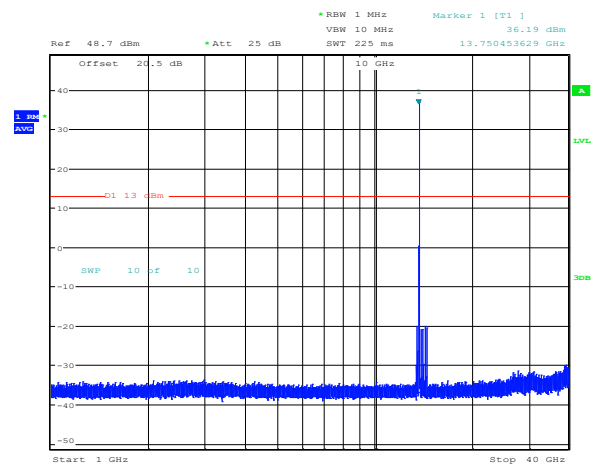


Figure 8.3-62: 1 to 40 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 13.75 GHz

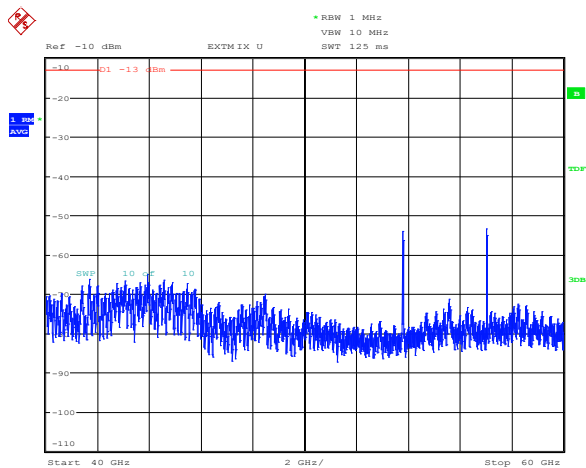


Figure 8.3-63: 40 to 60 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 13.75 GHz

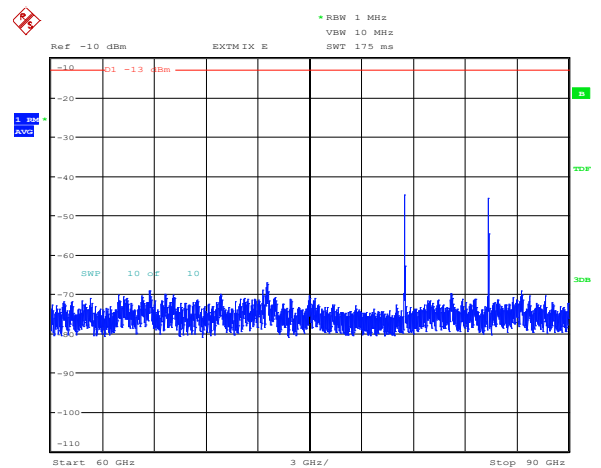


Figure 8.3-64: 60 to 80 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 13.75 GHz

8.3.4 Test data, continued

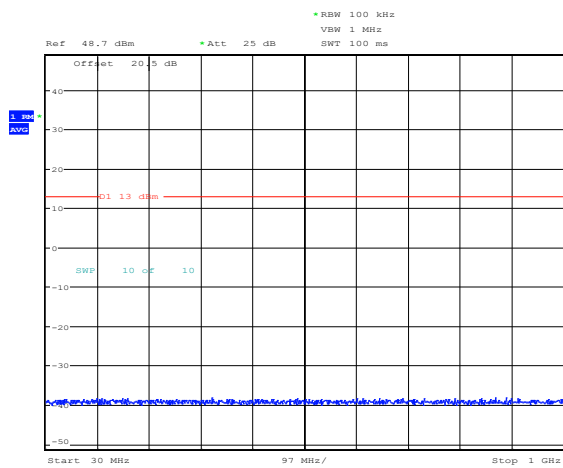


Figure 8.3-65: 30 to 1000 MHz, QPSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

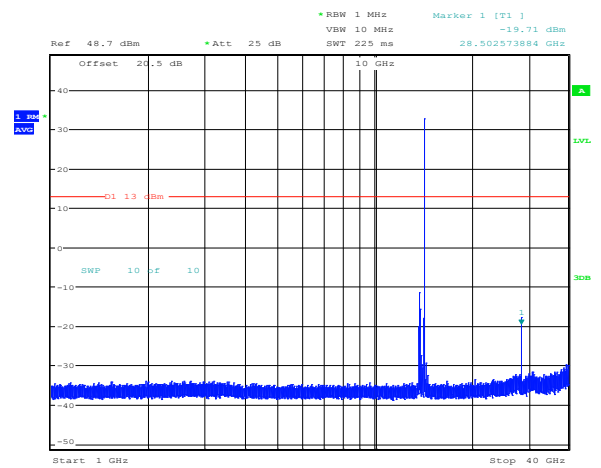


Figure 8.3-66: 1 to 40 GHz, QPSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

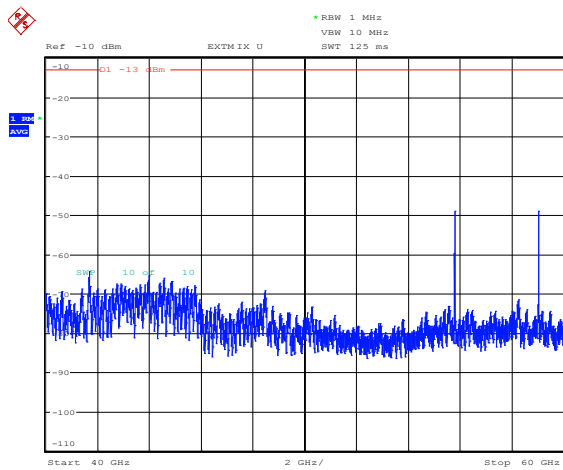


Figure 8.3-67: 40 to 60 GHz, QPSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GH

