FCC TEST REPORT No. 14/987	2014
for 47 CFR Part 90	November, 28

Model name:	LCU
Product description	Street light controller
FCC ID	NTA2WLCU
Applicant	Telematics Wireless Ltd., Israel
Manufacturer	Telematics Wireless Ltd., Israel

PUBLIC ENTERPRISE
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Approved by
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Chief TC of PE TC "OMEGA"

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1 EQUIPMENT UNDER TEST

1.1 Basic description

Equipment Category	**Transceiver**
Model name	**LCU**
Destination	**a compact RF Transceiver unit for street light control system**
Configuration	**stand-alone device**
Serial numbers	**n/a**

1.2 Technical characteristics declared by manufacturer

Table 1.2.1 Transmit Narrow Channel, complies Part 90

Narrow Channel	
Parameter	**Value**
Transmit frequency band	450-470 MHz
Channel Separation	6.25 kHz
Modulation	4GFSK
Max Frequency deviation	±1.2 kHz
Max Data rate	4.8 kbps
Frequency stability (including initial stability, temperature)	<0.5 ppm
Peak output power	35.2 dBm
Harmonics	< -62 dBc

Table 1.2.2 Parameters of the Receiver

Receive Parameters	
Parameter	**Value**
Receive frequency	Programmable in the range 450-470 MHz
Sensitivity (BER 1E-3)	-120 dBm
Modulation	4GFSK
Frequency deviation	1.2 kHz

1.3 Photos

Figure 1.3.1 External photo

Figure 1.3.2 External photo

2 GENERAL INFORMATION ABOUT TESTS

2.1 Test program and results of the tests

Number of test	FCC rule	Description of test	Result (Pass, Fail, N/A)
1	90.210(e)	Emission Mask	**Pass**
2	90.210(e)	Conducted Spurious Emissions	**Pass**
3	90.210(e)	Radiated Spurious Emissions	**Pass**
4	90.214	Transient Frequency Stability	**Pass**
5	90.213	Frequency Stability with temperature	**Pass**
6	90.213	Frequency Stability with supply voltage	**Pass**
7	15.207(a)	Conducted emissions	**Pass**
8	15.107(a)	Conducted emissions	**Pass**

Tested by:
tests No. 1,2,4-6: Laboratory engineer Boris Trifonov

tests No. 3, 7, 8: Laboratory engineer Vladimir Osaulko

Checked by:
Leading engineer Fjodor Shubin

2.2 Test conditions and test modes

Operating Temperature: -30 °C to + 85 °C
Storage Temperature: -40 °C to +85 °C
Humidity: Up to 95%

Nominal power source:
- Unom = 120.0 VAC

Extreme temperature:
- minimum temperature Tmin = minus 30 °C;
- maximum temperature Tmax = +85 °C.

Extreme power source:
- minimum voltage Umin = 132.0 VAC
- maximum voltage Umax = 108.0 VAC

The frequencies for the testing

Channel, No.	Frequency, MHz
Low	450
Mid	460
High	470

2.3 Test equipment used

№	Name	Model	Inventory or serial No.
1.	EMI Test receiver/spectrum analyzer	R&S ESU-26	100260
2.	Spectrum analyzer	R&S FSV40	105763
3.	Radiocommunication service monitor	R&S CMS-54	100033
4.	Vector Signal Generator	SMJ100A	101127
5.	Signal Generator	SMB100A	100217
6.	Oscilloscope	TDS1002	C041673
7.	Frequency meter	R&S HM8123	100269
8.	Dual directional coupler	778D-012	101895
9.	Attenuator	Agilent 8496B	100103
10.	Attenuator	6N25W	100196
11.	Attenuator	PE7014-10	101692
12.	Detector	Agilent 8471E	100104
13.	RF Trigger	-	111008
14.	Antenna (30 – 1000) MHz	Schwarzbeck UBAA 9114	9111-214
15.	Antenna (1000 - 6000) MHz	HP11966 model 3115	9903-5701
16.	Antenna (1000 - 6000) MHz	ETS-Lindgren 3117	100200
17.	Antenna (1000 - 6000) MHz	ETS-Lindgren 3117	100201
18.	Digital multimeter	FLUKE 189	89750179
19.	Preamplifier (0.1-18) GHz	Agilent 87405c	MY47010400
20.	Psychrometer	ВИТ-2	B931
21.	Shielded Semi-Anechoic Chamber	"DON"	1

All listed above test equipment is calibrated and certified in accordance with established procedure. The equipment has certificates currently in force.

