DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
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FCC LISTED, REGISTRATION NUMBER: 720267

ISED LISTED REGISTRATION NUMBER 4621A-2

Test report No:

NIE: 56182RRF.001

Test report
REFERENCE STANDARD:
USA FCC Part 90
CANADA IC RSS-119

Identificación del objeto ensayado.....: Identification of item tested	RF Transceiver / Base Station Repeater
Marca .....: Trade	PowerTrunk
Modelo y/o referencia tipo .....: Model and /or type reference	BSR75 -8
Other identification of the product .....:	D138861PT FCC ID: WT7PTBSR75450B IC: 8624A-PTBSR75450B
HW version .....:	CCP: 0.03.35.34.36
SW version .....:	CCP: 0.03.35.34.36
Características .....: Features	Power supply: ○ Nominal voltage: 27.4 VDC ○ Operational voltage range: [21.6 - 28.0 VDC] Frequency band: TX: 450-470 MHz RX: 450-470 MHz RF output power (nominal): TETRA: 48.75 dBm (75 W) TI D-LMR: 48.75 dBm (75 W) See full details on pages 5 and 6
Solicitante.....: Applicant	TELTRONIC, S.A.U. Polígono Malpica, Calle C/F-Oeste (50016). Zaragoza (SPAIN).
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 90 10-01-17 Edition. CANADA IC RSS-119 Issue 12, May 2015. ANSI C63.26-2015.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) .....: Approved by (name / position & signature)	A. Llamas RF Lab. Manager Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2018.02.23 13:53:17 +01'00'
Fecha de realización .....: Date of issue	2018-02-23

Formato de informe No. .....: Report template No	FDT08_20

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Competences and guarantees

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-2.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification at the time of performance of the test.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Code	Serial number	Reception date
56182B/001	RF Transceiver / Base Station Repeater	BSR75 -8	D138861PT	840834	2018-01-09

1. Sample S/01 has undergone the test(s).

   All tests indicated in appendix A.

Test sample description

The BSR75 (Base Station Repeater) is a digital RF transceiver aimed at providing the PowerTrunk-T Infrastructure with a TETRA carrier. It has been conceived as a module to be integrated in a PowerTrunk-T Cabinet with an SBS configuration (Site Base Station). The BSR75 -8 operates in the frequency band 450-470 MHz and provides an RF output power of 75 W in the whole band.

Features:

Power Supply:

Nominal voltage: 27.4 VDC

Operational voltage range: [21.6 - 28.0 VDC]

Access scheme:

TDMA with 4 physical channels (time slots) per RF channel.

Modulation scheme:

π/4-DQPSK with a modulation rate of 18 Ksym/s, equivalent to 36 Kbits/s. Based upon it, two digital communication systems are supported:

- TETRA:

  Modulation low-pass filter: Square-root raised cosine filter with a roll-off factor of 0.35.
- TI D-LMR:

  Modulation low-pass filter: Square-root raised cosine filter with a roll-off factor of 0.2.

RF channel bandwidth (channel spacing):

25 KHz

Spectral efficiency:

One voice & data physical channel with a rate of 9 Kbits/s is allocated a 6.25 KHz equivalent channel bandwidth.

Frequency band:
TX: 450-470 MHz
RX: 450-470 MHz

RF output power (nominal):
TETRA: 48.75 dBm (75 W)
TI D-LMR: 48.75 dBm (75 W)

RF authorized bandwidth:
TETRA: 22 KHz
TI D-LMR: 20 KHz

Emission designators:
TETRA: 22K0D7D, 22K0D7E, 22K0D7W
TI D-LMR: 20K0D7D, 20K0D7E, 20K0D7W

Additional features:
Audio low-pass filter (root-raised cosine filter).

Options:
O485002PT: OPTION ENCRYPTION POWERTRUNK-T

Identification of the client

TELTRONIC, S.A.U.

Polígono Malpica, Calle C/F-Oeste (50016). Zaragoza (SPAIN).

Testing period

The performed tests started on 2018-01-09 and finished on 2018-02-12.

The tests have been performed at DEKRA Testing and Certification.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

1: The tests have been performed by the technical personnel: Pedro Parada and Carolina Postigo.

2: Used instrumentation.

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Climatic chamber CTS C-70/600	2017/05	2018/05
2.	DC power supply R&S NGPE 40/40	---	---
3.	Digital multimeter FLUKE 113	2017/05	2019/05
4.	Radiocommunication analyser R&S CMTA84	2015/07	2018/07
5.	Power sensor R&S NRP-Z81	2016/04	2018/04
6.	Spectrum analyser R&S FSV40	2017/07	2019/07
7.	RF generator R&S SMB100A	2017/07	2019/07
8.	Storage oscilloscope Tektronix DPO4104B	2017/09	2018/09
9.	Radiocommunication analyser HP 8920A	2017/04	2019/04
10.	Spectrum analyser Agilent E4440A	2017/10	2019/10

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2015/06	2018/06
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
6.	EMI Test Receiver R&S ESU 40	2016/03	2018/03
7.	RF pre-amplifier 20 MHz-7 GHz A. H. SYSTEMS PAM-0207	2017/09	2018/09
8.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02
9.	DC power supply KEYSIGHT TECHNOLOGIES	---	---
10.	Digital multimeter FLUKE 113	2017/05	2019/05

3: This information has been provided by the applicant.

Testing verdicts

Not applicable ..... :	N/A
Pass ..... :	P
Fail ..... :	F
Not measured ..... :	N/M

FCC PART 90 / RSS-119 PARAGRAPH	VERDICT			
	NA	P	F	NM
Clause 2.1047, 90.207. Modulation characteristics				NM[3]
Clause 90.209 / RSS-119 Clause 5.5: Occupied Bandwidth		P		
Clause 90.205, 90.279 / RSS-119 Clause 5.4: RF output power		P		
Clause 90.210 / RSS-119 Clause 5.5, 5.8: Emission mask		P		
Clause 90.221: Adjacent channel power		P		
Clause 90.213 / RSS-119 Clause 5.3: Frequency stability		P		
Clause 90.210 / RSS-119 Clause 5.8: Spurious emissions at antenna terminals		P		
Clause 90.210 / RSS-119 Clause 5.8: Radiated emissions		P		
Clause 90.214 / RSS-119 Clause 5.9: Transient frequency behaviour		P		

3: see point “Remarks and comments”.

Appendix A – Test results

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TEST CONDITIONS

Power supply (V):

V_{nom} = 27.40 Vdc

V_{max} = 31.51 Vdc

V_{min} = 21.60 Vdc

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = DC Voltage from external power supply

Type of antenna = external connectable antenna

Rated RF Output Power:

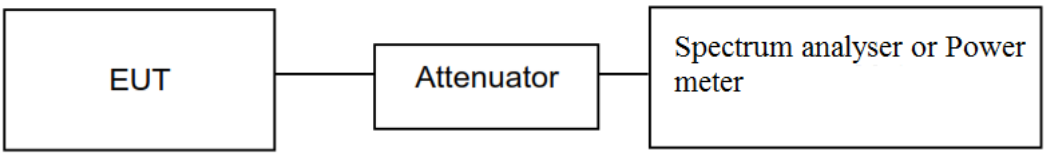
- Mode TETRA (22 kHz bandwidth): 48.75 dBm (75 W)
- Mode TI D-LMR (20 kHz bandwidth): 48.75 dBm (75 W)

TEST FREQUENCIES:

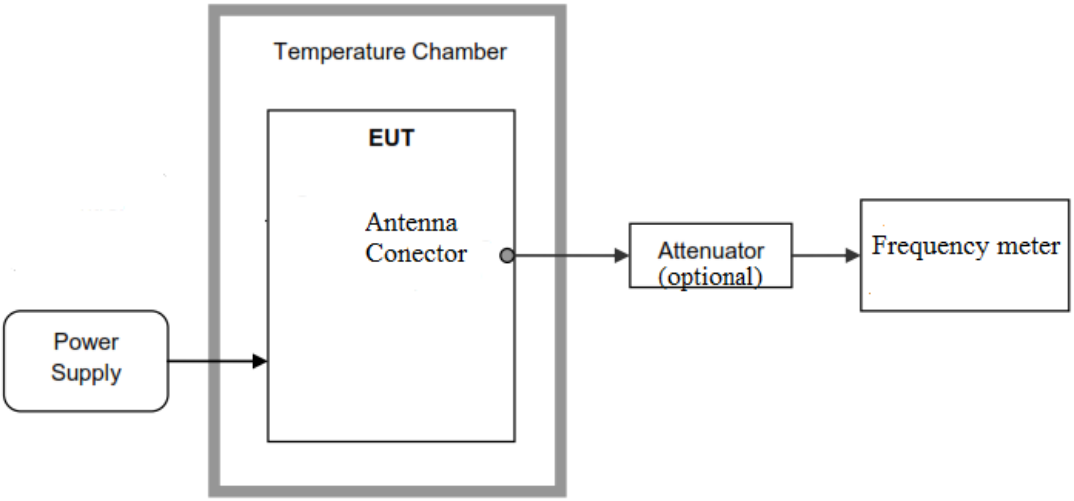
FCC 90 TI D-LMR 20 kHz bandwidth & TETRA 22 kHz bandwidth	
Lowest channel	450 MHz
Middle channel	460 MHz
Highest channel	470 MHz
RSS-119 TETRA 22 kHz bandwidth	
Lowest channel	450 MHz
Middle channel	460 MHz
Highest channel	470 MHz

CONDUCTED MEASUREMENTS

The equipment under test (EUT) was set up in a shielded room and it is connected to the spectrum analyzer or power meter through a calibrated attenuator and a low loss RF cable. The reading of the instrument is corrected taking into account the attenuator and cable loss.



For frequency stability test the EUT was placed inside a climatic chamber and connected to a frequency meter using a low loss cable. An external DC power supply was connected to the EUT for voltage variation test.



RADIATED MEASUREMENTS

The equipment under test was scanned for spurious emissions in the frequency range 30 to 5000 MHz.

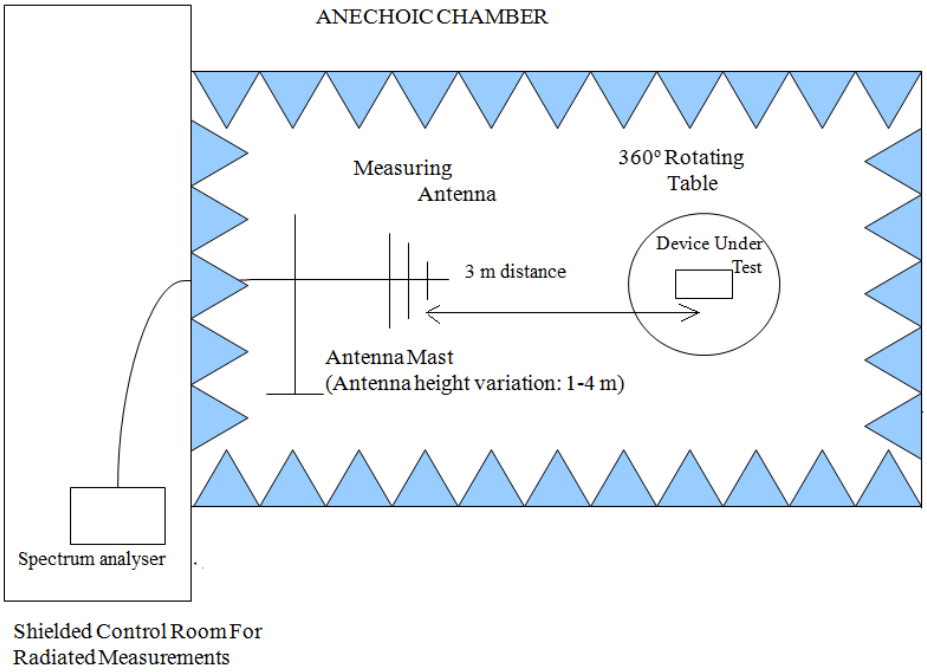
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-5 GHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1 GHz-5 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

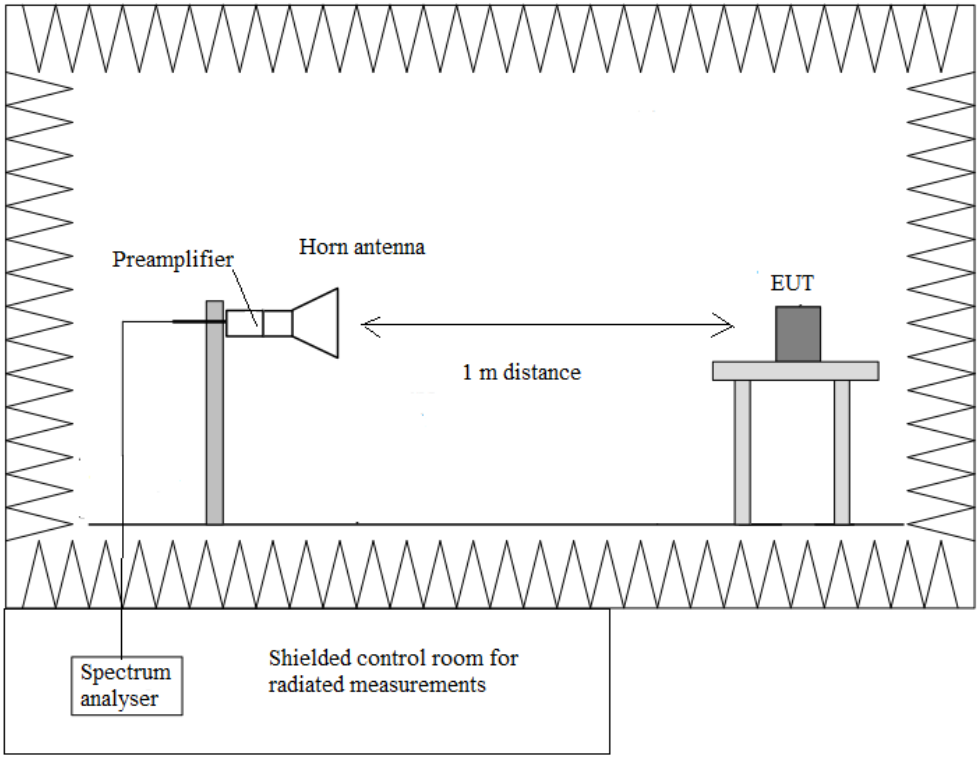
The equipment under test was set up on a non-conductive platform and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Modulation Characteristics

SPECIFICATION

FCC §2.1047 and §90.207

(a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

(b) Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

(c) Single sideband and independent sideband radiotelephone transmitters which employ a device or circuit to limit peak envelope power. A curve showing the peak envelope power output versus the modulation input voltage shall be supplied. The modulating signals shall be the same in frequency as specified in paragraph (c) of § 2.1049 for the occupied bandwidth tests.

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

RESULTS (The following information has been provided by the applicant)

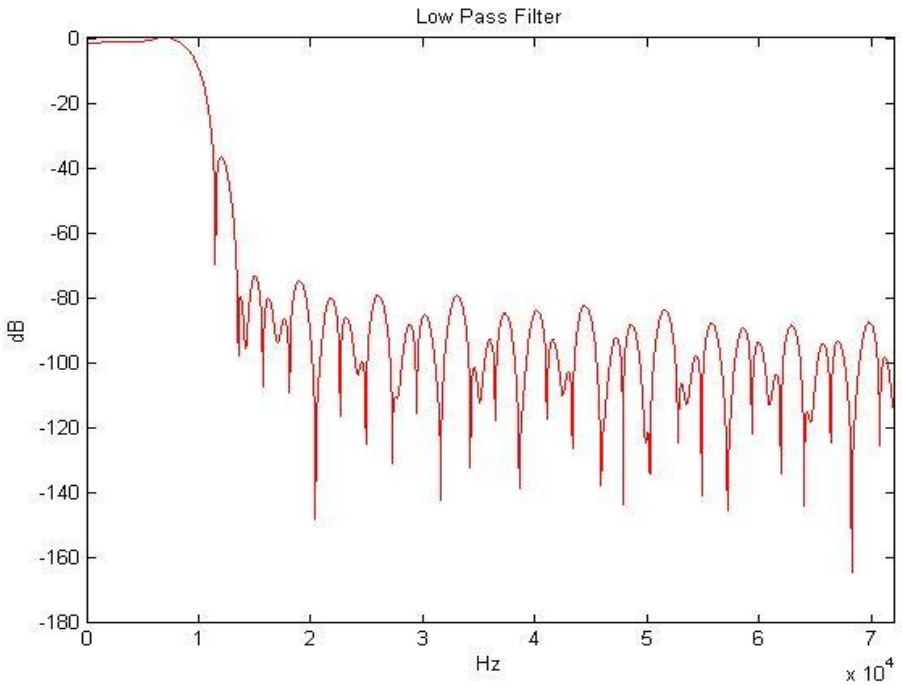
The EUT operates with π/4-shifted Differential Quaternary Phase Shift Keying (π/4-DQPSK) in both TI D-LMR and TETRA, featuring a modulation rate of 18 ksym/s (36 kbits/s).

The access scheme is TDMA with 4 physical channels per carrier.