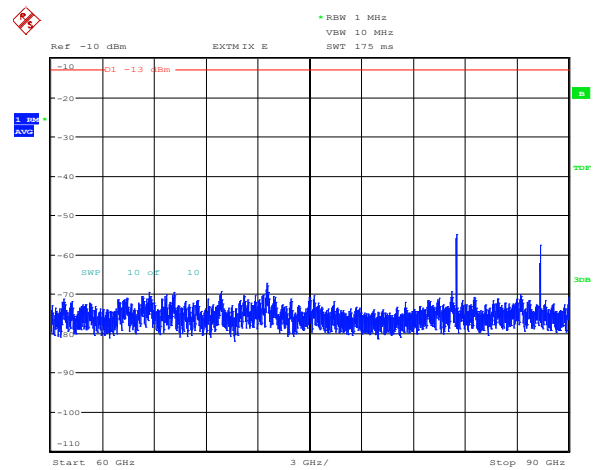


Figure 8.3-68: 60 to 80 GHz, QPSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GH

8.3.4 Test data, continued

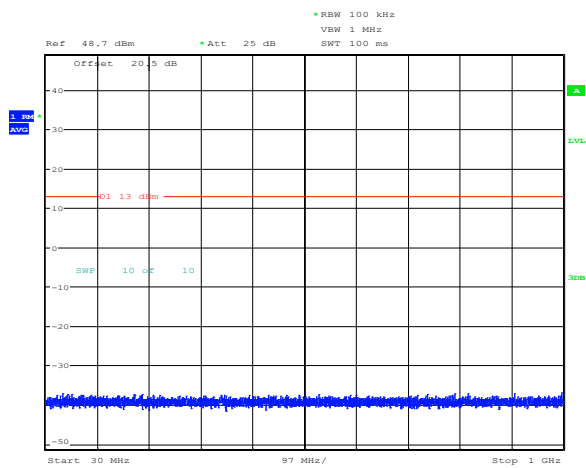


Figure 8.3-69: 30 to 1000 MHz, QPSK ¼ with 5 MHz Bandwidth Tx 14.5 GHz

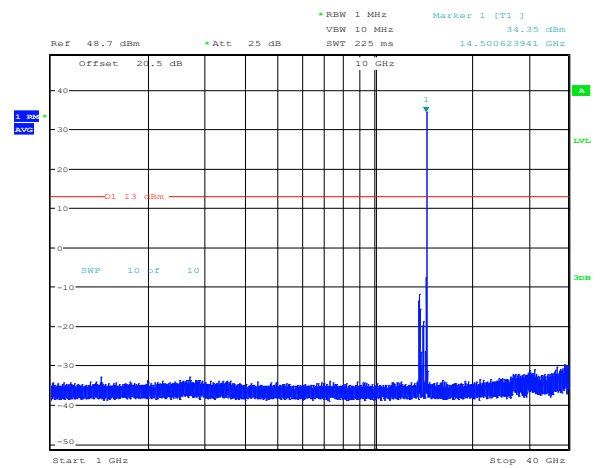


Figure 8.3-70: 1 to 40 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 14.5 GHz

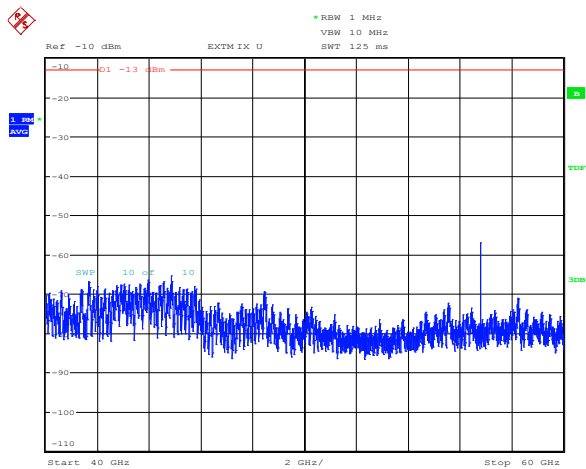


Figure 8.3-71: 40 to 60 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 14.5 GHz

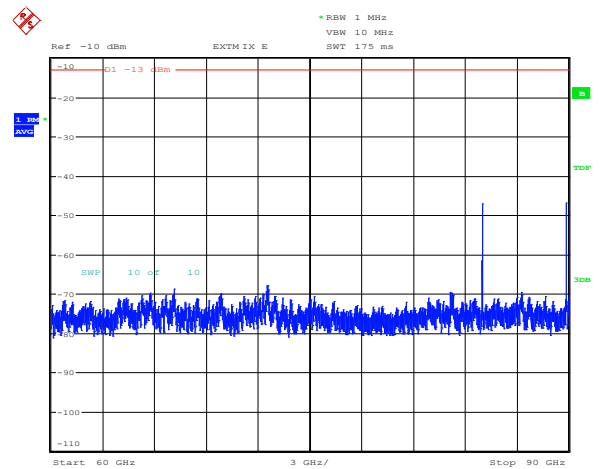


Figure 8.3-72: 60 to 90 GHz, QPSK ¼ with 5 MHz Bandwidth Tx 14.5 GHz

8.3.4 Test data, continued

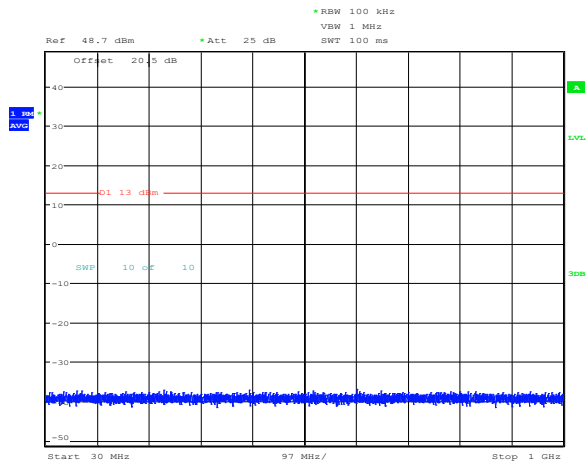


Figure 8.3-73: 30 to 1000 MHz, 8PSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