Ancillary equipment

№	Name	Model
1.	Test load	Telematics Wireless RTU_S
2.	Notebook	IBM ThinkPad

2.4 Measurement uncertainty

Parameter	Maximum uncertainty
Radiated emission	± 5.2 dB
Conducted emission	± 2.7 dB
Frequency	$\pm 1 \times 10^{-8}$
Temperature	± 1 °C
Humidity	± 2 %
Voltage supply DC	± 2 %

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of k=2.

2.5 Photo of test site

Figure 2.5.1 Conducted Measurements

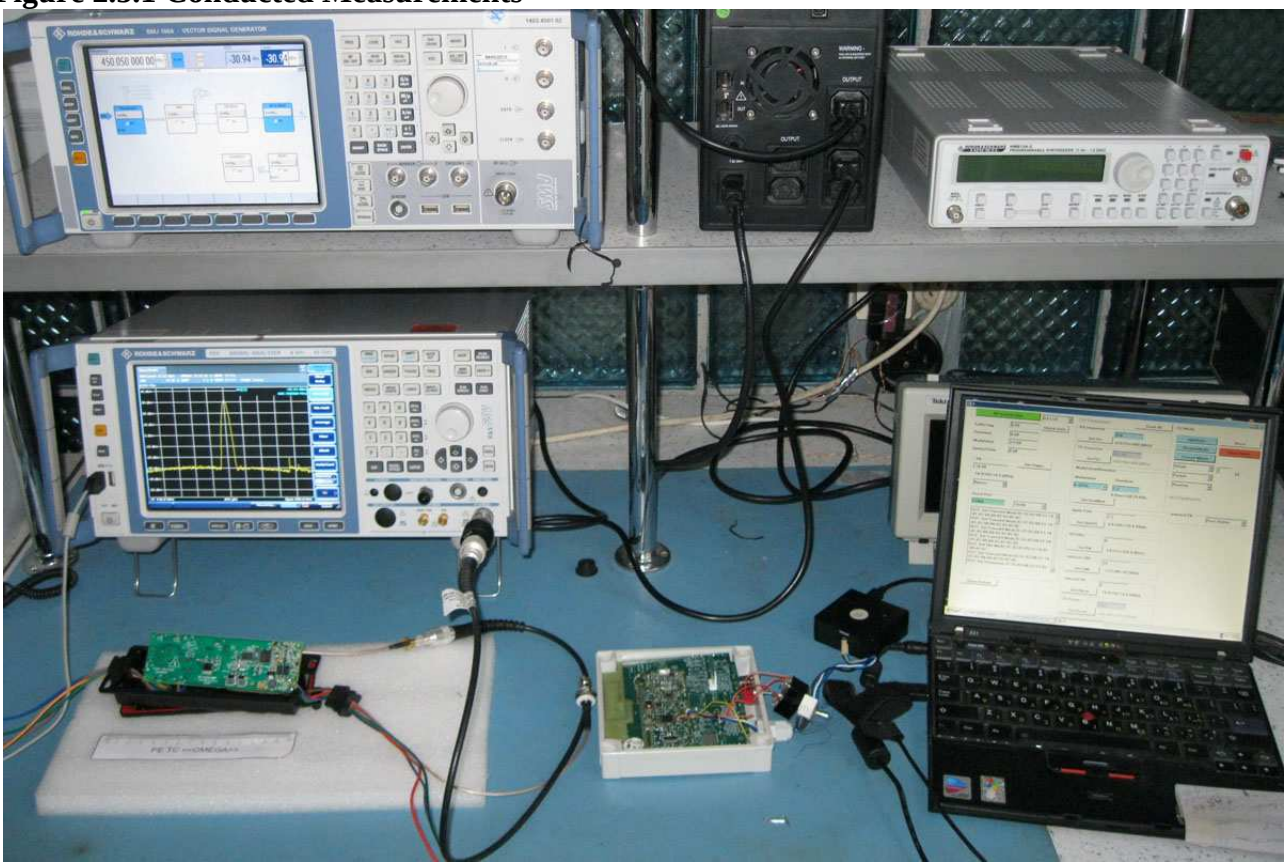


Figure 2.5.2 Radiated Spurious Emissions Measurements

Figure 2.5.3 Conducted emissions measurements

3 REPORT OF MEASUREMENTS AND EXAMINATIONS

3.1 Emission mask

3.1.1 Test requirements 90.210(e)

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (m) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating in the frequency bands governed under this part.