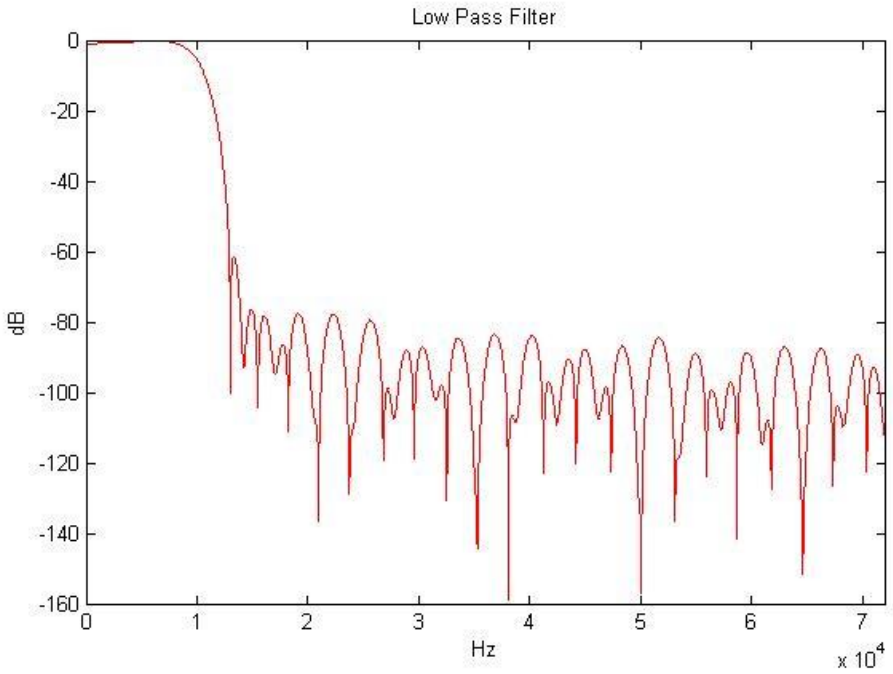
A root-raised-cosine filter (RRC) is used as a transmitting and receiving filter in both digital communication systems to perform matched filtering. The combined response of such two filters is that of the raised-cosine filter. The raised-cosine filter is often used for pulse-shaping in digital modulation, known for its ability to minimize intersymbol interference (ISI).

The graphs below show the transfer function of the aforementioned filter when the authorized modulation bandwidth is 20 KHz and 22 KHz, respectively.

BSR75 transmitter low pass filter for TI D-LMR (20 KHz authorized bandwidth):



BSR75 transmitter low pass filter for TETRA (22 KHz modulation bandwidth):



Occupied Bandwidth

SPECIFICATION

FCC §2.1049, §90.209.

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
406-512	25	20

Note: Operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the Adjacent Channel Power limits of § 90.221.

RSS-119 Clause 5.5.

Frequency Band (MHz)	**Related SRSP for Channelling Plan and e.r.p.**	**Channel Spacing (kHz)**	**Authorized Bandwidth (kHz)**
406.1-430 and 450-470	SRSP-501	25	20 22

METHOD

The EUT was configured to transmit a modulated carrier signal. The 99% occupied bandwidth and the -26 dBc bandwidths were measured directly using the built-in bandwidth measuring option of spectrum analyzer.

RESULTS (see next plots)

TI D-LMR 20 kHz.

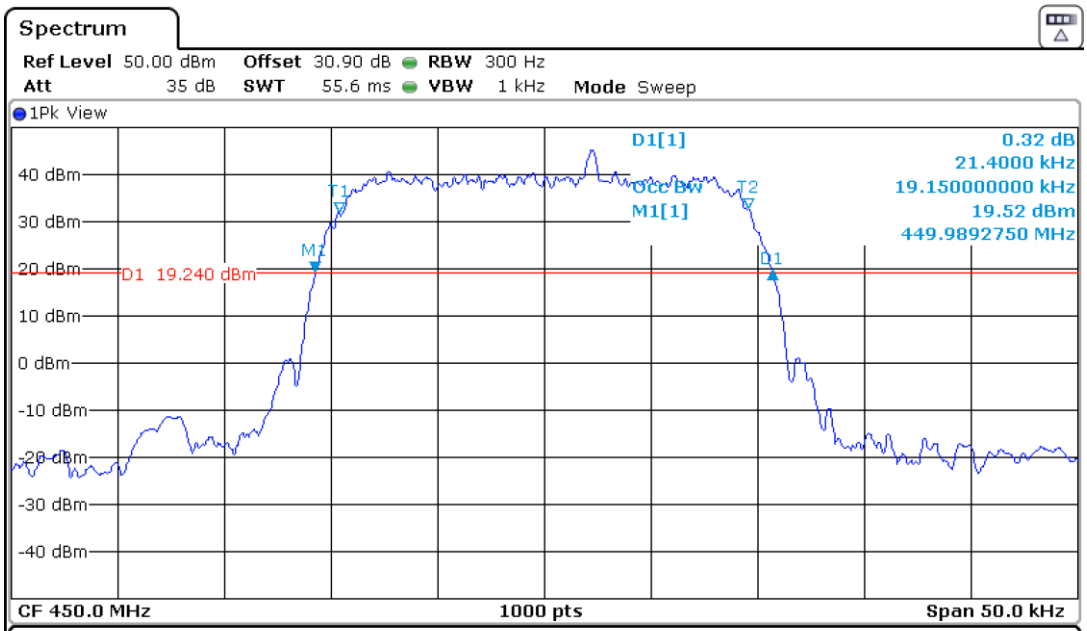
Channel	99% Occupied bandwidth (kHz)	-26 dBc bandwidth (kHz)
450MHz	19.15	21.40
460 MHz	19.20	21.55
470 MHz	19.15	21.70
Measurement uncertainty (kHz)	<±0.03	

TETRA 22 kHz.

Channel	99% Occupied bandwidth (kHz)	-26 dBc bandwidth (kHz)
450MHz	20.30	23.00
460 MHz	20.30	23.10
470 MHz	20.20	22.95
Measurement uncertainty (kHz)	<±0.03	

TI D-LMR 20 kHz.

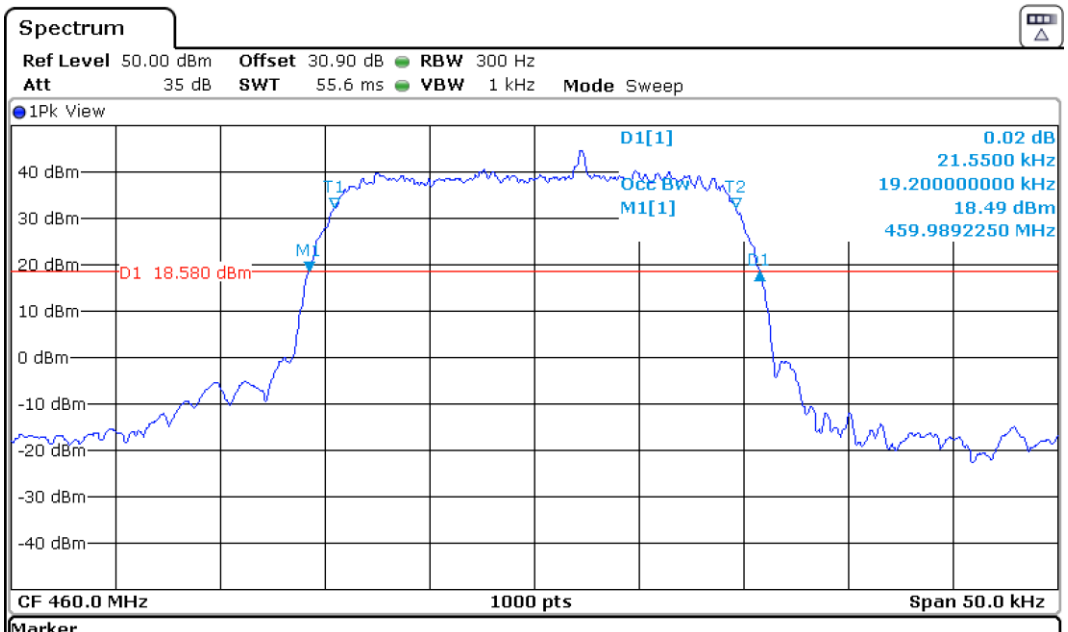
Lowest Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	449.989275 MHz	19.52 dBm		
T1		1	449.990375 MHz	31.94 dBm	Occ Bw	19.15 kHz
T2		1	450.009525 MHz	32.82 dBm		
D1	M1	1	21.4 kHz	0.32 dB		

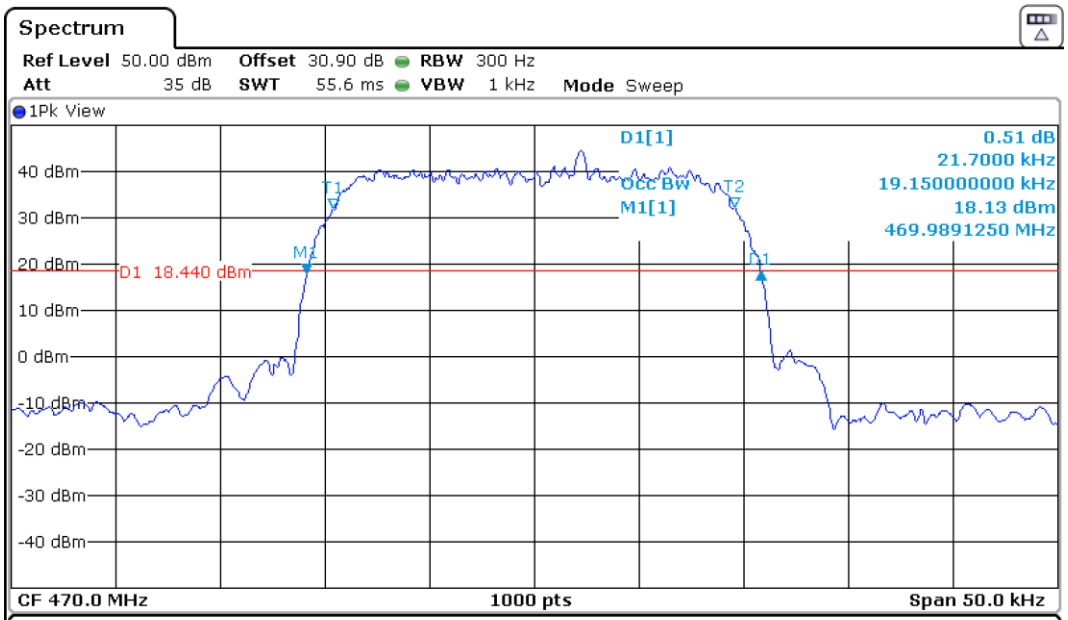
Middle Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	459.989225 MHz	18.49 dBm		
T1		1	459.990425 MHz	32.32 dBm	Occ Bw	19.2 kHz
T2		1	460.009625 MHz	32.18 dBm		
D1	M1	1	21.55 kHz	0.02 dB		

Highest Channel

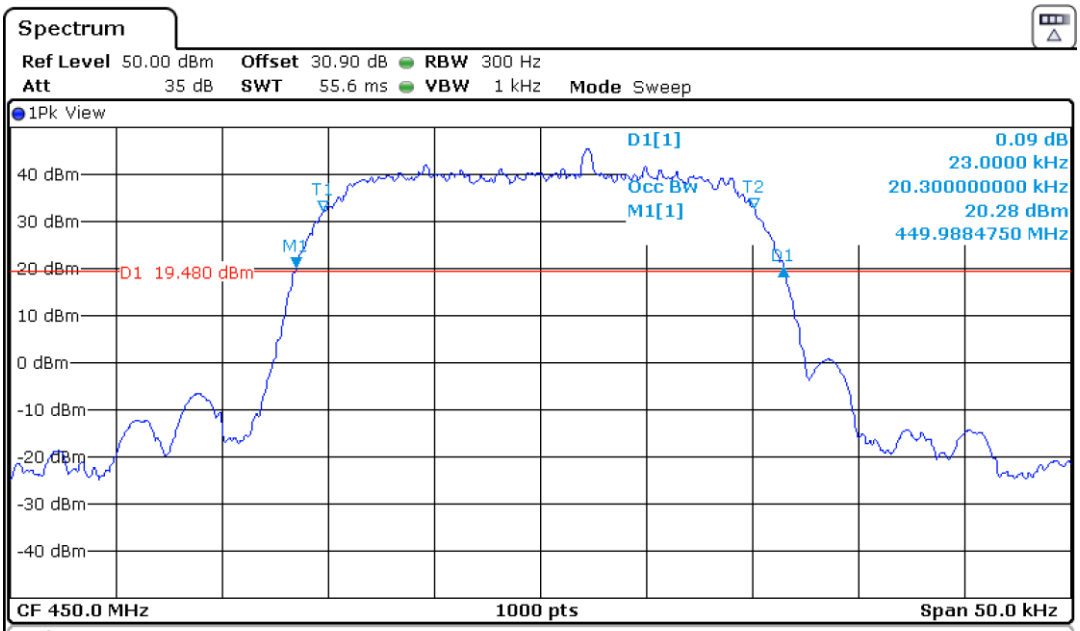


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	469.989125 MHz	18.13 dBm		
T1		1	469.990375 MHz	31.86 dBm	Occ Bw	19.15 kHz
T2		1	470.009525 MHz	32.19 dBm		
D1	M1	1	21.7 kHz	0.51 dB		

TETRA 22 kHz.

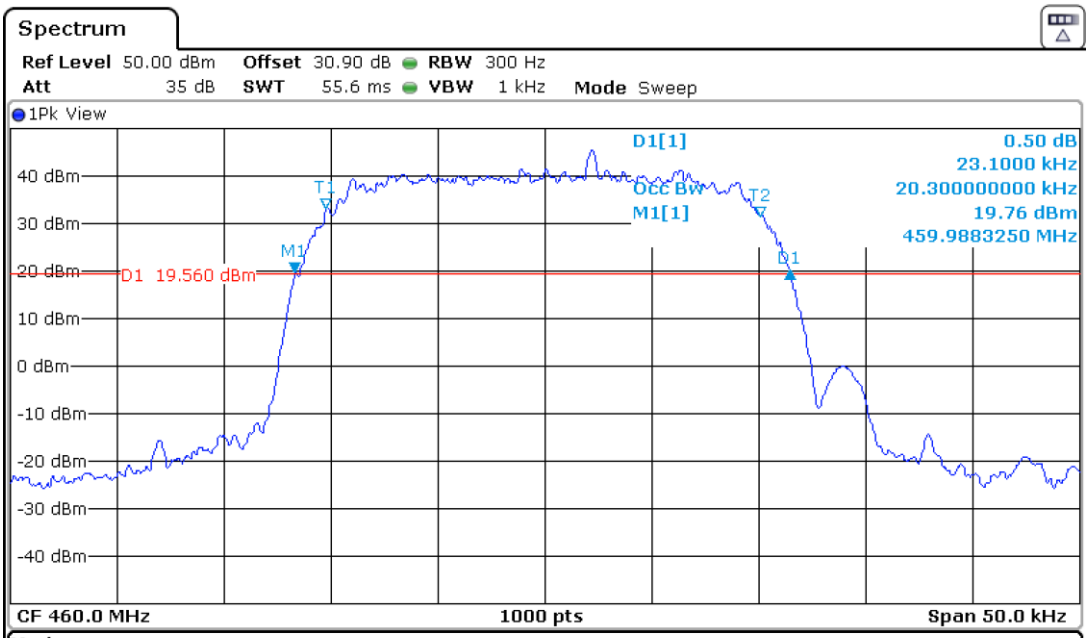
Lowest Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	449.988475 MHz	20.28 dBm		
T1		1	449.989775 MHz	32.26 dBm	Occ Bw	20.3 kHz
T2		1	450.010075 MHz	32.91 dBm		
D1	M1	1	23.0 kHz	0.09 dB		

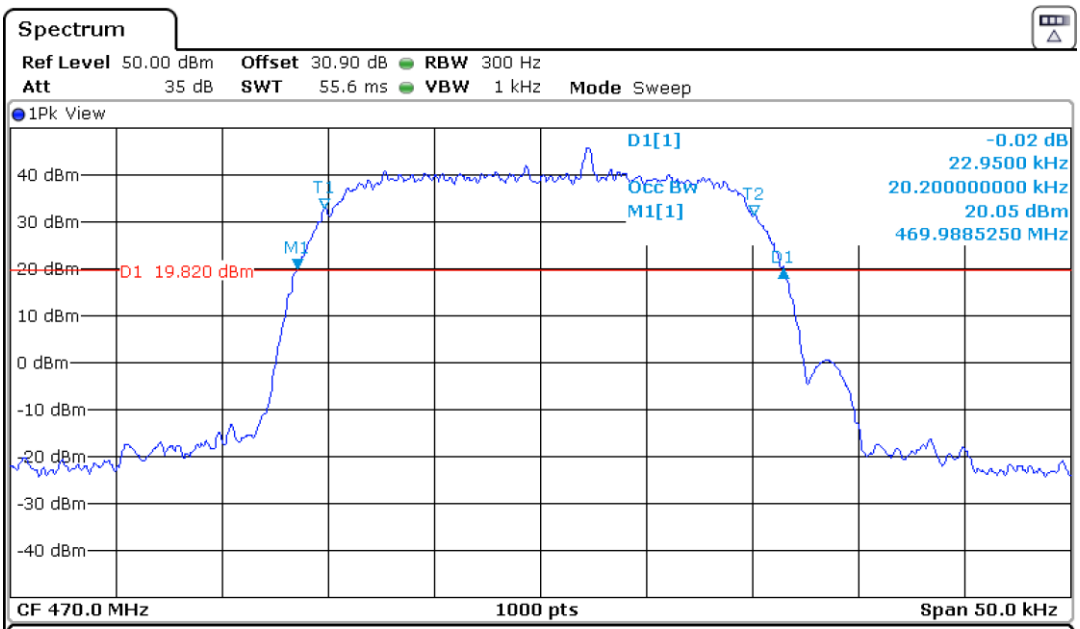
Middle Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	459.988325 MHz	19.76 dBm		
T1		1	459.989775 MHz	33.10 dBm	Occ Bw	20.3 kHz
T2		1	460.010075 MHz	31.40 dBm		
D1	M1	1	23.1 kHz	0.50 dB		

Highest Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	469.988525 MHz	20.05 dBm		
T1		1	469.989825 MHz	32.90 dBm	Occ Bw	20.2 kHz
T2		1	470.010025 MHz	31.51 dBm		
D1	M1	1	22.95 kHz	-0.02 dB		

RF Output Power

SPECIFICATION

FCC §90.205. 450-470 MHz band.