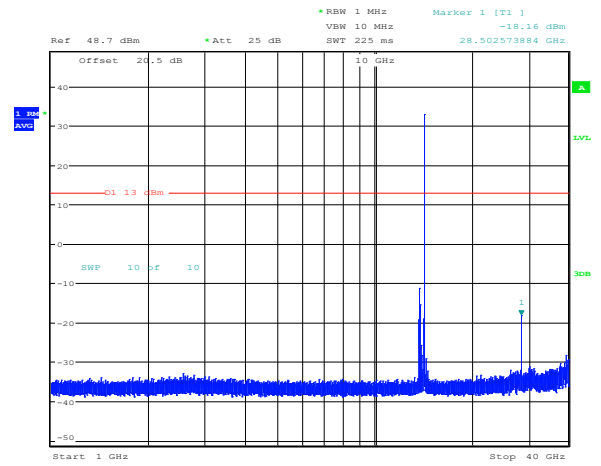


Figure 8.3-74: 1 to 40 GHz, 8PSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

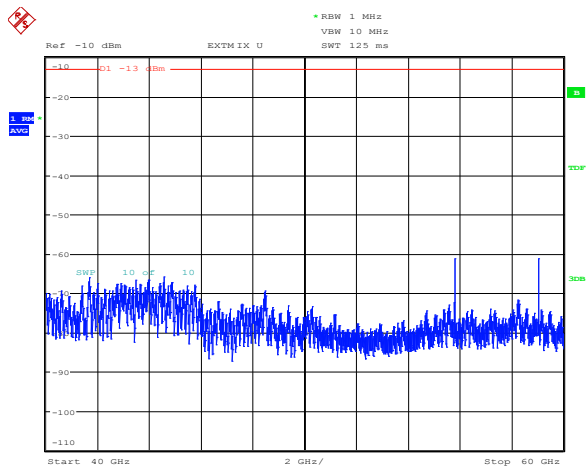


Figure 8.3-75: 40 to 60 GHz, 8PSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

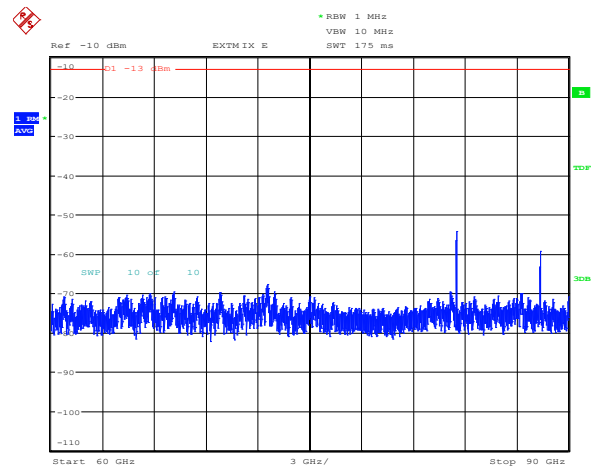


Figure 8.3-76: 60 to 90 GHz, 8PSK ¼ with 5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

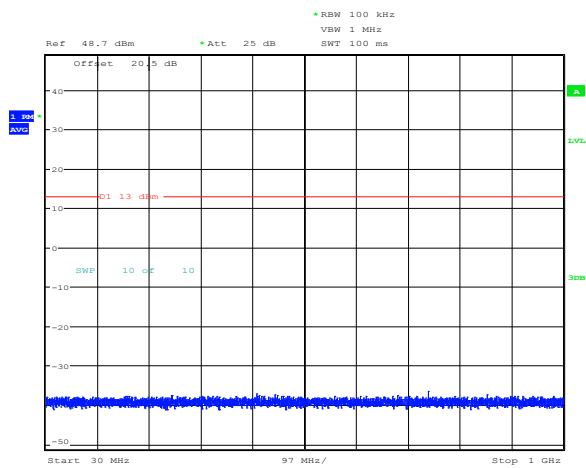


Figure 8.3-77: 30 to 1000 MHz, 16APSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

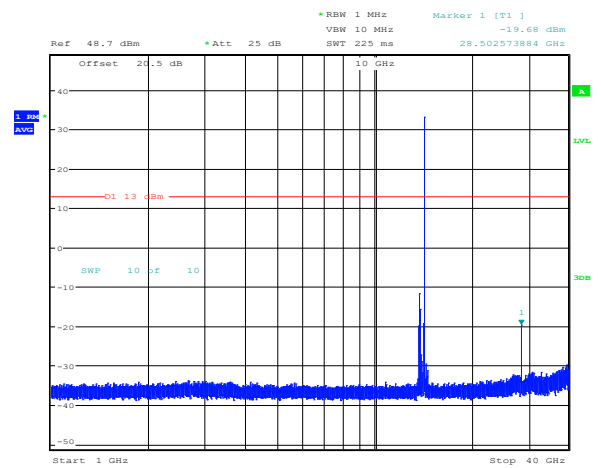


Figure 8.3-78: 1 to 40 GHz, 16APSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