Table 3.1.1 Limit Emissions Mask

Frequency band (MHz)	Mask for equipment with Audio low pass filter	Mask for equipment without audio low pass filter
Below 25 [1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174 [2]	B, D, or E	C, D, or E
150 Paging-only	B	C
220-222	F	F
421-512 [2]	B, D, or E	C, D, or E
450 Paging-only	B	G
806-809/851-854	B	H
809-824/854-869 [3]	B	G
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M.
5850-5925 [4]		
All other bands	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. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

(e) Emission Mask E—6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with a 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 3.0 kHz removed from f0 : Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(fd −3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

3.1.2 Test procedure

1) The transmitter output was connected to the test load and then to the spectrum analyzer.
2) The transmitter was set up to the normal operational mode with maximum output power.
3) Spectrum analyzer was set to the measurement mode of Spectrum Emission Mask (SEM) with the following settings:
   - Centre frequency set to the center frequency of the channel
   - The Relative Mask setting was chosen
   - RBW=100 Hz, VBW=300 Hz, Video Detector = Peak, Trace = MAX HOLD.

3.1.3 Test setup layout

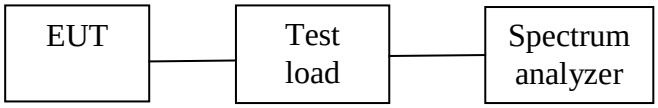
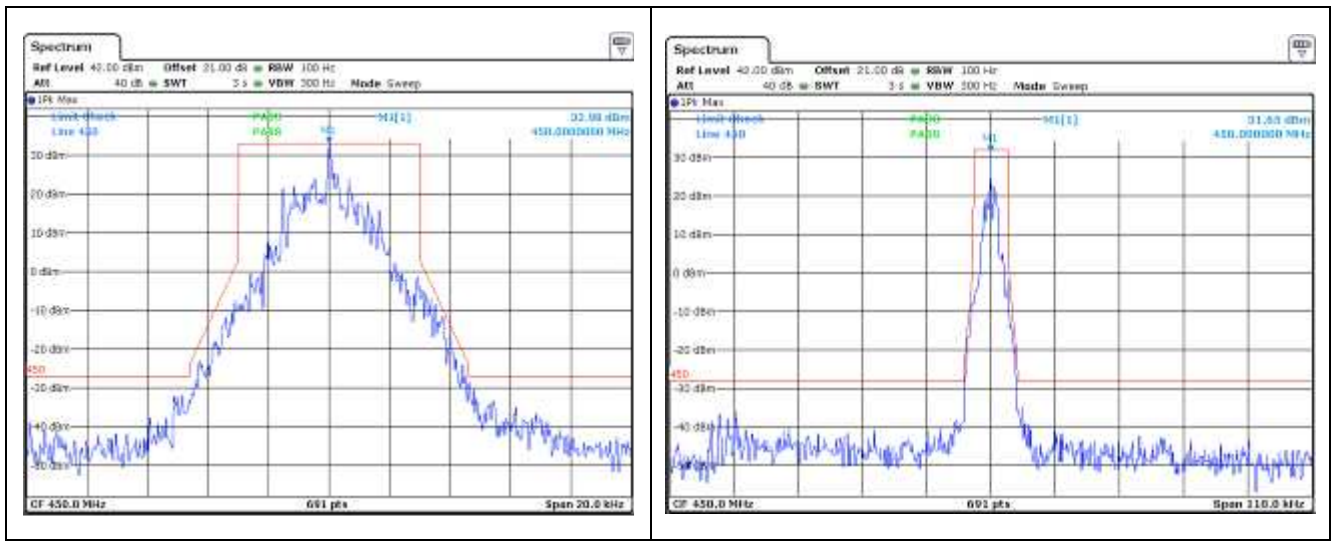