(h) *450-470 MHz.* (1) The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2. Applicants requesting an ERP in excess of that listed in table 2 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 2 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 39 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 32 km (20 mi) must justify the requested service area radius, which may be authorized only in accordance with table 2, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and will be entitled to no protection from primary operations.

Table 2—450-470 MHz—Maximum ERP/Reference HAAT for a Specific Service Area Radius

	Service area radius (km)									
	3	**8**	**13**	**16**	**24**	**32**	**40[4]**	**48[4]**	**64[4]**	**80[4]**
Maximum ERP (w)[1]	2	100	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500	[2]500
Up to reference HAAT (m)[3]	15	15	15	27	63	125	250	410	950	2700

[1]Maximum ERP indicated provides for a 39 dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See §73.699, Fig. 10 b).
[2]Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 39 dBu.
[3]When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: $ERP_{allow} = ERP_{max} \times (HAAT_{ref} / HAAT_{actual})^2$.
[4]Applications for this service area radius may be granted upon specific request with justification and must include a technical demonstration that the signal strength at the edge of the service area does not exceed 39 dBu.

RSS-119 Clause 5.4.

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.

The transmitter output power limits set forth in the following table will come into force upon the publication of Issue 12 of this standard and will apply to newly certified equipment.

Frequency Band (MHz)	Transmitter Output Power (W)	
	Base/Fixed Equipment	Mobile Equipment
406.1-430 and 450-470	110	60

METHOD

The conducted RF output power measurements were made at the RF output terminals of the EUT using an attenuator and a calibrated power sensor.

RESULTS

Type of equipment: Base station.

Manufacturer's rated power: 75 W (48.75 dBm).

TI D-LMR. 20 kHz Bandwidth	Frequency (MHz)	Maximum average power (dBm)	Maximum deviation (dB)
	450	48.08	-0.67
	460	48.03	-0.72
	470	47.96	-0.79
Measurement uncertainty (dB)		<±0.33	

TETRA. 22 kHz Bandwidth	Frequency (MHz)	Maximum average power (dBm)	Maximum deviation (dB)
	450	48.72	-0.03
	460	48.69	-0.06
	470	48.66	-0.09
Measurement uncertainty (dB)		<±0.33	

The sum of the system loss (dB) and antenna gain (dBd) for the worst case of conducted power (48.72 dBm) shall be such that the Effective Radiated Power (E.R.P.) shall not exceed the limit indicated above.

Verdict: PASS

Emission Mask

SPECIFICATION

FCC §90.210:

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
421-512[2,5]	B	C

2: Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C. as applicable.

5: Equipment may alternatively meet the Adjacent Channel Power limits of §90.221.

Emission Mask B. For transmitters that are equipped with an audio low-pass filter. the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent. but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent. but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

RSS-119 Clauses 5.5 and 5.8.

Frequency Band (MHz)	**Related SRSP for Channelling Plan and e.r.p.**	**Channel Spacing (kHz)**	**Authorized Bandwidth (kHz)**	**Spectrum Masks for equipment with Audio Filter**	**Spectrum Masks for equipment Without Audio Filter**
406.1-430 and 450-470	SRSP-501	25	22	Y	Y

FM transmitters with voice input may use the spectrum mask for equipment with an audio filter if they are equipped with suitable filters to be used for the audio signal only and not for other purposes. Equipment employing other modulations shall comply with the spectrum masks for equipment without an audio filter.

Table 17 - Emission Mask Y

Displacement Frequency. fd (kHz)	**Minimum Attenuation (dB)**	**Resolution Bandwidth (Hz)**
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

The emission masks were measured at the RF output terminals of the EUT using an attenuator and a spectrum analyser with a built-in spectrum mask measurement function.

RESULTS (see next plots)

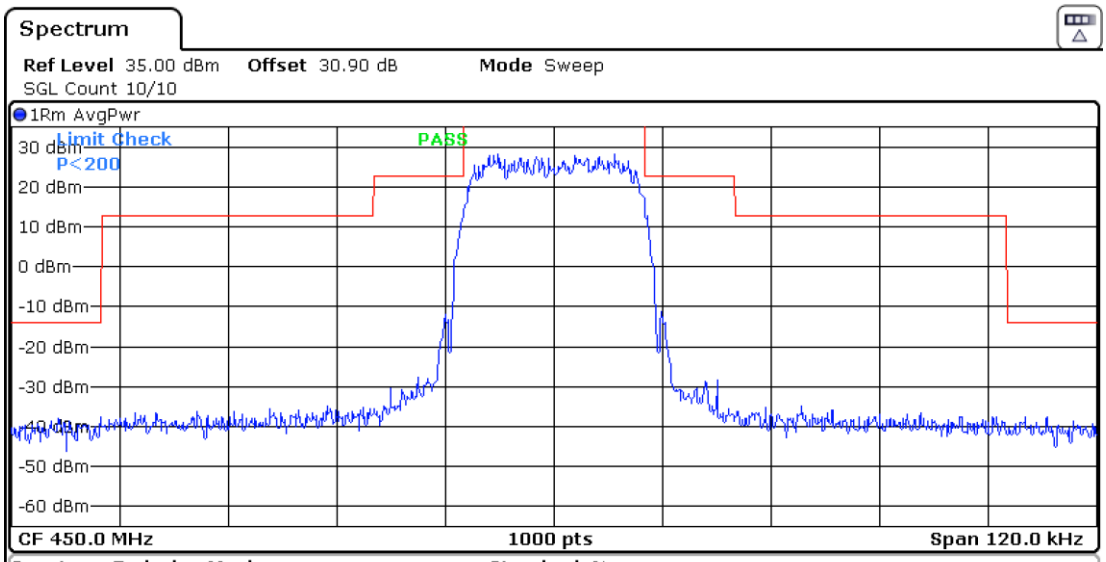
Measurement uncertainty (dB)	<±0.34

Verdict: PASS

FCC 90 Emission Mask B.

TI D-LMR 20 kHz Bandwidth.

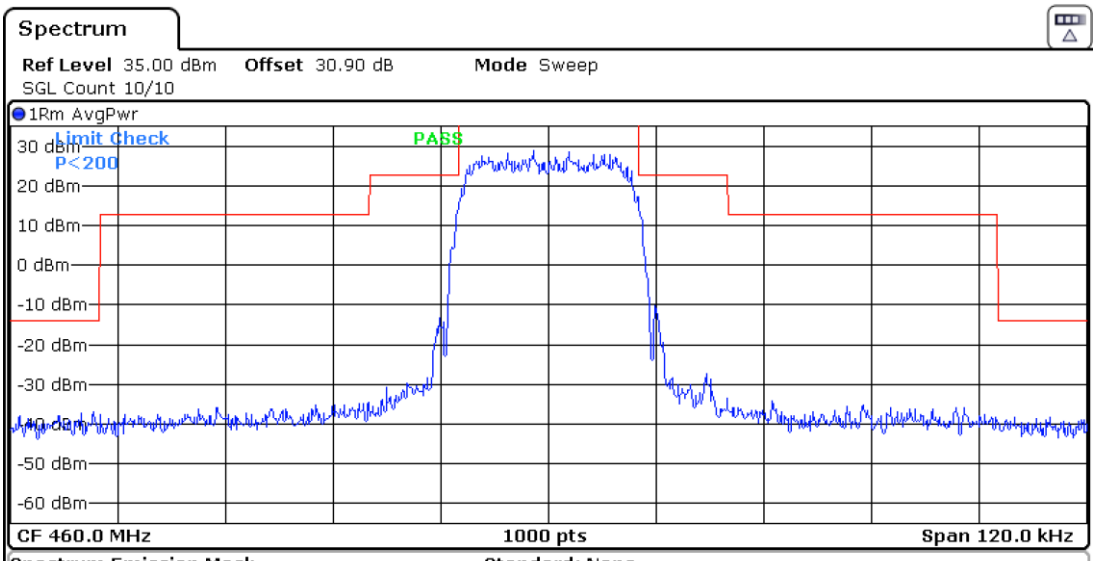
FCC 90 Lowest Channel



Spectrum Emission Mask — Standard: None
Tx Power 47.74 dBm — Tx Bandwidth 20.000 kHz — RBW 100.000 Hz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 kHz	-50.000 kHz	100.000 Hz	449.94994 MHz	-37.56 dBm	-85.30 dB	-23.60 dB
-50.000 kHz	-20.000 kHz	100.000 Hz	449.97490 MHz	-34.82 dBm	-82.56 dB	-47.56 dB
-20.000 kHz	-10.000 kHz	100.000 Hz	449.98994 MHz	13.43 dBm	-34.31 dB	-9.31 dB
10.000 kHz	20.000 kHz	100.000 Hz	450.01006 MHz	15.72 dBm	-32.02 dB	-7.02 dB
20.000 kHz	50.000 kHz	100.000 Hz	450.02738 MHz	-34.70 dBm	-82.44 dB	-47.44 dB
50.000 kHz	60.000 kHz	100.000 Hz	450.05452 MHz	-37.47 dBm	-85.21 dB	-23.51 dB

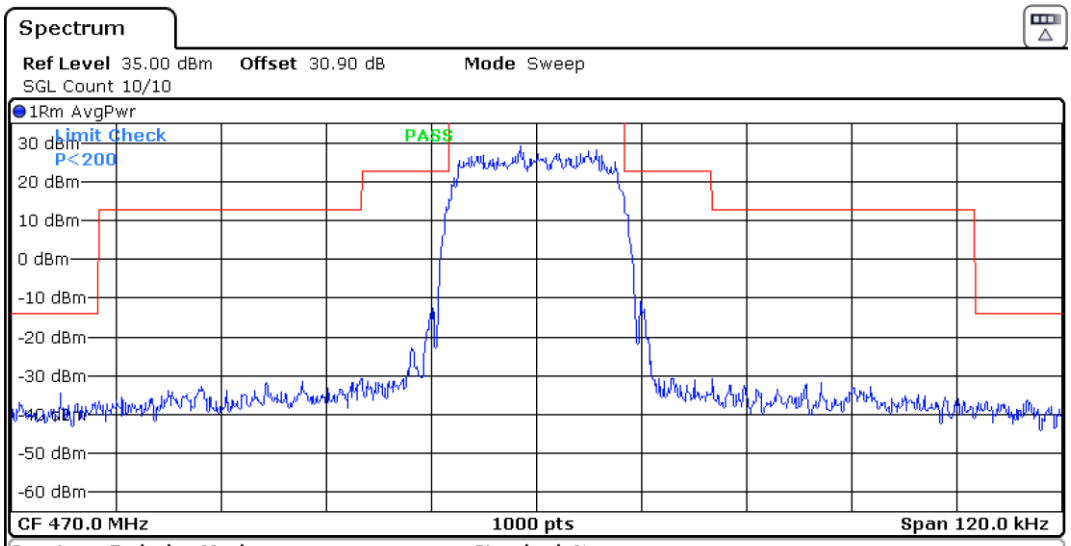
FCC 90 Middle Channel



Spectrum Emission Mask — Standard: None
Tx Power 47.80 dBm — Tx Bandwidth 20.000 kHz — RBW 100.000 Hz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 kHz	-50.000 kHz	100.000 Hz	459.94934 MHz	-37.02 dBm	-84.82 dB	-23.12 dB
-50.000 kHz	-20.000 kHz	100.000 Hz	459.97994 MHz	-34.51 dBm	-82.31 dB	-47.31 dB
-20.000 kHz	-10.000 kHz	100.000 Hz	459.98994 MHz	15.92 dBm	-31.88 dB	-6.88 dB
10.000 kHz	20.000 kHz	100.000 Hz	460.01006 MHz	15.43 dBm	-32.37 dB	-7.37 dB
20.000 kHz	50.000 kHz	100.000 Hz	460.02486 MHz	-34.18 dBm	-81.98 dB	-46.98 dB
50.000 kHz	60.000 kHz	100.000 Hz	460.05187 MHz	-38.17 dBm	-85.97 dB	-24.27 dB

FCC 90 Highest Channel



Spectrum Emission Mask **Standard: None**

Tx Power 47.58 dBm **Tx Bandwidth 20.000 kHz** **RBW 100.000 Hz**

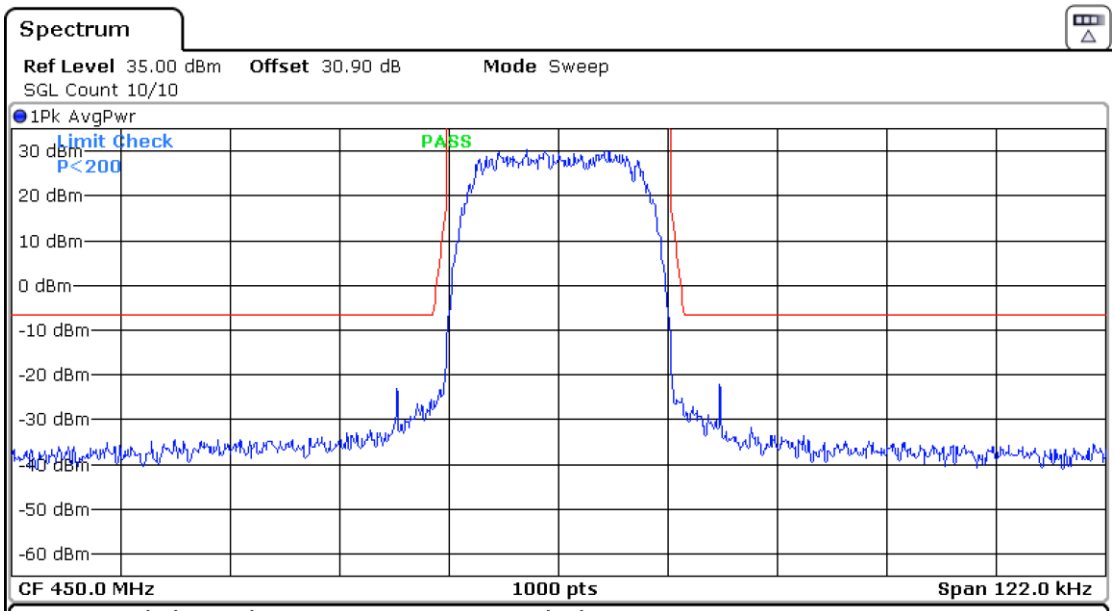
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 kHz	-50.000 kHz	100.000 Hz	469.94572 MHz	-34.57 dBm	-82.15 dB	-20.45 dB
-50.000 kHz	-20.000 kHz	100.000 Hz	469.97994 MHz	-30.73 dBm	-78.32 dB	-43.32 dB
-20.000 kHz	-10.000 kHz	100.000 Hz	469.98994 MHz	15.49 dBm	-32.10 dB	-7.10 dB
10.000 kHz	20.000 kHz	100.000 Hz	470.01006 MHz	16.08 dBm	-31.50 dB	-6.50 dB
20.000 kHz	50.000 kHz	100.000 Hz	470.02006 MHz	-30.61 dBm	-78.19 dB	-43.19 dB
50.000 kHz	60.000 kHz	100.000 Hz	470.05596 MHz	-36.24 dBm	-83.82 dB	-22.12 dB

Verdict: PASS

RSS-119 Emission Mask Y.

TETRA 22 kHz Bandwidth.