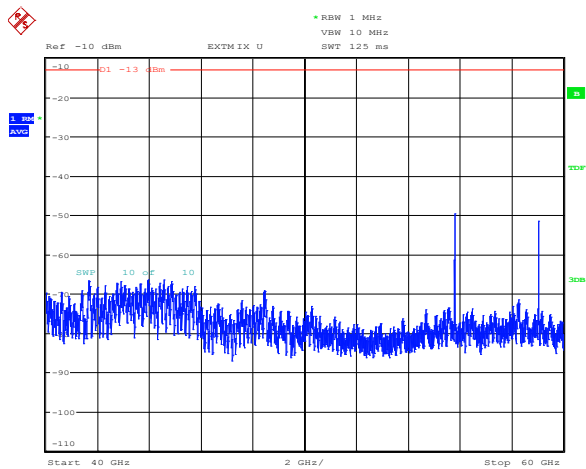


Figure 8.3-79: 40 to 60 GHz, 16APSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

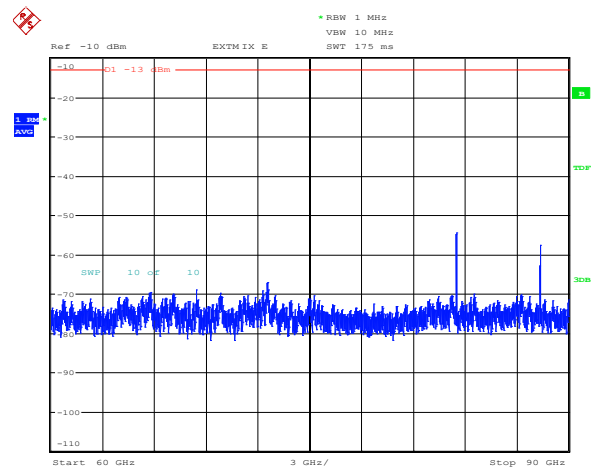


Figure 8.3-80: 60 to 90 GHz, 16APSK $\frac{3}{4}$ with 5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

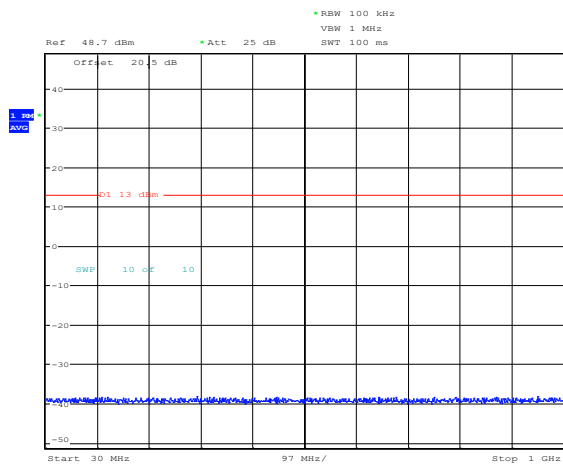


Figure 8.3-81: 30 to 1000 MHz, QPSK $\frac{3}{4}$ with 2.5 MHz Bandwidth Tx 13.75 GHz

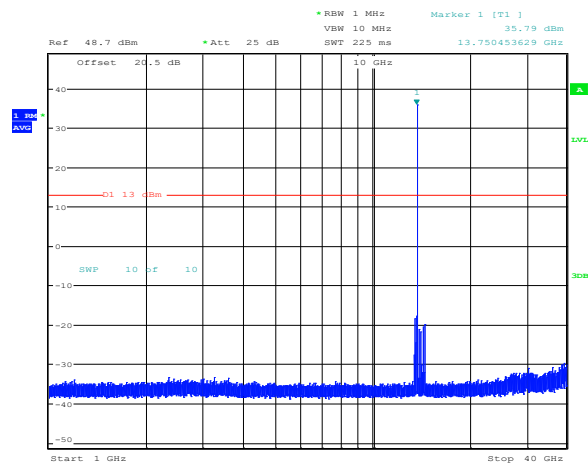


Figure 8.3-82: 1 to 40 GHz, QPSK $\frac{3}{4}$ with 2.5 MHz Bandwidth Tx 13.75 GHz

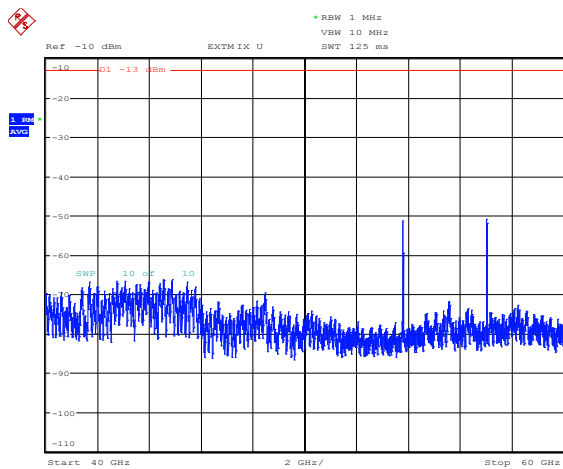


Figure 8.3-83: 40 to 60 GHz, QPSK $\frac{3}{4}$ with 2.5 MHz Bandwidth Tx 13.75 GHz

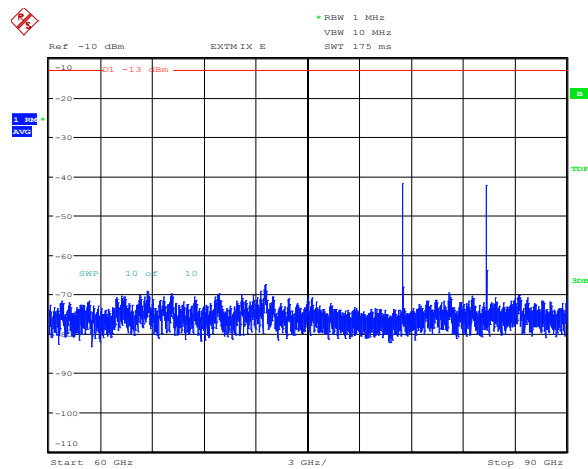


Figure 8.3-84: 60 to 90 GHz, QPSK $\frac{3}{4}$ with 2.5 MHz Bandwidth Tx 13.75 GHz