Figure 3.1.1

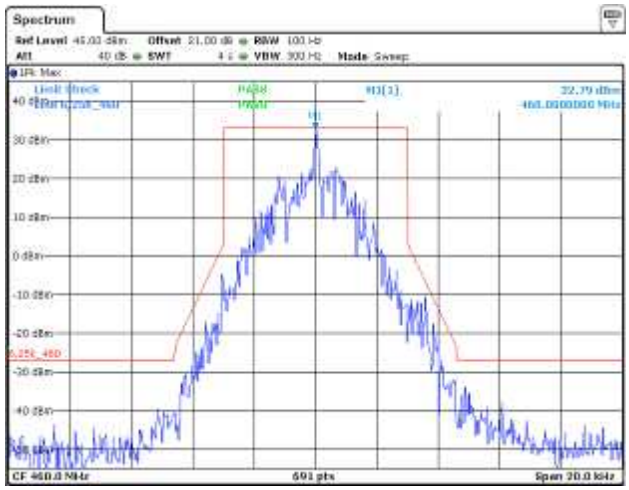
3.1.4 Test result

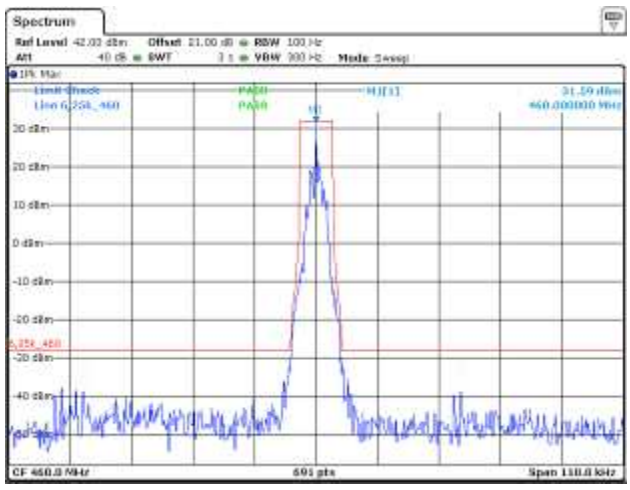
Temperature: +23 ^{o}C Relative humidity: 47 %

3.1.4.1 Plots Emissions Mask test result at the low channel

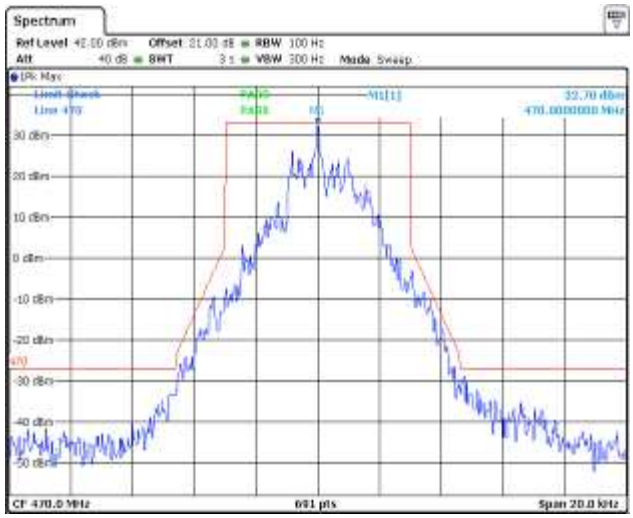


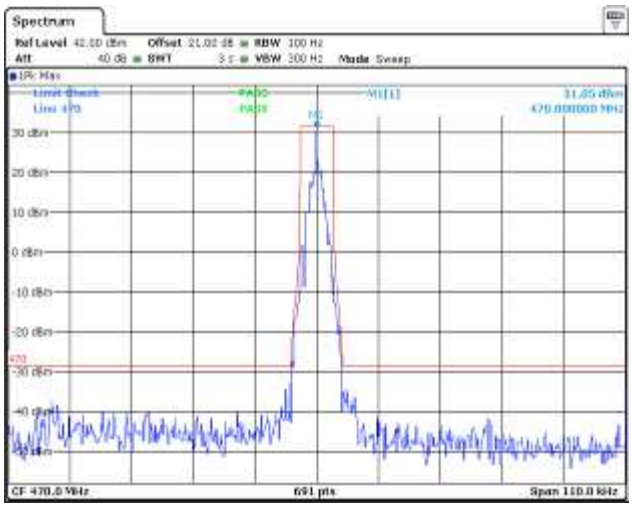
3.1.4.2 Plots Emissions Mask test result at mid channel