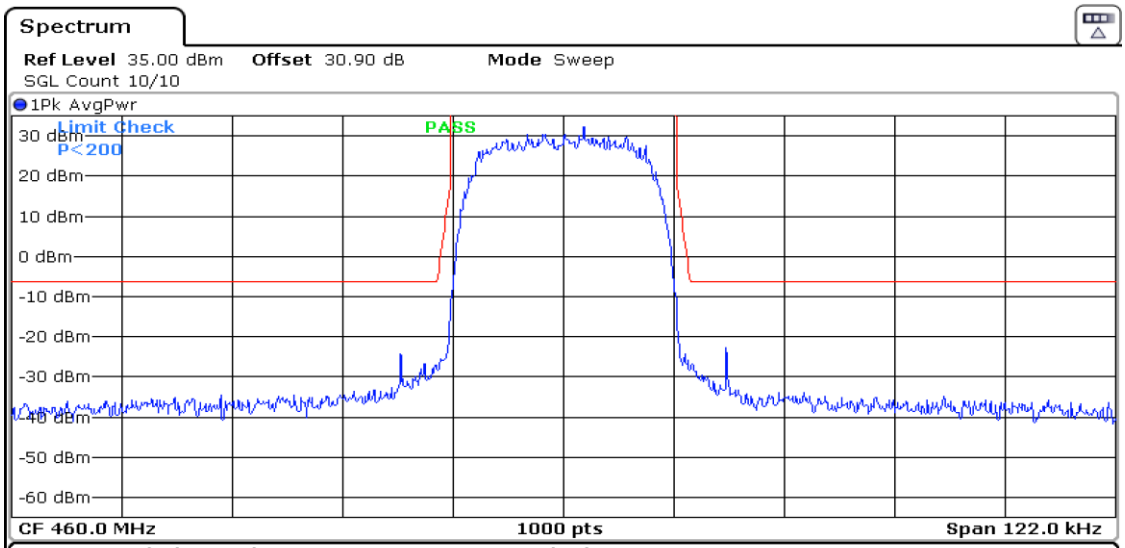
RSS-119 Lowest Channel



Spectrum Emission Mask — Standard: None
Tx Power 50.48 dBm — Tx Bandwidth 22.000 kHz — RBW 100.000 Hz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-61.000 kHz	-13.975 kHz	100.000 Hz	449.98193 MHz	-23.20 dBm	-73.67 dB	-16.67 dB
-13.975 kHz	-12.375 kHz	100.000 Hz	449.98609 MHz	-25.88 dBm	-76.35 dB	-20.39 dB
12.375 kHz	13.975 kHz	100.000 Hz	450.01391 MHz	-26.37 dBm	-76.84 dB	-20.88 dB
13.975 kHz	61.000 kHz	100.000 Hz	450.01794 MHz	-22.15 dBm	-72.62 dB	-15.62 dB

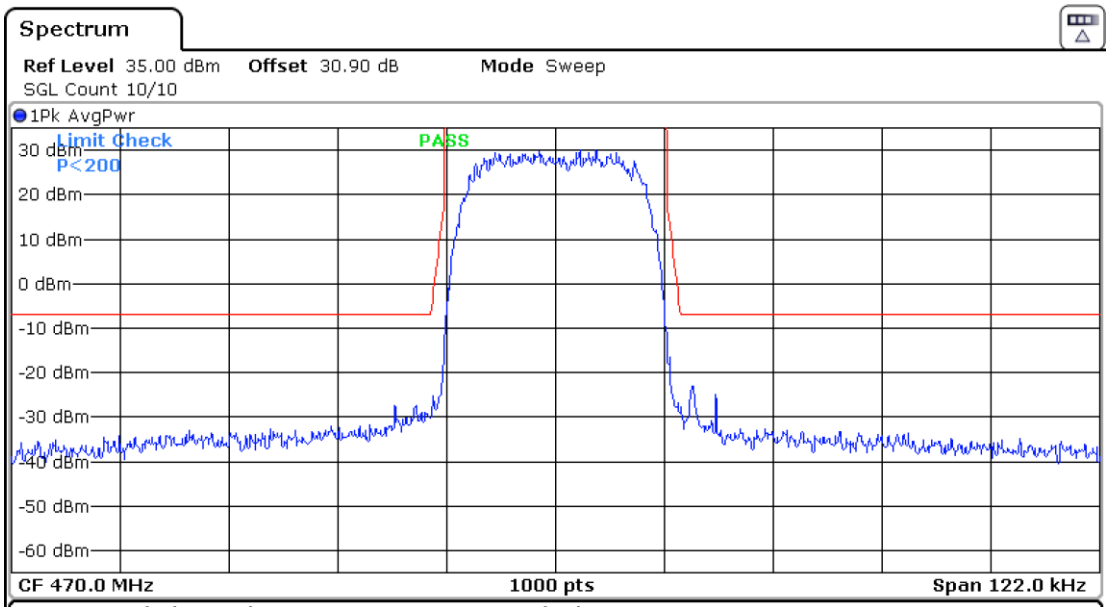
RSS-119 Middle Channel



Spectrum Emission Mask — Standard: None
Tx Power 50.57 dBm — Tx Bandwidth 22.000 kHz — RBW 100.000 Hz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-61.000 kHz	-13.975 kHz	100.000 Hz	459.98193 MHz	-24.37 dBm	-74.94 dB	-17.94 dB
-13.975 kHz	-12.375 kHz	100.000 Hz	459.98609 MHz	-28.40 dBm	-78.97 dB	-23.01 dB
12.375 kHz	13.975 kHz	100.000 Hz	460.01379 MHz	-25.98 dBm	-76.55 dB	-22.67 dB
13.975 kHz	61.000 kHz	100.000 Hz	460.01794 MHz	-22.62 dBm	-73.19 dB	-16.19 dB

RSS-119 Highest Channel



Spectrum Emission Mask Standard: None
Tx Power 50.21 dBm Tx Bandwidth 22.000 kHz RBW 100.000 Hz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-61.000 kHz	-13.975 kHz	100.000 Hz	469.98438 MHz	-27.31 dBm	-77.52 dB	-20.52 dB
-13.975 kHz	-12.375 kHz	100.000 Hz	469.98609 MHz	-27.58 dBm	-77.79 dB	-21.83 dB
12.375 kHz	13.975 kHz	100.000 Hz	470.01391 MHz	-28.91 dBm	-79.12 dB	-23.16 dB
13.975 kHz	61.000 kHz	100.000 Hz	470.01538 MHz	-22.97 dBm	-73.18 dB	-16.18 dB

Verdict: PASS

Adjacent channel power

SPECIFICATION

FCC §90.221.

(a) For the frequency bands indicated below, operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the adjacent channel power (ACP) limits below. The table specifies a value for the ACP as a function of the displacement from the channel center frequency and a measurement bandwidth of 18 kHz.

(b)(1) Maximum adjacent power levels for frequencies in the 450-470 MHz band:

Frequency offset	Maximum ACP (dBc) for devices 1 watt and less	Maximum ACP (dBc) for devices above 1 watt
25 kHz	-55 dBc	-60 dBc
50 kHz	-70 dBc	-70 dBc
75 kHz	-70 dBc	-70 dBc

(2) In any case, no requirement in excess of -36 dBm shall apply.

(d) On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (Pwatts) dB.

METHOD

The Adjacent Channel Power measurements were made at the RF output terminals of the EUT using an attenuator and a spectrum analyzer with a built-in adjacent channel power (ACP) measurement function.

RESULTS. See next plots.

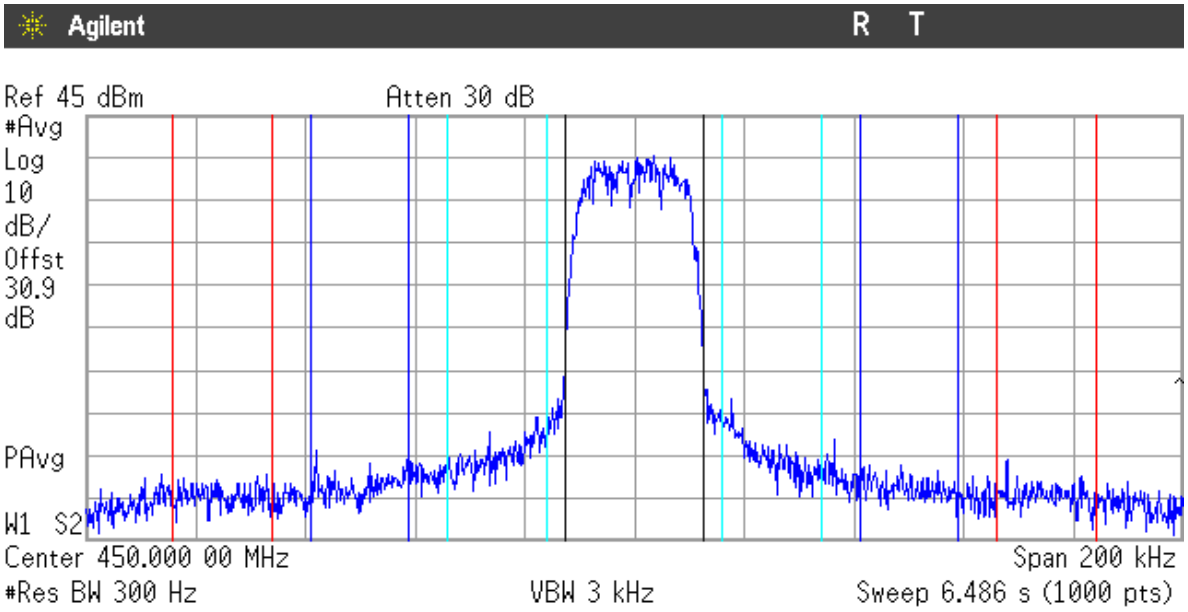
Declared maximum output power: 48.75 dBm (75W).

Measurement uncertainty (dB)	<±0.34

Verdict: PASS

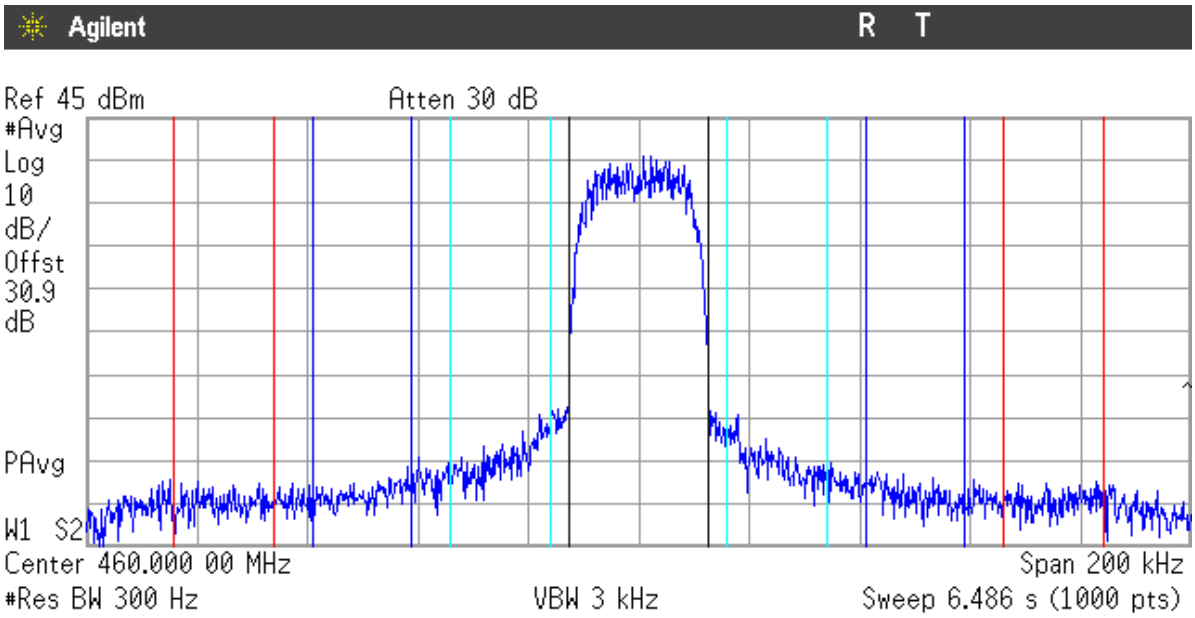
TETRA, 22 kHz. FCC 450-470 MHz band.

Lowest Channel



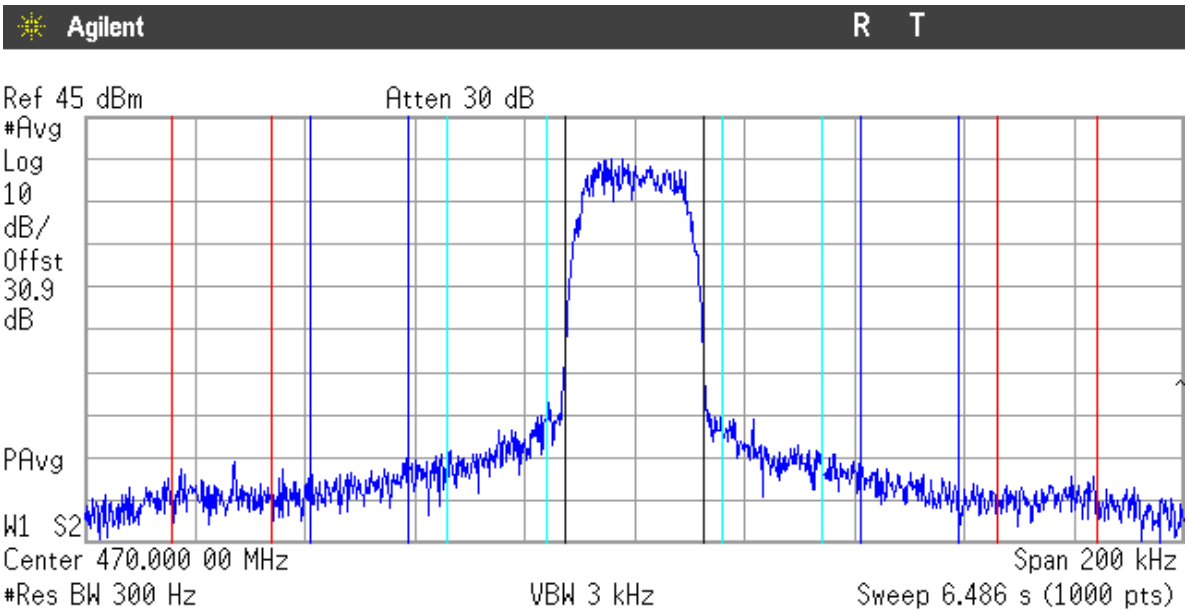
RMS Results	Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
Carrier Power	25.00 kHz	18.00 kHz	-64.89	-15.71	-64.10	-14.93
49.18 dBm /	50.00 kHz	18.00 kHz	-73.13	-23.95	-73.60	-24.42
25.0000 kHz	75.00 kHz	18.00 kHz	-75.51	-26.33	-75.18	-26.00

Middle Channel



RMS Results	Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
Carrier Power	25.00 kHz	18.00 kHz	-63.56	-15.08	-64.39	-15.91
48.49 dBm /	50.00 kHz	18.00 kHz	-73.32	-24.83	-73.34	-24.86
25.0000 kHz	75.00 kHz	18.00 kHz	-75.30	-26.82	-75.06	-26.57

Highest Channel



RMS Results

Carrier Power	Freq Offset	Ref BW	Lower dBc	Lower dBm	Upper dBc	Upper dBm
48.71 dBm /	25.00 kHz	18.00 kHz	-63.58	-14.87	-64.17	-15.46
25.0000 kHz	50.00 kHz	18.00 kHz	-71.69	-22.98	-72.69	-23.98
	75.00 kHz	18.00 kHz	-74.46	-25.75	-75.17	-26.46

Frequency Stability

SPECIFICATION

FCC §2.1055. §90.213. 421–512 MHz band

Unless noted elsewhere. transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

Frequency range (MHz)	Fixed and base stations
421-512	[7, 11, 14] 2.5 ppm

Note 7: In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

Note 11: Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

Note 14: Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

RSS-119 Clause 5.3.

The carrier frequency shall not depart from the reference frequency in excess of the values given in the following table:

Frequency Band (MHz)	Channel Bandwidth (kHz)	Frequency Stability (ppm)
		Base/Fixed
406.1-430 and 450-470 (Note 6)	25 (Note 2)	0.5

Note 2: This provision is for digital equipment with a channel spacing of 25 kHz and an occupied bandwidth greater than 20 kHz. The mobile station's frequency stability values given in Table 1 are for mobile. portable and control transmitters using automatic frequency control (AFC) to lock onto the base station signal. When the mobile. portable and control transmitters are operating without using AFC to lock onto the base station signal. the frequency stability limit shall be better than 1 kHz and the equipment's unwanted emissions measured with maximum frequency shift shall still comply with emission mask Y (Section 5.8.10) at nominal carrier frequency.

Note 6: Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

METHOD

The frequency tolerance measurements over temperature variations were made over the temperature range of –30ºC to +50ºC. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10ºC steps from –30ºC up to +50ºC.

Frequency Stability vs Voltage: Vary primary supply voltage between the extreme voltage values.

The EUT is set in continuous transmission without modulation (only carrier) and the frequency is measured with the frequency meter of Radiocommunication analyzer HP 8920A.

RESULTS

Channel 460 MHz.

Voltage (Vdc)	Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
Frequency stability with Temperature			
27.4	+50	15	0.03261
	+40	14	0.03043
	+30	15	0.03261
	+20	15	0.03261
	+10	15	0.03261
	0	15	0.03261
	-10	14	0.03043
	-20	14	0.03043
	-30	14	0.03043
Frequency stability with Supply Voltage			
21.6	20	15	0.03261
31.51	20	15	0.03261

Measurement uncertainty	$<\pm 1x\ 10^{-6}$

Verdict: PASS

Spurious emissions at antenna terminals

SPECIFICATION

FCC §2.1051. §90.210 (421–512 MHz band), §90.221 (450-470 MHz band).

Emission Mask B.

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P_{watts}) dB.

Adjacent channel power limits.

On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (P_{watts}) dB.

RSS-119 Clause 5.8.

Table 17 - Emission Mask Y

Displacement Frequency. fd (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

The EUT RF output connector was connected to a spectrum analyser using a 50 ohm attenuator and the resolution bandwidth of the spectrum analyser was set to 100 kHz for frequencies < 1GHz and 1 MHz for frequencies > 1 GHz. The spectrum was investigated from 9 kHz to 5 GHz.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyzer.

RESULTS (see plots in next pages)

TI D-LMR 20 kHz bandwidth.

CHANNEL: LOWEST

All peaks found are more than 20 dB below the limit.

CHANNEL: MIDDLE

All peaks found are more than 20 dB below the limit.

CHANNEL: HIGHEST

All peaks found are more than 20 dB below the limit.

TETRA 22 kHz bandwidth.

CHANNEL: LOWEST

All peaks found are more than 20 dB below the limit.

CHANNEL: MIDDLE

All peaks found are more than 20 dB below the limit.