8.3.4 Test data, continued

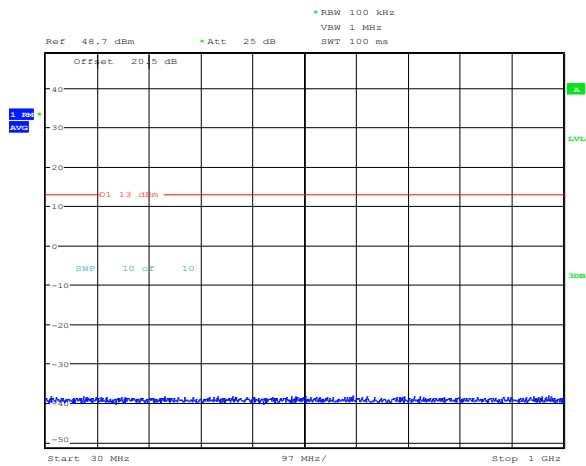


Figure 8.3-85: 30 to 1000 MHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

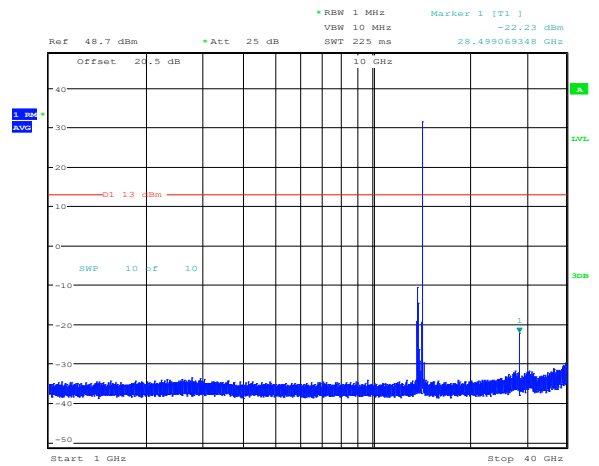


Figure 8.3-86: 1 to 40 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

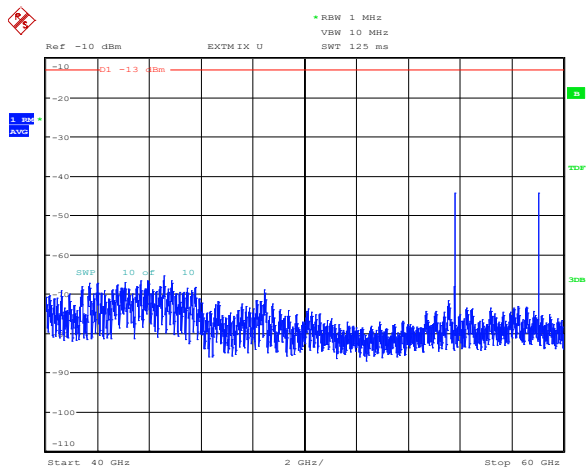


Figure 8.3-87: 40 to 60 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

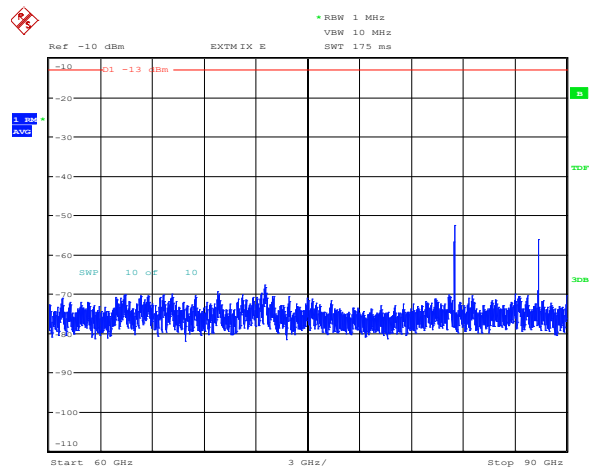


Figure 8.3-88: 60 to 90 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

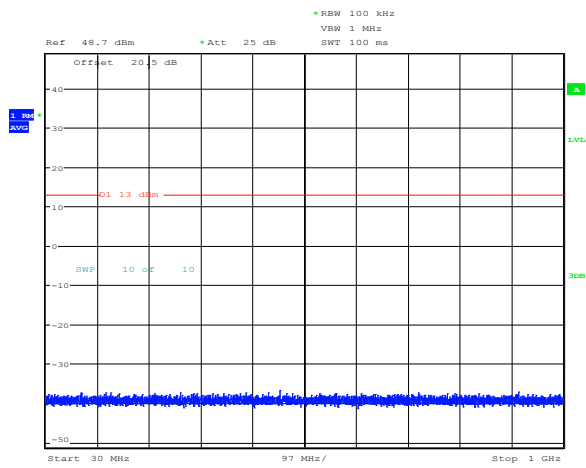


Figure 8.3-89: 30 to 1000 MHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.5 GHz

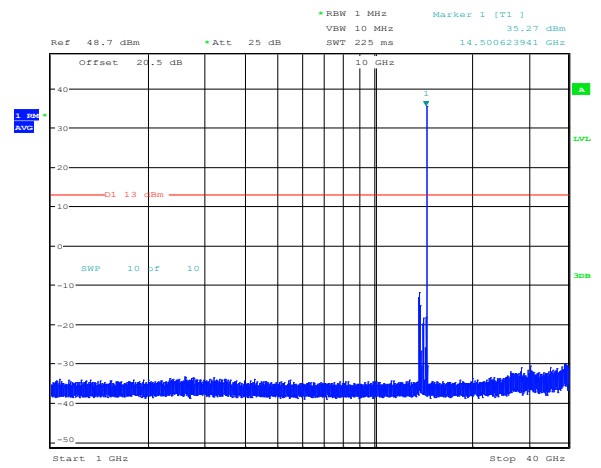


Figure 8.3-90: 1 to 40 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.5 GHz