3.1.4.3 Plots Emissions Mask test result at high channel





3.2 Conducted Spurious Emissions

3.2.1 Test requirements 90.210 (e)

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (m) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating in the frequency bands governed under this part.

Frequency band (MHz)	Mask for equipment with Audio low pass filter	Mask for equipment without audio low pass filter
Below 25 [1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174 [2]	B, D, or E	C, D, or E
150 Paging-only	B	C
220-222	F	F
421-512 [2]	B, D, or E	C, D, or E
450 Paging-only	B	G
806-809/851-854	B	H
809-824/854-869 [3]	B	G
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M.
5850-5925 [4]		
All other bands	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. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

(e) Emission Mask E—6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with a 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 3.0 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(fd −3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

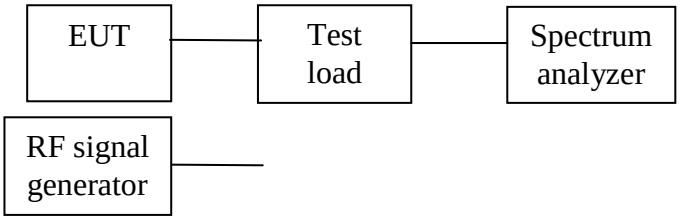
(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

3.2.2 Test procedure

The procedure used was ANSI/TIA-603-D:2010. Substitution RF signal generator was used.
1) The transmitter was connected to the spectrum analyzer using the test load.
2) The transmitter was set up to the normal operational mode with maximum output power rating.
3) The spurious emissions were observed in the band of +50 kHz from the edge of the authorized bandwidth to frequency equal 10 times the carrier frequency.
The spectrum analyzer was adjusted for the following settings:
Resolution Bandwidth = 10 kHz for spurious emission below 1 GHz, and 1 MHz for spurious emission above 1 GHz.
Video Bandwidth ≥ 3 times the resolution bandwidth.
Sweep Speed ≤ 2000 Hz per second.
Detector Mode = average power.

3.2.3 Test setup layout



3.2.4 Test result

Temperature: +23 °C Relative humidity: 47 %

Table 3.2.1

Frequency, MHz	Output Power (dBc)	Gen. Output (dBm)	Difference, dBc	Limit, dBc	Result (Pass, Fail, N/A)
450	33.34	-	-	-	-
450.0448	- 30.56	- 30.94	- 64.28	- 60	Pass
450.1955	- 31.64	- 31.97	- 65.31	- 60	Pass
450.2476	- 33.53	- 33.89	- 67.23	- 60	Pass
460	33.39	-	-	-	-
460.0517	- 31.09	- 31.53	- 64.92	- 60	Pass
460.1584	- 32.55	- 32.34	- 65.73	- 60	Pass
460.2384	- 34.13	- 34.52	- 67.91	- 60	Pass
470	33.46	-	-	-	-
470.0529	- 30.70	- 31.07	- 64.53	- 60	Pass
470.1549	- 31.78	- 32.16	- 65.62	- 60	Pass
470.2036	- 34.35	- 33.91	- 67.37	- 60	Pass

Plot 3.2.1 Output Power (Frequency 450 MHz)