CHANNEL: HIGHEST

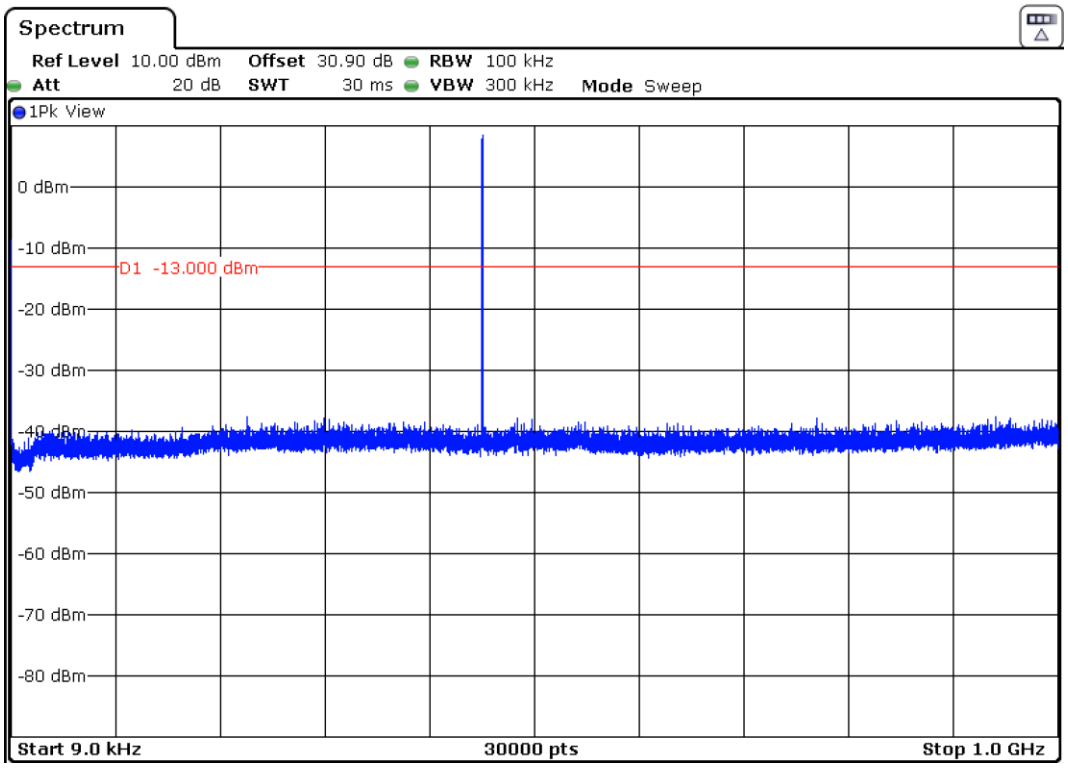
All peaks found are more than 20 dB below the limit.

Measurement uncertainty (dB)	<±0.34

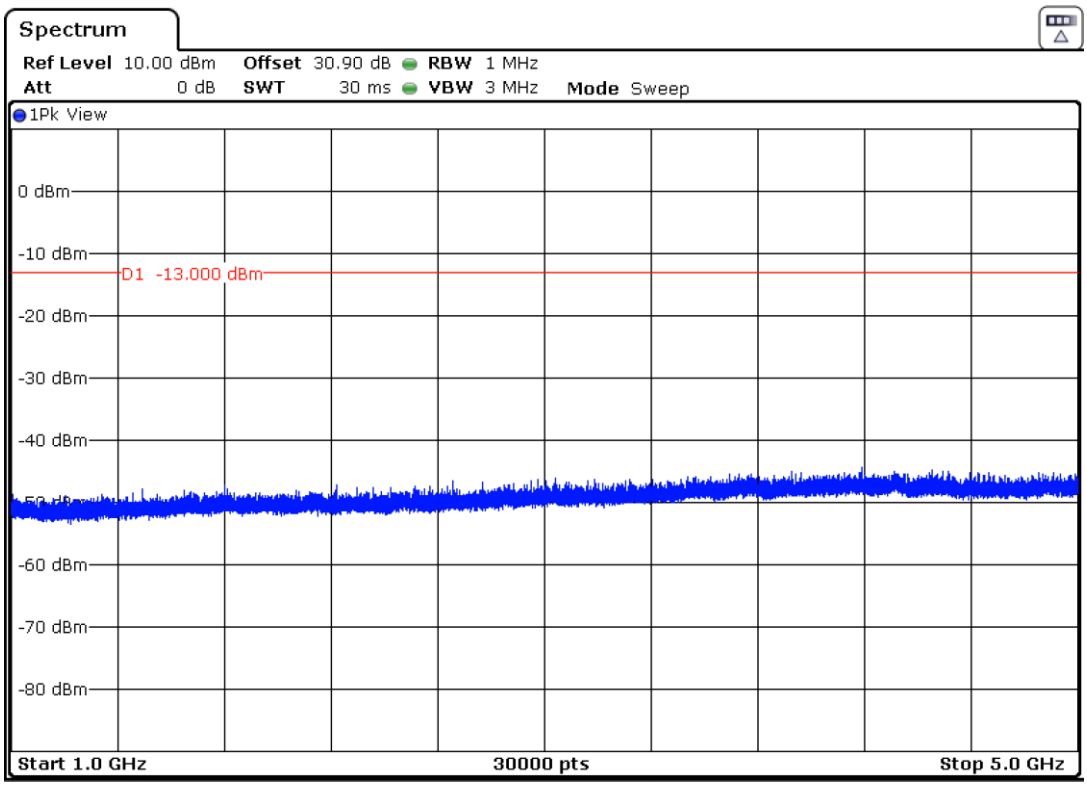
Verdict: PASS

TI D-LMR 20 kHz bandwidth.

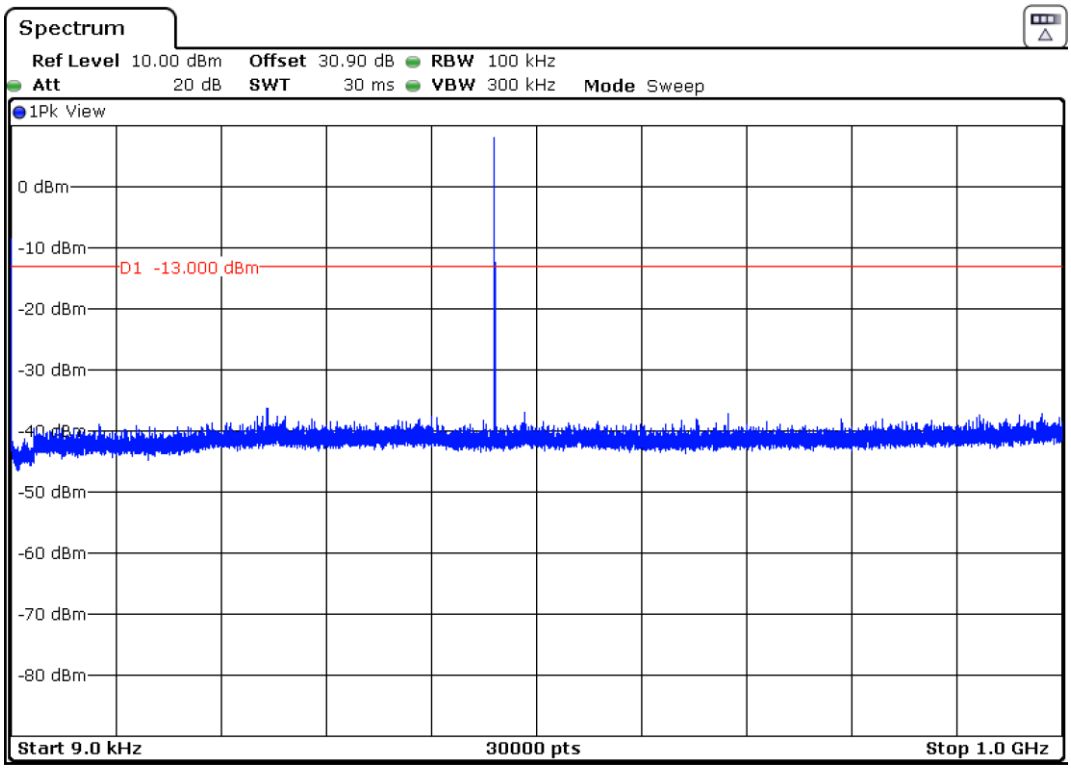
CHANNEL: LOWEST



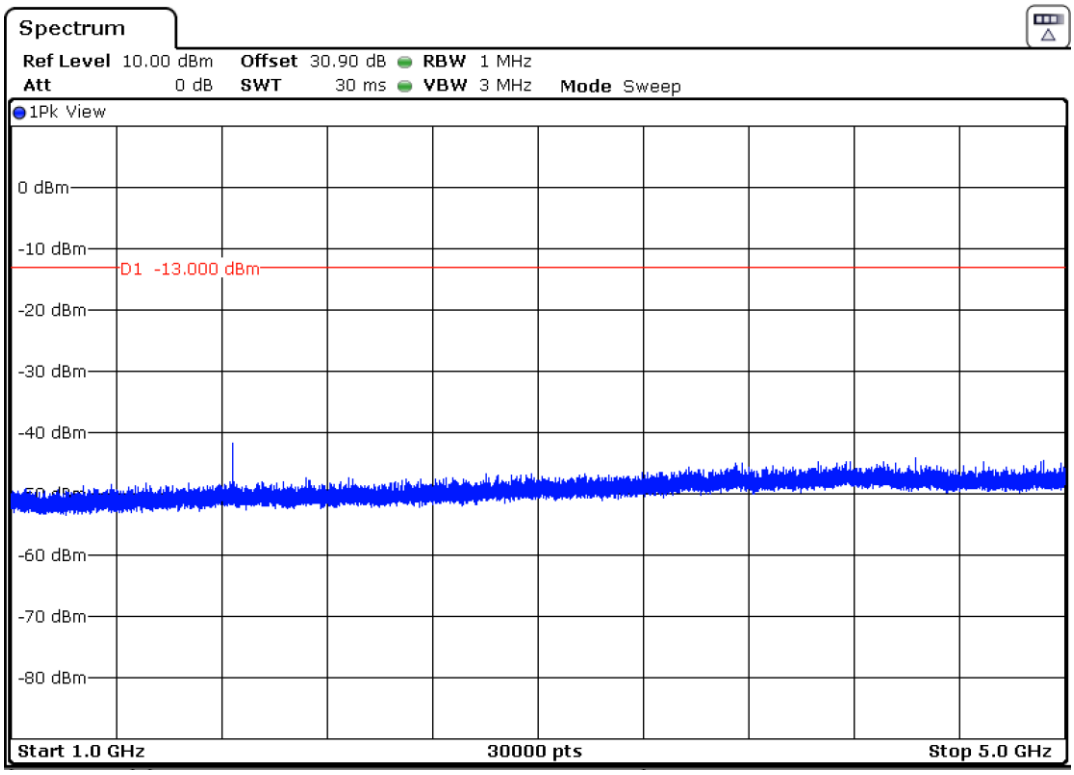
Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.



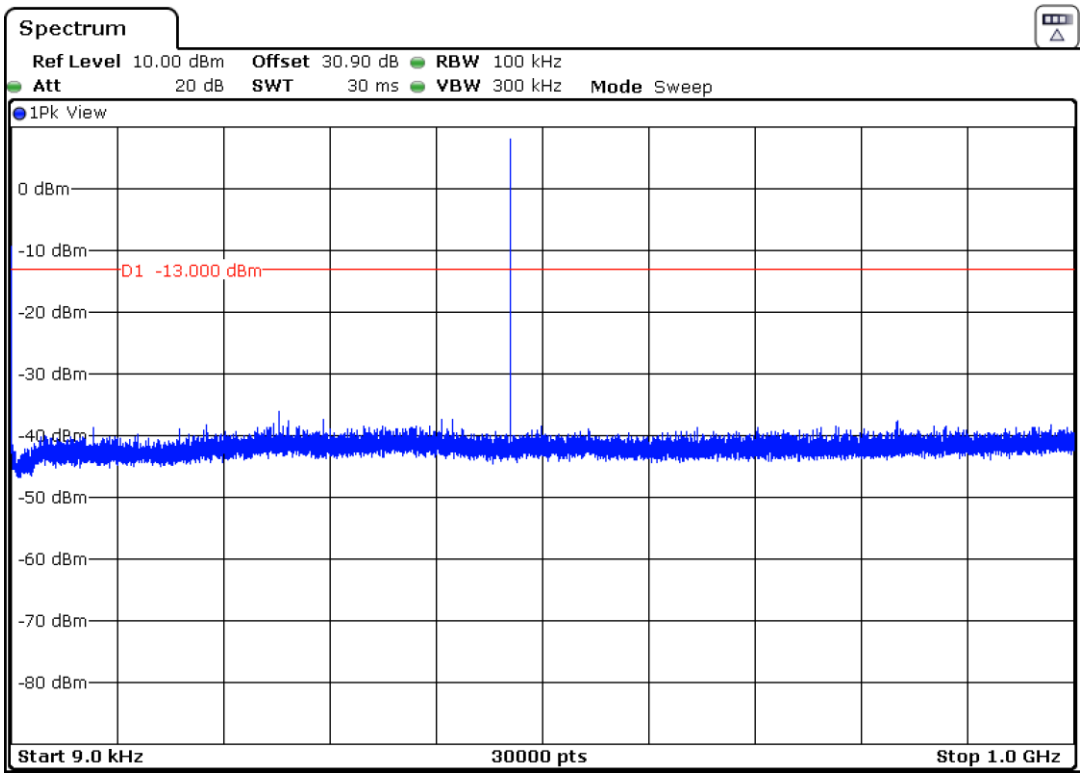
CHANNEL: MIDDLE



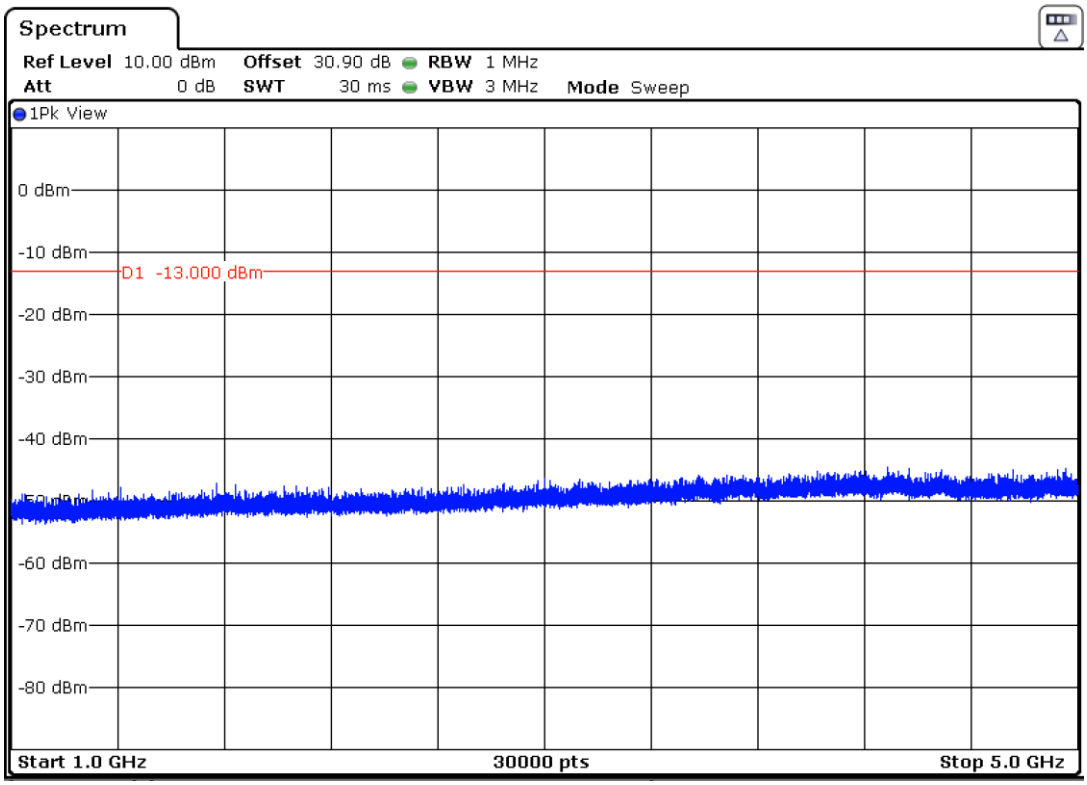
Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.