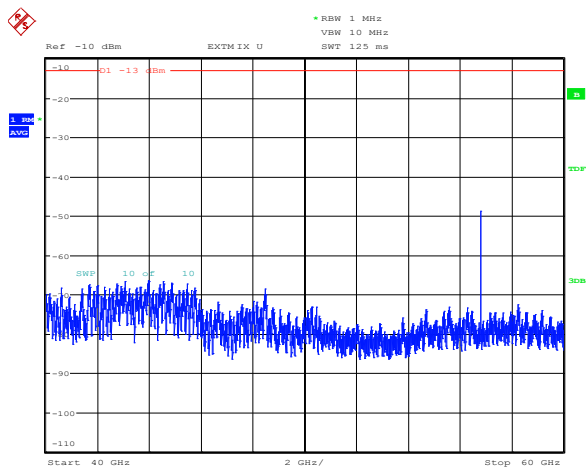


Figure 8.3-91: 40 to 60 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.5 GHz

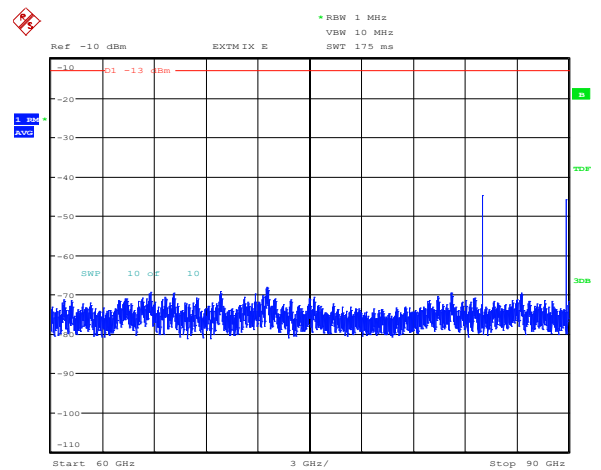


Figure 8.3-92: 60 to 90 GHz, QPSK ¼ with 2.5 MHz Bandwidth Tx 14.5 GHz

8.3.4 Test data, continued

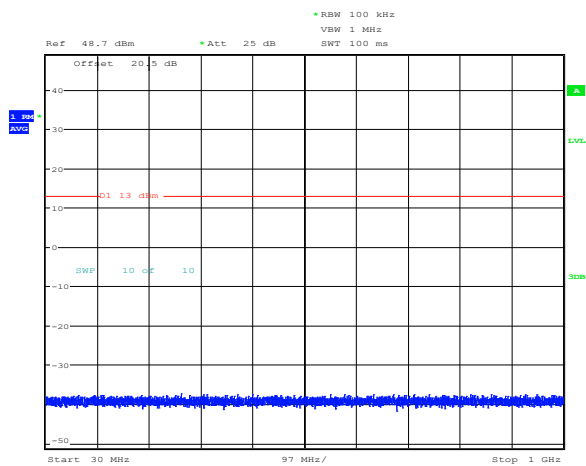


Figure 8.3-93: 30 to 1000 MHz, 8PSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

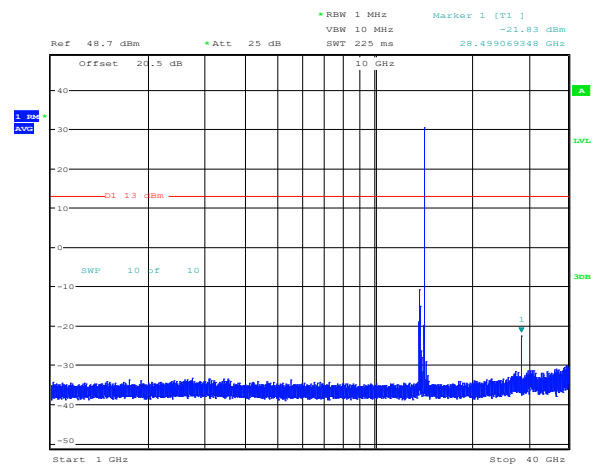


Figure 8.3-94: 1 to 40 GHz, 8PSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

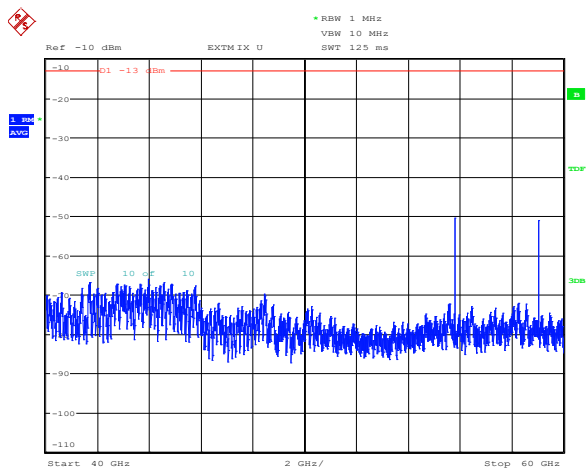


Figure 8.3-95: 40 to 60 GHz, 8PSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

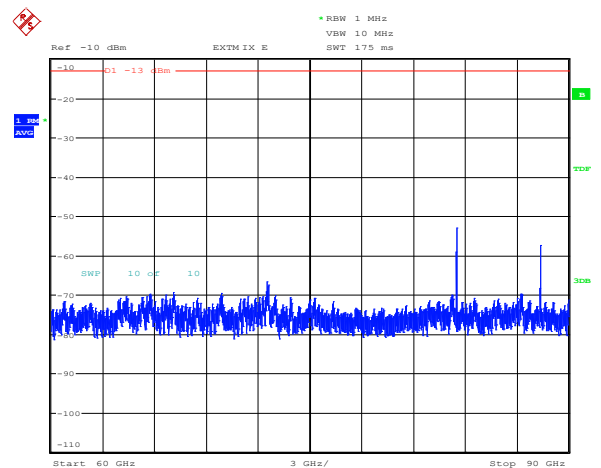


Figure 8.3-96: 60 to 90 GHz, 8PSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