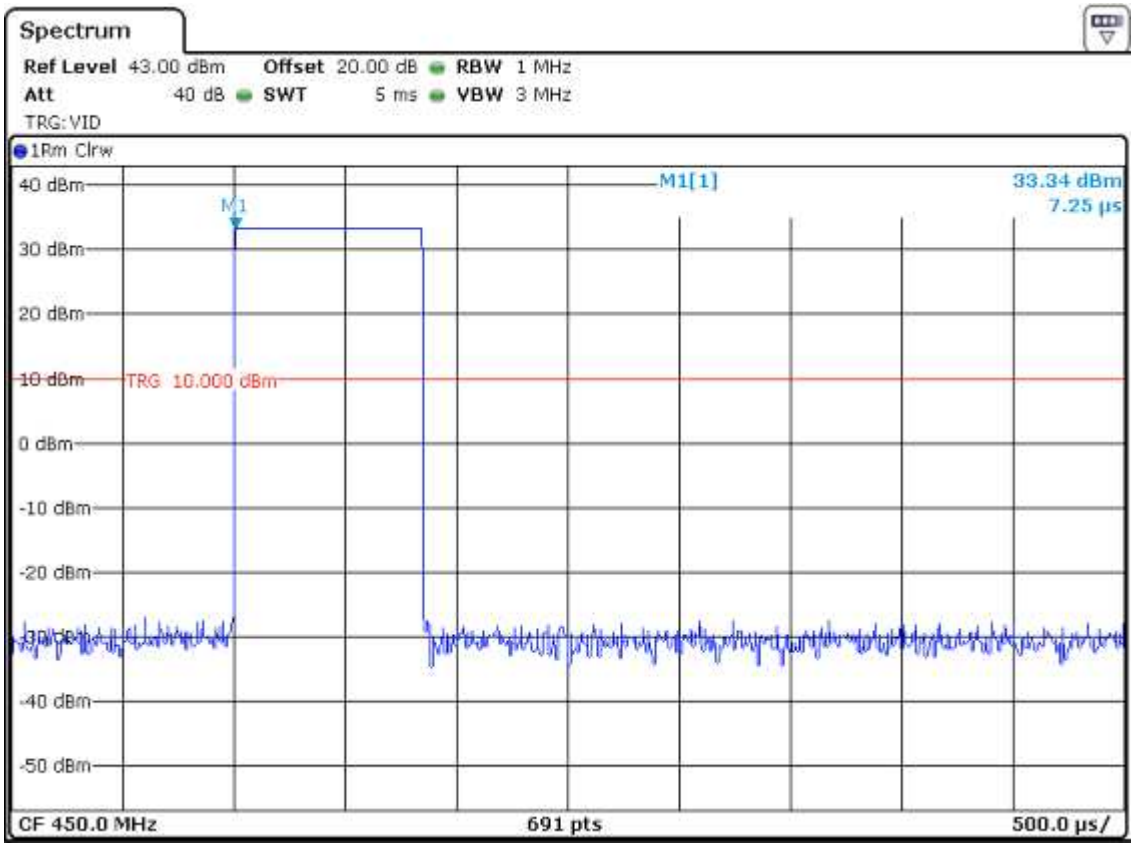


Table 3.2.2 Conducted Spurious Emissions (Frequency 450 MHz)

Frequency, MHz	Output Power, dBm	Gen. Output, dBm	Difference, dBc	Limit, dBc	Result (Pass, Fail, N/A)
450	33.34	-	-	-	-
900	- 44.82	- 44.38	- 77.82	- 60	Pass
1350	- 70.88	- 70.27	- 103.61	- 60	Pass
1800	-	-	-	- 60	Pass
2250	-	-	-	- 60	Pass
2700	-	-	-	- 60	Pass
3150	-	-	-	- 60	Pass
3600	-	-	-	- 60	Pass
4050	-	-	-	- 60	Pass
4500	-	-	-	- 60	Pass

Plot 3.2.2 Output Power (Frequency 460 MHz)