CHANNEL: HIGHEST

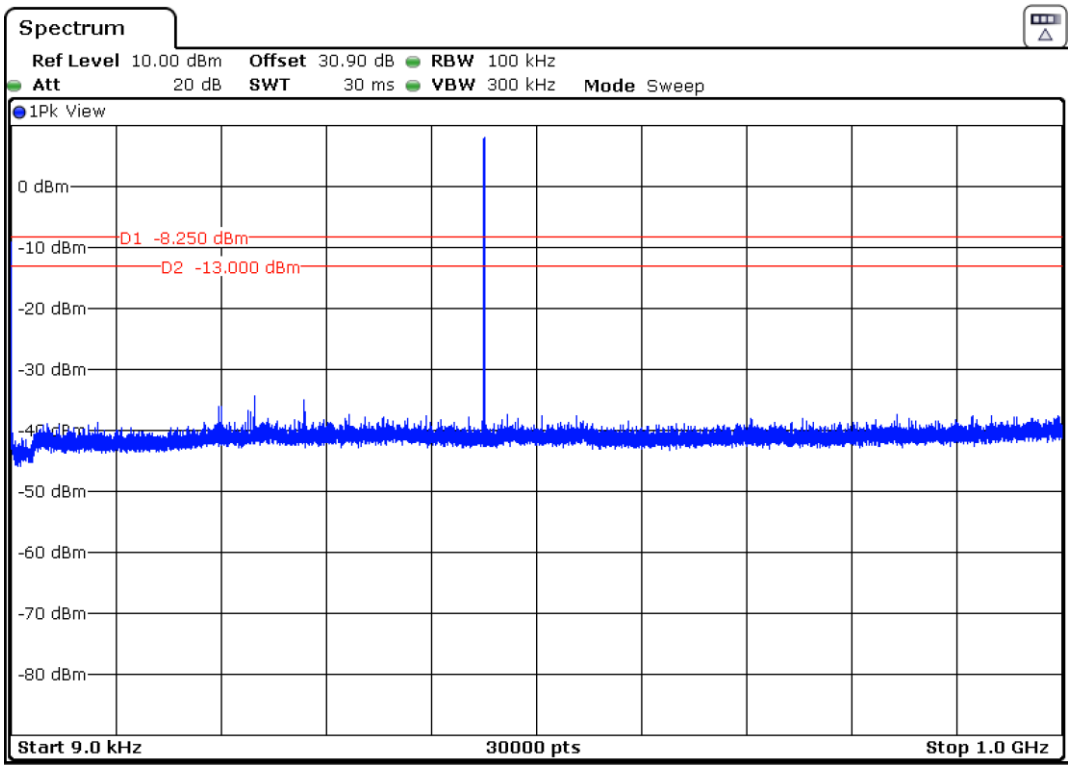


Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.

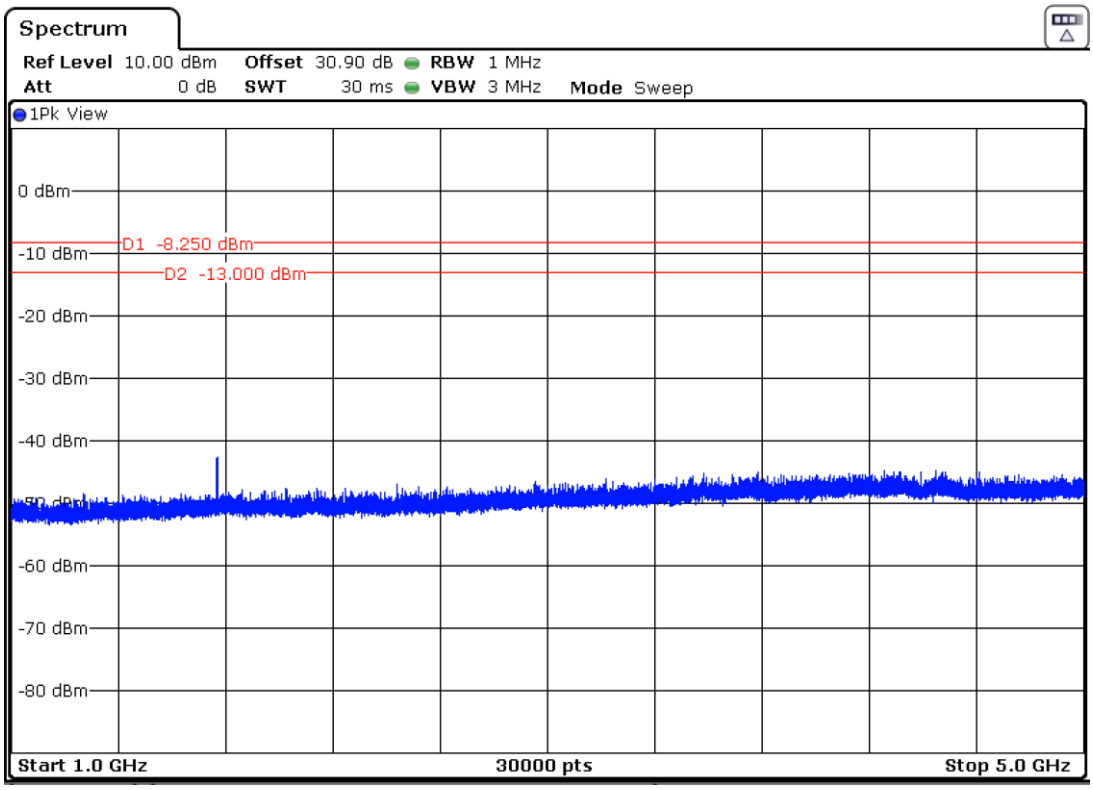


TETRA 22 kHz bandwidth.

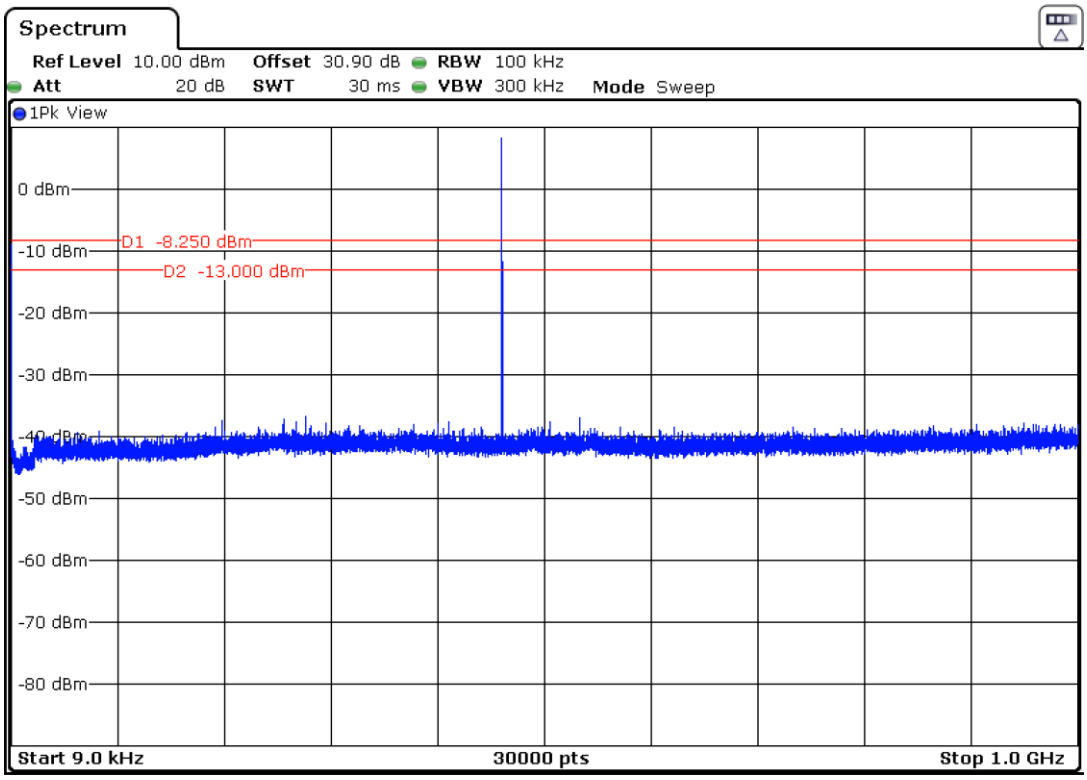
CHANNEL: LOWEST



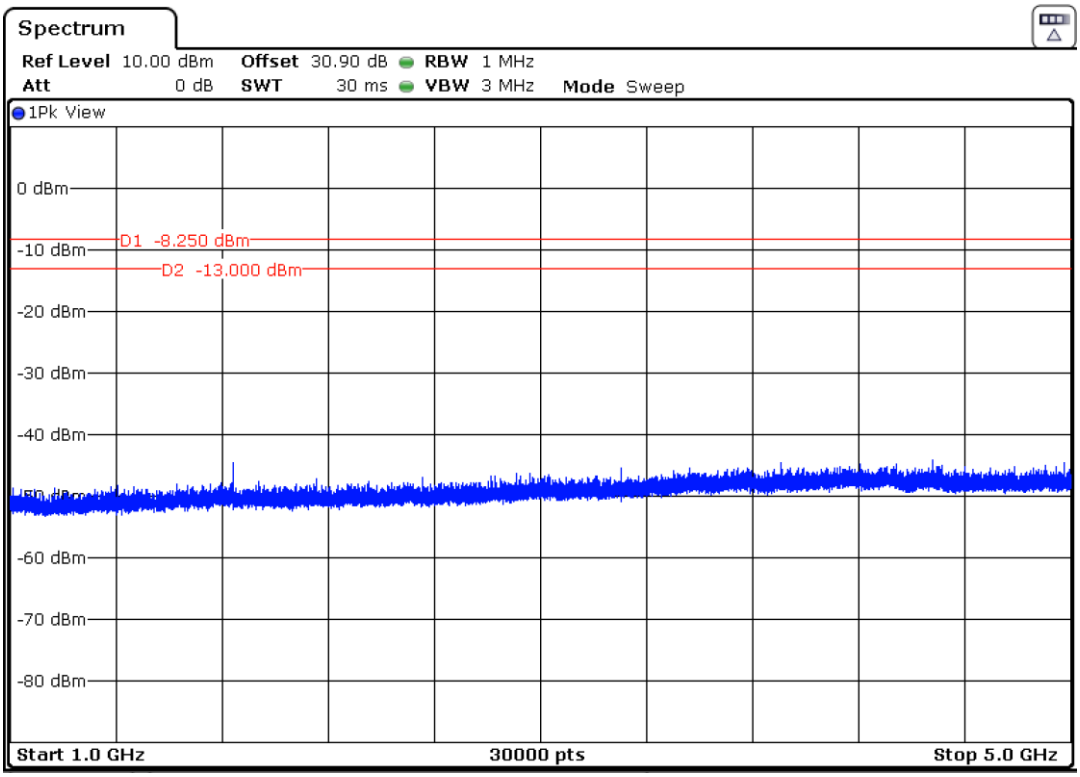
Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.



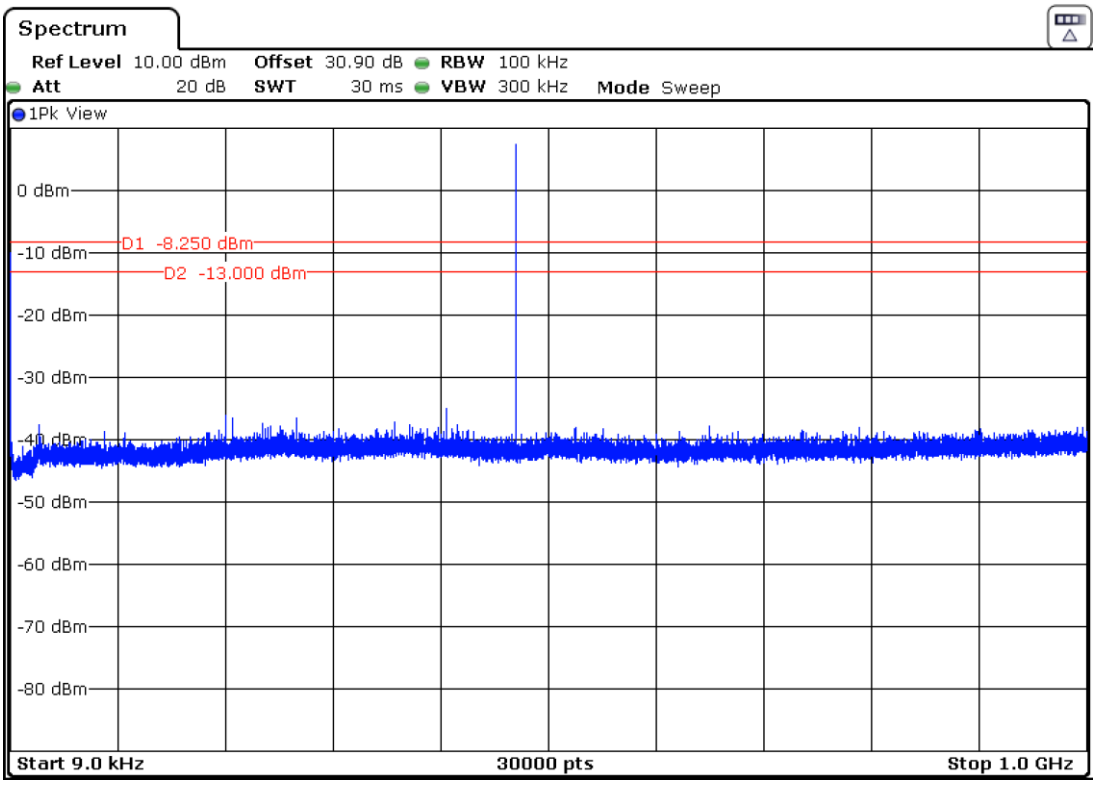
CHANNEL: MIDDLE



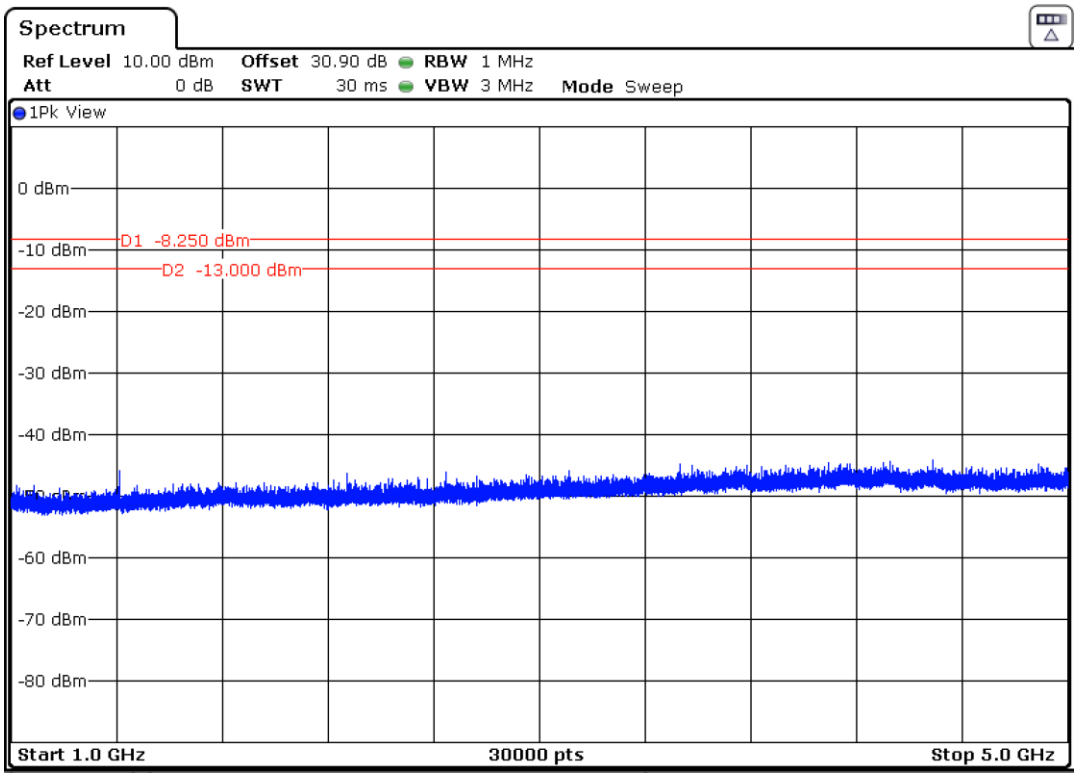
Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.



CHANNEL: HIGHEST



Note: The peak above the limit is the carrier frequency. The carrier is attenuated with a notch filter.



Radiated emissions

SPECIFICATION

FCC §2.1051. §90.210 (421–512 MHz band), §90.221 (450-470 MHz band).

Emission Mask B.

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P_{watts}) dB.

Adjacent channel power limits.

On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (P_{watts}) dB.

RSS-119 Clause 5.8.

Table 17 - Emission Mask Y

Displacement Frequency. fd (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

The measurement was performed with the EUT inside an anechoic chamber with the accessories connected. The RF output connector of the EUT is terminated with an attenuator and a 50 ohm load.

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.
A preliminary scan was performed to determine the worst case of modulation mode.
Each detected emission is substituted by the Substitution method.

RESULTS

A preliminary scan determined the TETRA 22 kHz mode as the worst case. The following tables and plots show the results for this configuration.

CHANNEL: LOWEST.

Highest spurious signals.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
83.9826	-26.23	100	Peak	Vertical	-56.13	0.23	1.03	-53.33
143.9539	-23.59	100	Peak	Vertical	-51.30	0.40	0.91	-50.79
167.9930	-23.10	100	Peak	Vertical	-52.42	0.53	3.15	-49.80
900.0478	-48.83	100	Peak	Vertical	-44.72	1.23	6.72	-39.23
4050.470	-55.15	1000	Peak	Horizontal	-60.54	2.80	11.97	-51.37
4950.070	-61.77	1000	Peak	Horizontal	-63.12	3.15	11.52	-54.76

2. CHANNEL: MIDDLE.

Highest spurious signals.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
83.9826	-23.96	100	Peak	Vertical	-53.86	0.23	1.03	-53.06
143.9539	-24.48	100	Peak	Vertical	-52.19	0.40	0.91	-51.68
165.8843	-37.26	100	Peak	Vertical	-66.60	0.51	3.15	-53.96
920.0383	-50.16	100	Peak	Vertical	-46.14	1.25	6.63	-40.76
1120.200	-52.63	1000	Peak	Horizontal	-60.67	1.26	6.80	-55.13
3680.200	-58.45	1000	Peak	Horizontal	-65.13	2.68	11.87	-55.94

3. CHANNEL: HIGHEST.

Highest spurious signals.