8.3.4 Test data, continued

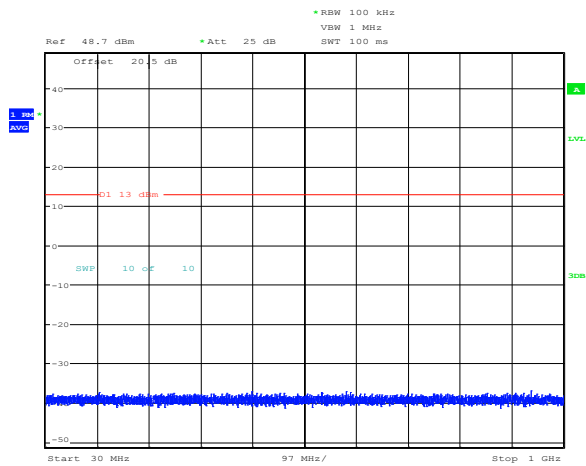


Figure 8.3-97: 30 to 1000 MHz, 16APSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

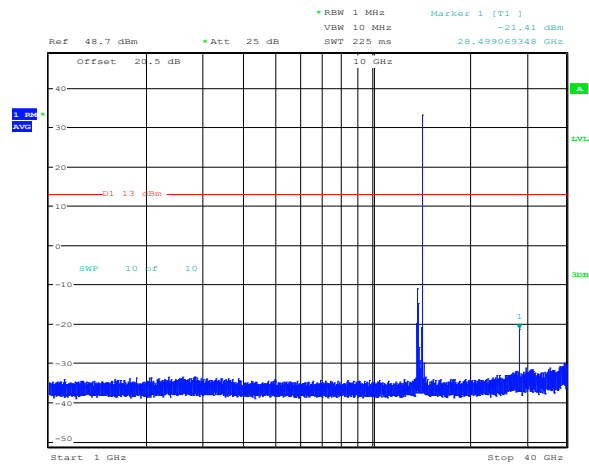


Figure 8.3-98: 1 to 40 GHz, 16APSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

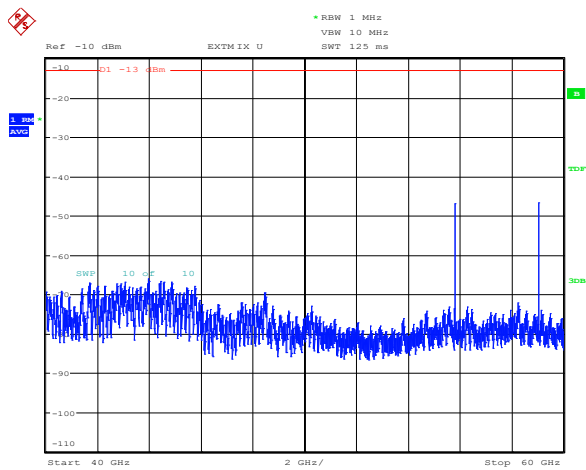


Figure 8.3-99: 40 to 60 GHz, 16APSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz

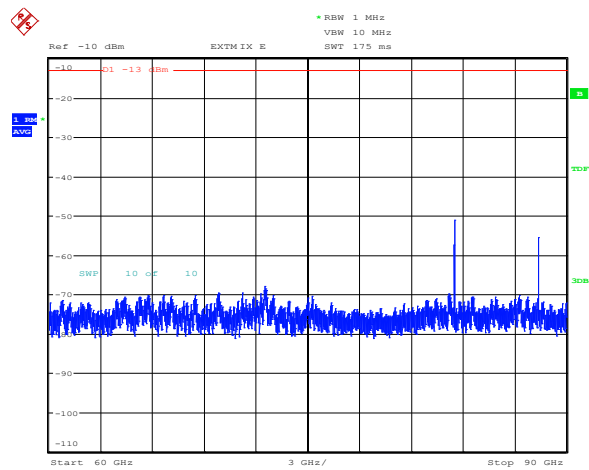


Figure 8.3-100: 60 to 90 GHz, 16APSK ¼ with 2.5 MHz Bandwidth Tx 14.25 GHz



8.3.4 Test data, continued

Table 8.3-1: Field strength of spurious radiation results

Configured modem output power ¹ , dBm	Test Freq., GHz	Freq. MHz	Field strength, dBμV/m	EIRP*, dBm	EIRP limit, dBm	Margin, dB
-4.0	13.75	14.502	75.6	-19.7	-13.0	6.7
-5.3	14.25	14.000	75.3	-20.0	-13.0	7.0
-3.5	14.5	14.273	75.9	-19.4	-13.0	6.4

Notes: ¹Configured modem output power (dBm) = 1 dB compression
 – 1 dB compression @ 13.75 GHz = -4 dBm, 1 dB compression @ 14.25 GHz = -5.3 dBm, 1 dB compression @ 14.50 GHz = -3.5 dBm
²Modulation was QPSK ¼.
³Channel bandwidth was 10 MHz.

* EIRP (dBm) = Field Strngth (dBμV/m) + 20log(D) –104.8; where D is the measurement distance (Test distance was 3m)

All other spurious radiation emissions were greater than 10 dB below the limit.