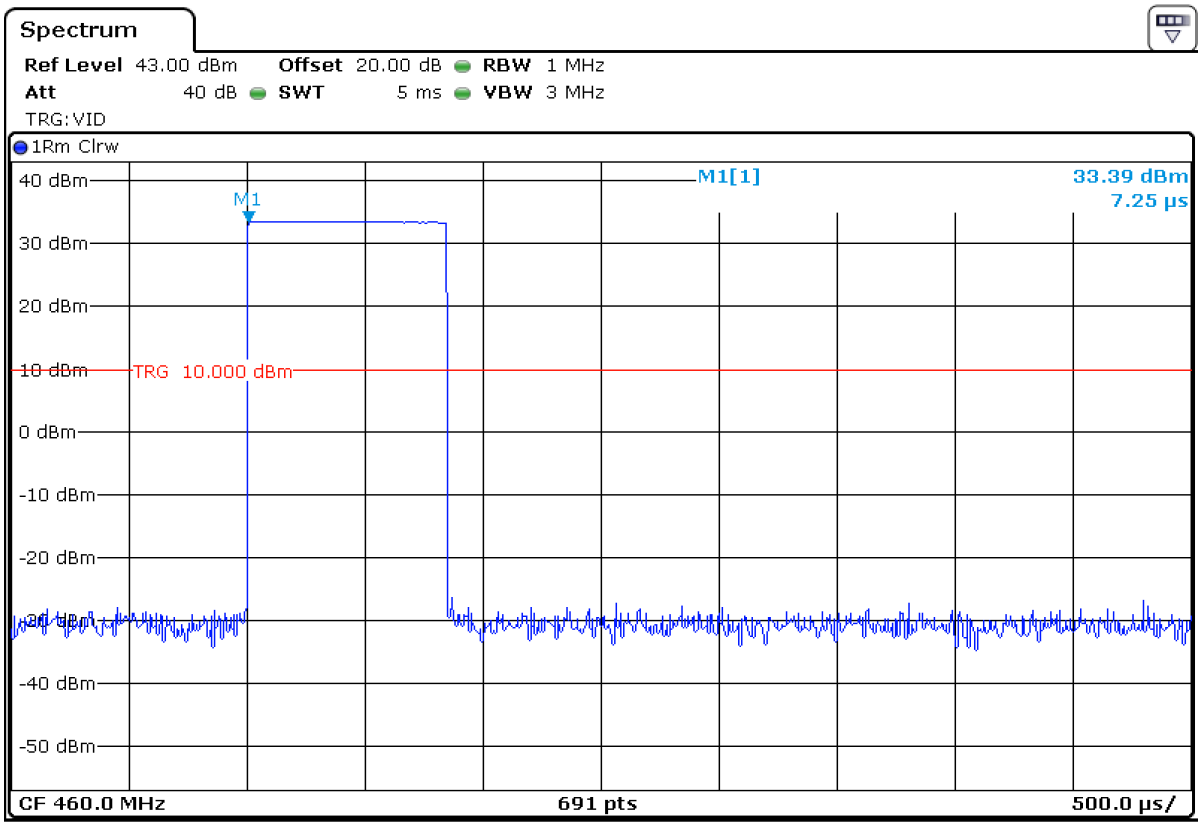


Table 3.2.4 Conducted Spurious Emissions (Frequency 460 MHz)

Frequency, MHz	Output Power, dBm	Gen. Output, dBm	Difference, dBc	Limit, dBc	Result (Pass, Fail, N/A)
460	33.39	-	-	-	-
920	- 43.91	- 43.64	- 77.03	- 60	Pass
1380	- 70.62	- 70.23	- 103.62	- 60	Pass
1840	-	-	-	- 60	Pass
2300	-	-	-	- 60	Pass
2760	-	-	-	- 60	Pass
3220	-	-	-	- 60	Pass
3680	-	-	-	- 60	Pass
4140	-	-	-	- 60	Pass
4600	-	-	-	- 60	Pass

Plot 3.2.3 Output Power (Frequency 470 MHz)