Substitution method data

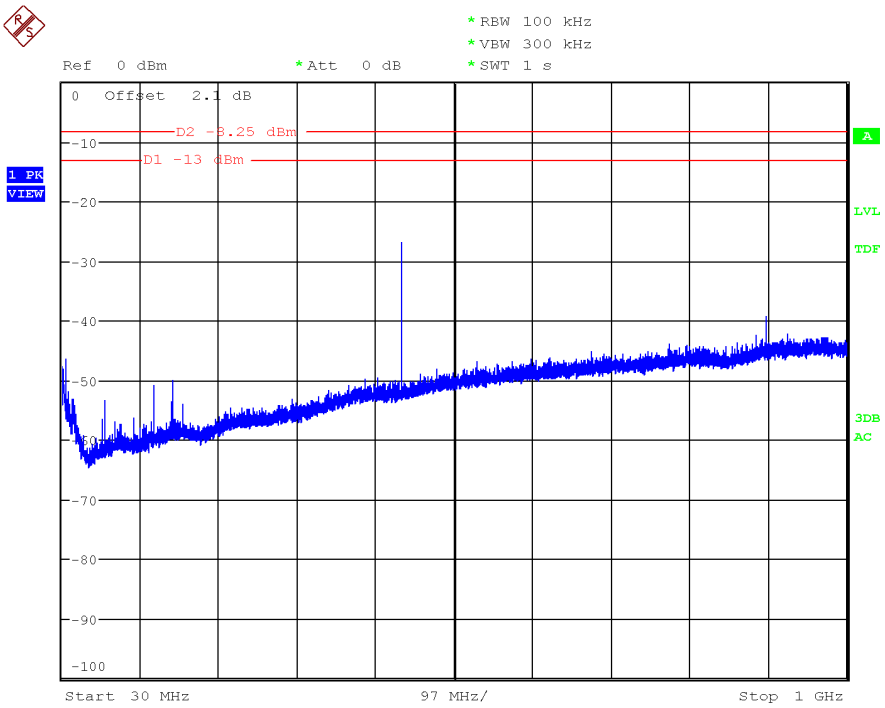
Frequency (MHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
83.8983	-23.56	100	Peak	Vertical	-53.46	0.23	1.03	-52.66
165.9687	-26.71	100	Peak	Vertical	-56.05	0.51	3.15	-53.41
940.0196	-51.38	100	Peak	Vertical	-47.29	1.23	6.64	-41.88
1263.930	-50.82	1000	Peak	Horizontal	-61.12	1.30	7.10	-55.32
3760.200	-55.79	1000	Peak	Horizontal	-62.15	2.76	11.90	-53.01
4699.670	-58.66	1000	Peak	Horizontal	-61.10	3.00	11.62	-52.48

Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±4.87 for f ≥ 1 GHz up to 18 GHz

Verdict: PASS

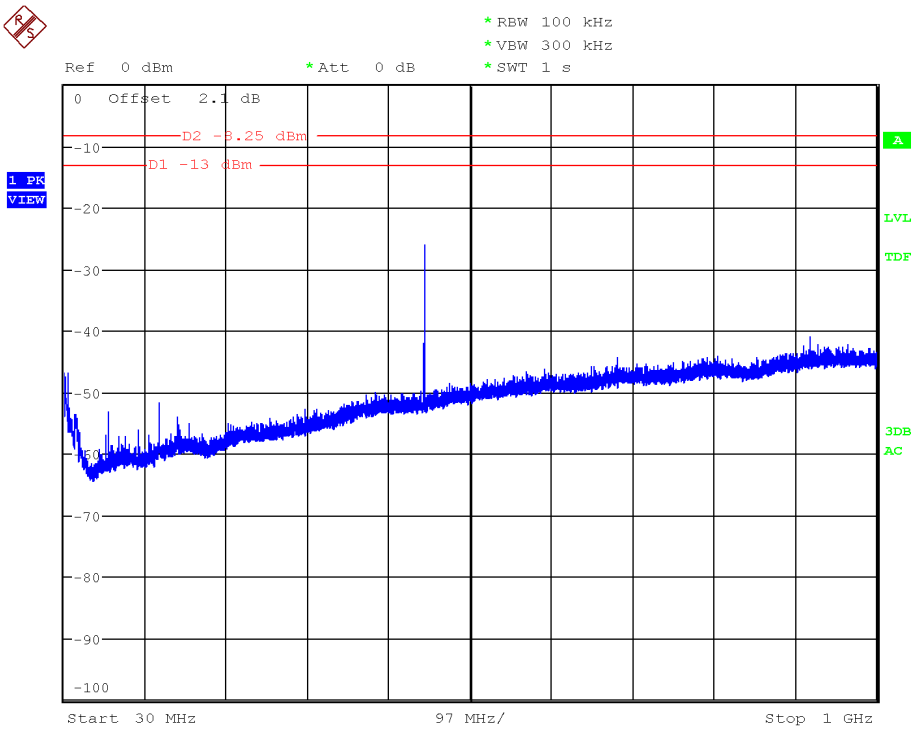
FREQUENCY RANGE 30 MHz-1000 MHz.

CHANNEL: LOWEST



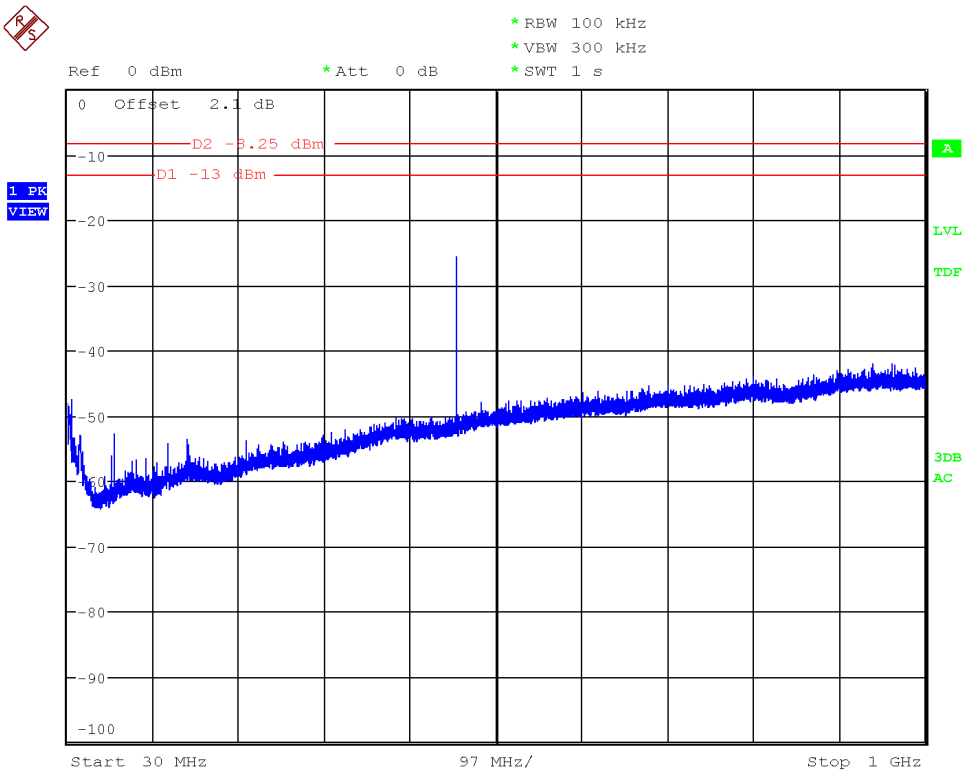
Note: The highest peak shown in the plot is the carrier frequency.

CHANNEL: MIDDLE.



Note: The highest peak shown in the plot is the carrier frequency.

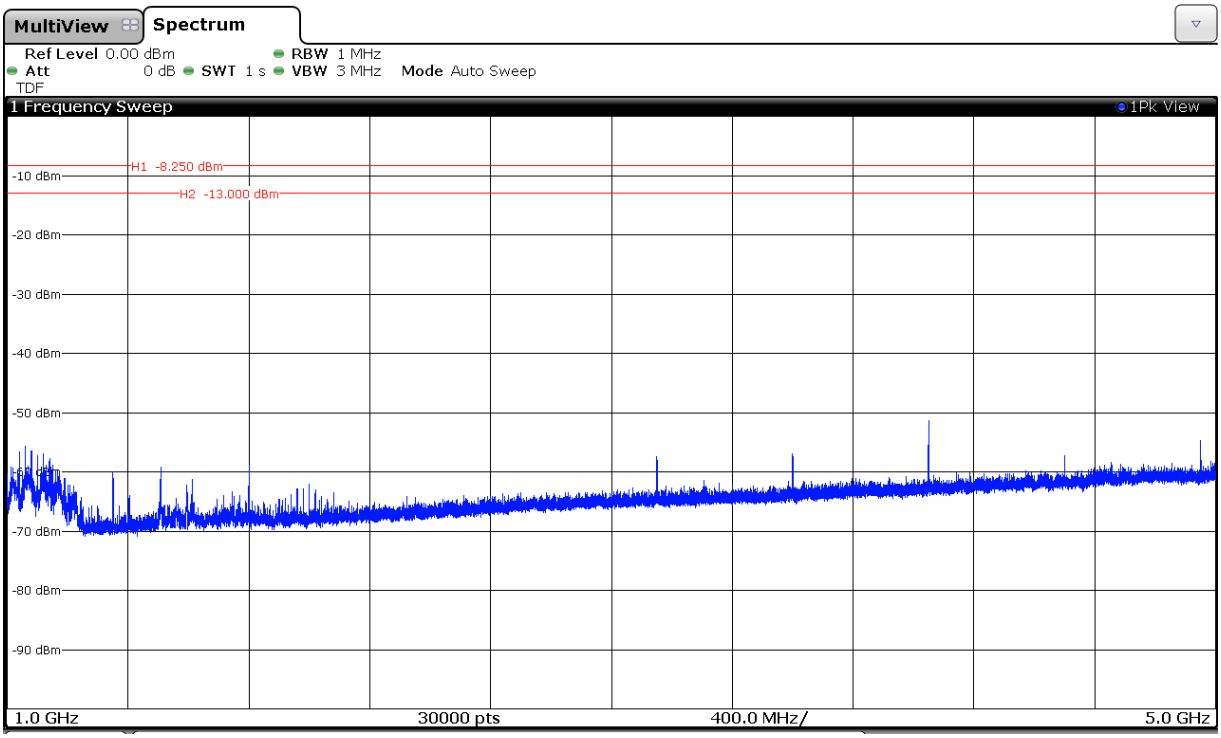
CHANNEL: HIGHEST.



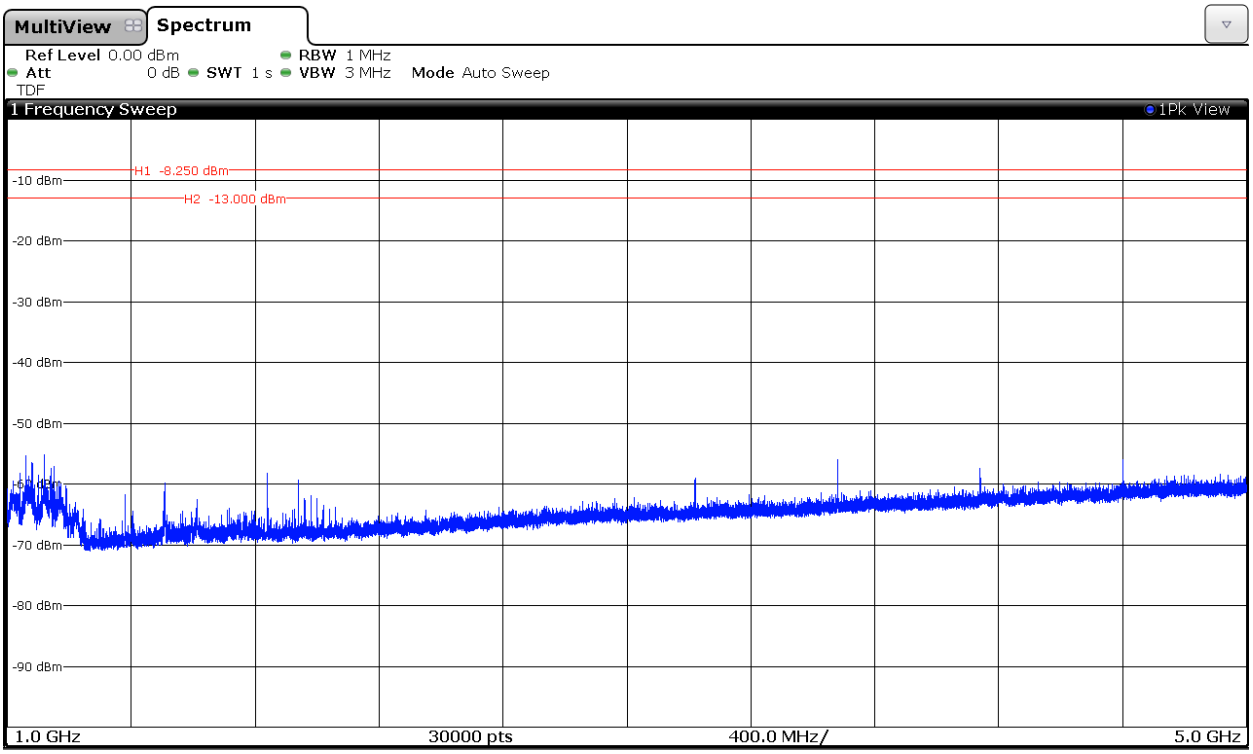
Note: The highest peak shown in the plot is the carrier frequency.

FREQUENCY RANGE 1 GHz to 5 GHz.

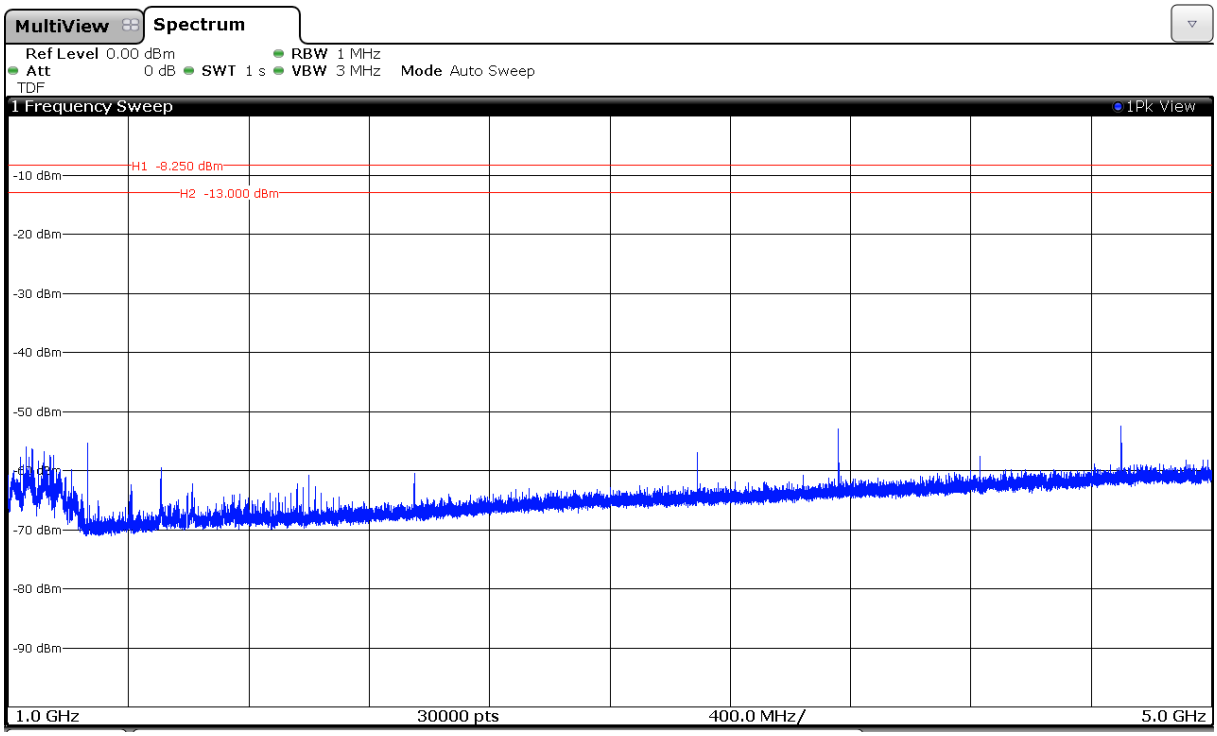
CHANNEL: LOWEST



CHANNEL: MIDDLE.



CHANNEL: HIGHEST.



Transient Frequency Behaviour

SPECIFICATION

FCC §90.214

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals[1 2]	**Maximum frequency difference[3]**	**All equipment**	
		150 to 174 MHz	**421 to 512 MHz**
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms

1. t_{on} is the instant when a 1 kHz test signal is completely suppressed. including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

t_{off} is the instant when the 1 kHz test signal starts to rise.

2. During the time from the end of t_2 to the beginning of t_3. the frequency difference must not exceed the limits specified in §90.213.

3. Difference between the actual transmitter frequency and the assigned transmitter frequency.

4. If the transmitter carrier output power rating is 6 watts or less. the frequency difference during this time period may exceed the maximum frequency difference for this time period.

RSS-119 §5.9.