8.4 FCC 25.202(d) Frequencies tolerance

8.4.1 Definitions and limits

§25.202

- (d) Frequency tolerance, Earth stations. The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

8.4.2 Test summary

Verdict	Pass		
Tested by	David Duchesne	Test date	October 8, 2019

8.4.3 Observations, settings and special notes

- **Test Method:** KDB 971168 D01 Power Meas License Digital Systems v03r01
- **Test procedure used:** ANSI C63.26-2015 – Section 5.6.3 & 5.6.4 & 5.6.5

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	≥ 3 × RBW
Frequency span	Wider than emission bandwidth
Detector mode	Peak

8.4.4 Test data

Table 8.4-1: Frequency tolerance, earth stations test cases

Modulation	Channel bandwidth, MHz	Configured modem output power, dBm	Test Freq., GHz
QPSK ¾	10	-5.3	14.25
Notes: None			

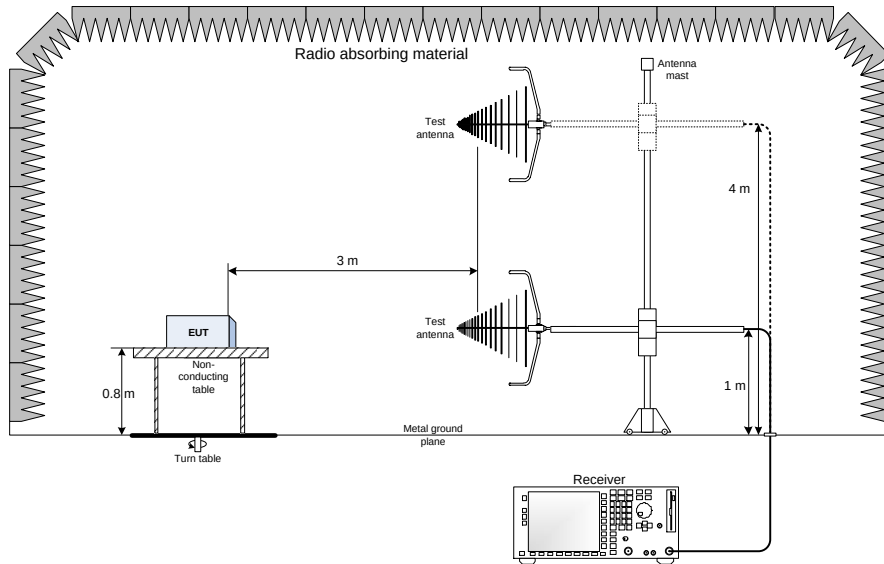
Table 8.4-2: Frequency tolerance, earth stations result

Test conditions	Frequency, Hz	Offset, ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	14250001545	-0.01	10.00	9.99
+40 °C, Nominal	14250001670	0	10.00	10.00
+30 °C, Nominal	14250001670	0	10.00	10.00
+20 °C, +15 %	14250001670	0	10.00	10.00
+20 °C, Nominal	14250001670		Reference	
+20 °C, -15 %	14250001670	0	10.00	10.00
+10 °C, Nominal	14250001670	0	10.00	10.00
0 °C, Nominal	14250001670	0	10.00	10.00
-10 °C, Nominal	14250002171	0.04	10.00	9.96
-20 °C, Nominal	14250002171	0.04	10.00	9.96
-30 °C, Nominal	14250002171	0.04	10.00	9.96

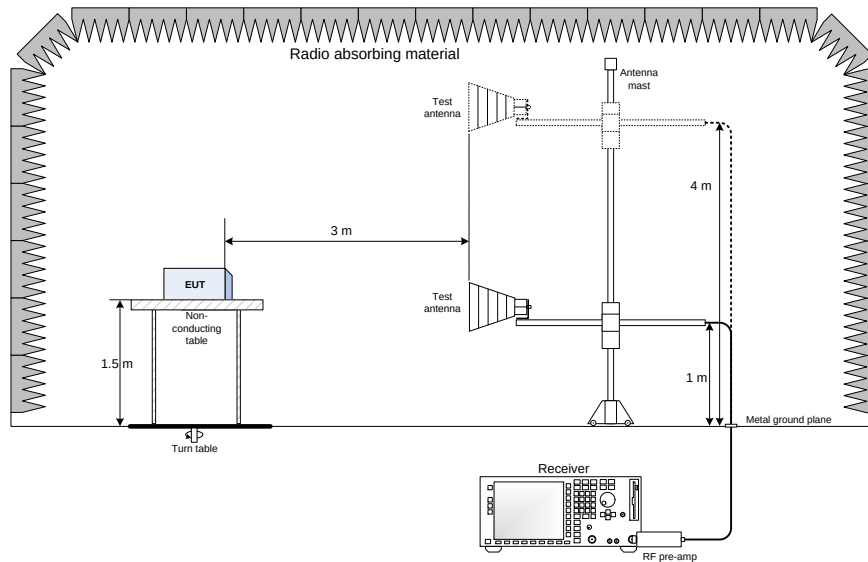
Note: Offset was calculated as per the following formula: $\frac{F_{\text{Measured}} - F_{\text{reference}}}{F_{\text{reference}}} \times 1 \cdot 10^6$

Section 9 Block diagrams of test set-ups

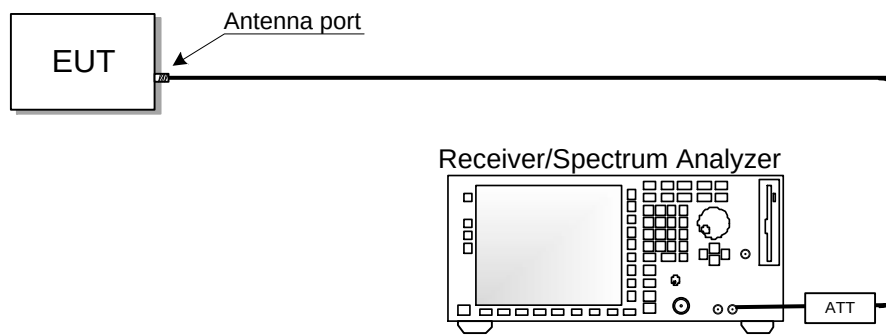
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Antenna port set-up



End of report