When a transmitter is turned on. the radio frequency may take some time to stabilize. During this initial period. the frequency error or frequency difference (i.e.. between the instantaneous and the steady state frequencies) shall not exceed the limits specified in Table 18.

Table 18 – Transient Frequency Behaviour

Channel Bandwidth (kHz)	**Time intervals (Notes 1. 2)**	**Maximum Frequency Difference (kHz)**	**Transient Duration Limit (ms)**	
			138 to 174 MHz	**406.1 to 512 MHz**
25	t_1	±25.0 kHz	5.0	10.0
	t_2	±12.5 kHz	20.0	25.0
	t_3	±25.0 kHz	5.0	10.0

Notes:

1. t_{on}: the instant when a 1 kHz test signal is completely suppressed. including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

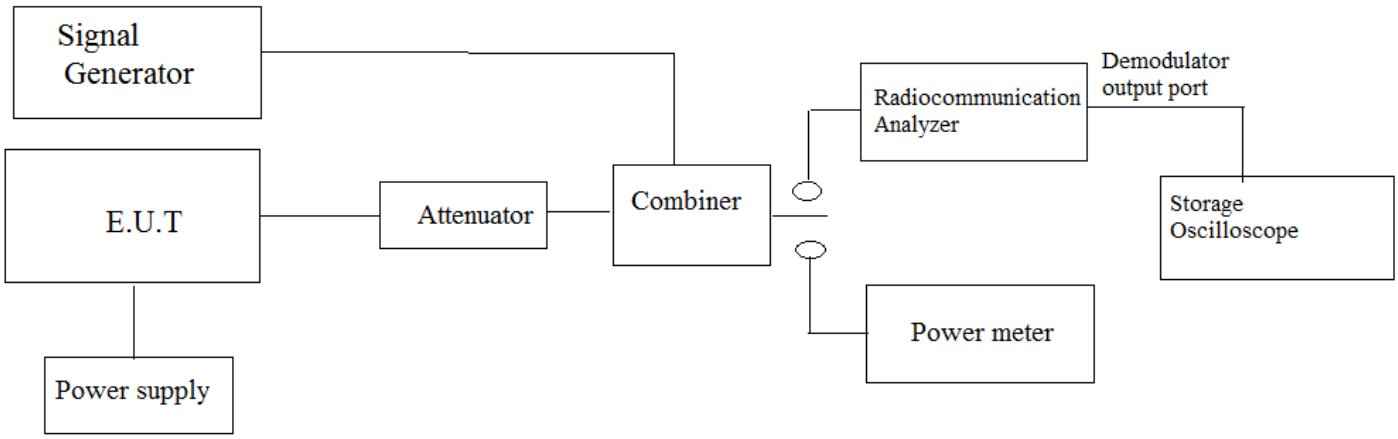
t_{off} is the instant when the 1 kHz test signal starts to rise.

2. If the transmitter carrier output power rating is 6 watts or less. the frequency difference during the time periods t_1 and t_3 may exceed the maximum frequency difference for theses time periods.

METHOD

The method used was according to ANSI C63.26-2015 6.5.2.3. “Transient frequency behaviour alternative method using a test receiver”.

An attenuator and a calibrated wideband power sensor were used to measure the power levels.



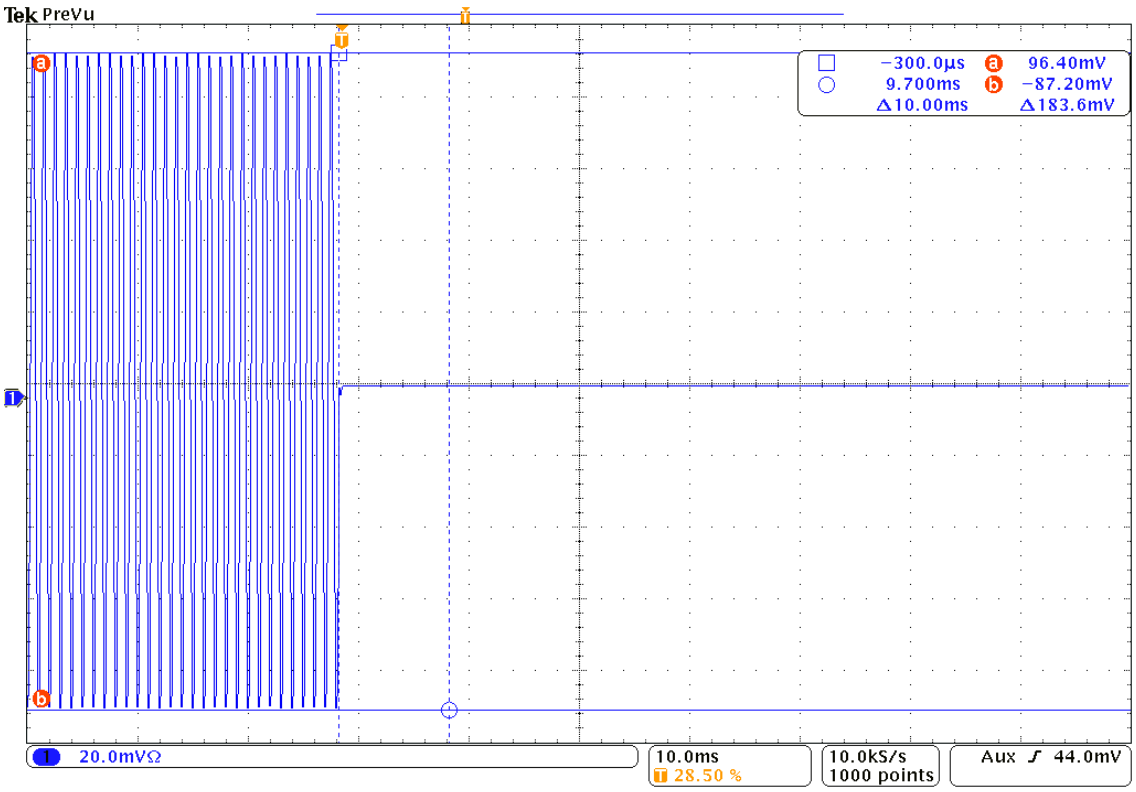
RESULTS (see next plots).

CHANNEL: 460 MHz.

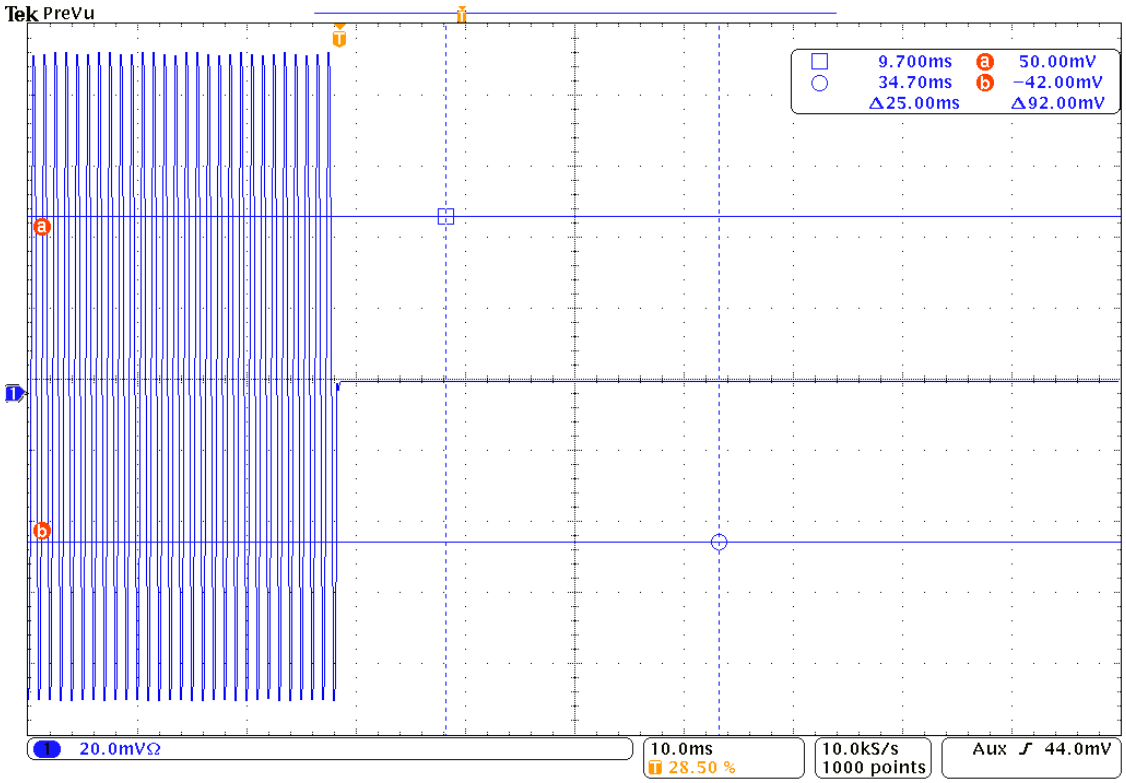
Time intervals	**Maximum Frequency Difference (kHz)**
t_1	< 1
t_2	< 0.230
t_3	< 6.2
Measurement uncertainty (kHz)	< ± 0.75

Verdict: PASS

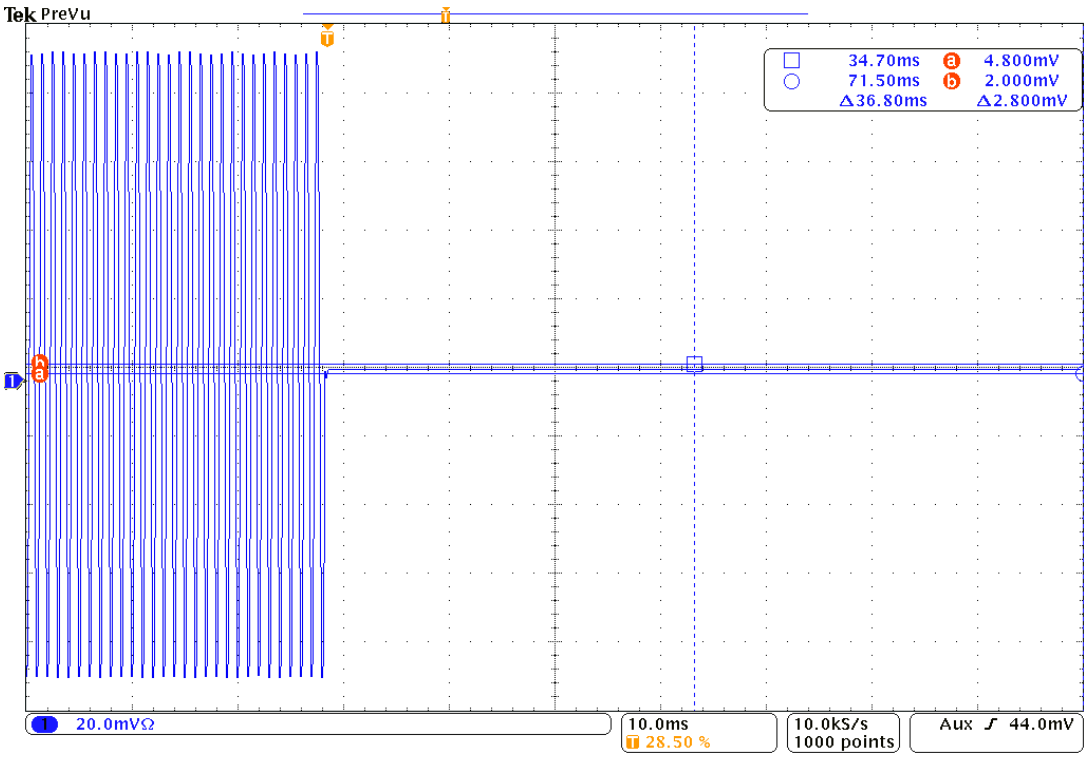
Transient Frequency Behaviour t_{on} to t_1.



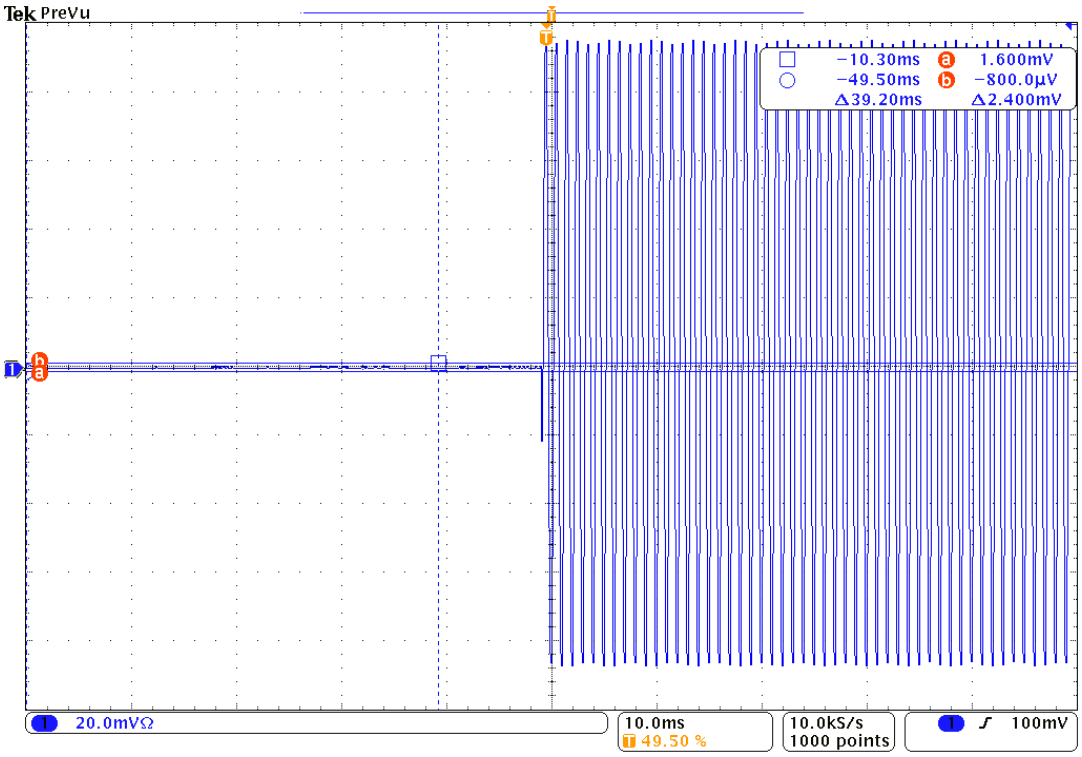
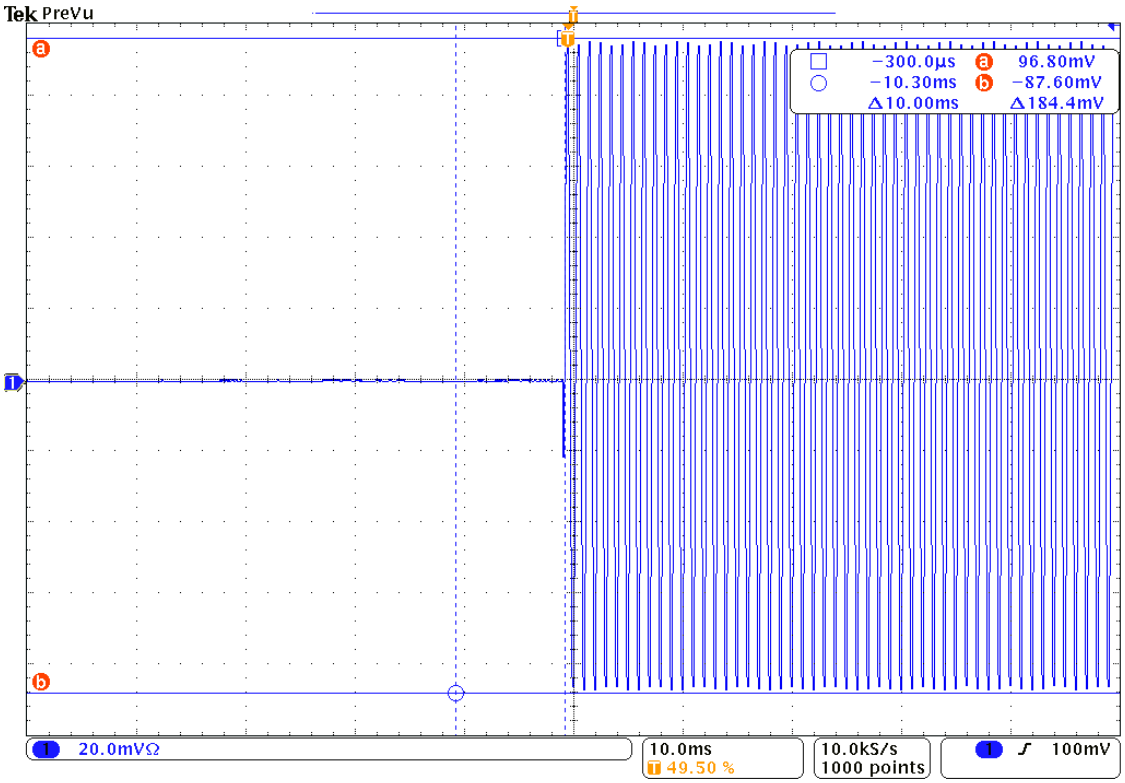
Transient Frequency Behaviour t_1 to t_2.



Transient Frequency Behaviour following t_2.



Transient Frequency Behaviour before t_3.



Transient Frequency Behaviour t_3 to t_{off}.