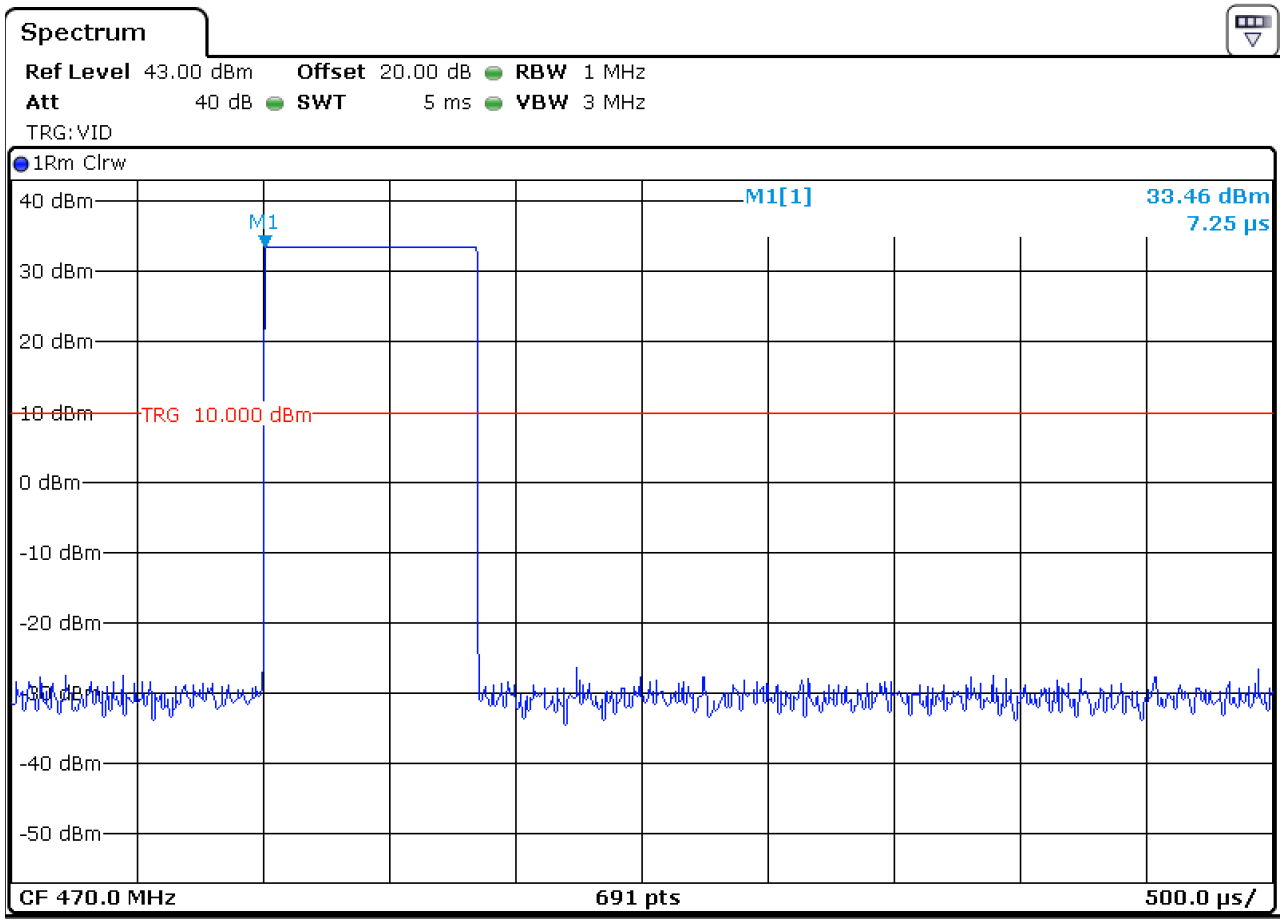


Table 3.2.4 Conducted Spurious Emissions (Frequency 470 MHz)

Frequency, MHz	Output Power, dBm	Gen. Output, dBm	Difference, dBc	Limit, dBc	Result (Pass, Fail, N/A)
470	33.46	-	-	-	-
940	- 43.53	- 43.47	- 77.93	- 60	Pass
1410	- 70.43	- 70.05	- 103.51	- 60	Pass
1880	- 72.70	- 72.08	- 105.54	- 60	Pass
2350	-	-	-	- 60	Pass
2820	-	-	-	- 60	Pass
3290	-	-	-	- 60	Pass
3760	-	-	-	- 60	Pass
4230	-	-	-	- 60	Pass
4700	-	-	-	- 60	Pass

3.3 Radiated Spurious Emissions

3.3.1 Test requirements 90.210 (e)

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (m) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating in the frequency bands governed under this part.

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25-50	B	C
72-76	B	C
150-174 [2]	B, D, or E	C, D, or E
150 Paging-only	B	C
220-222	F	F
421-512 [2]	B, D, or E	C, D, or E
450 Paging-only	B	G
806-809/851-854	B	H
809-824/854-869 [3]	B	G
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M.
5850-5925 [4]		
All other bands	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. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

(e) Emission Mask E—6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with a 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 3.0 kHz removed from f0 : Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(fd −3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient

number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

3.3.2 Test procedure

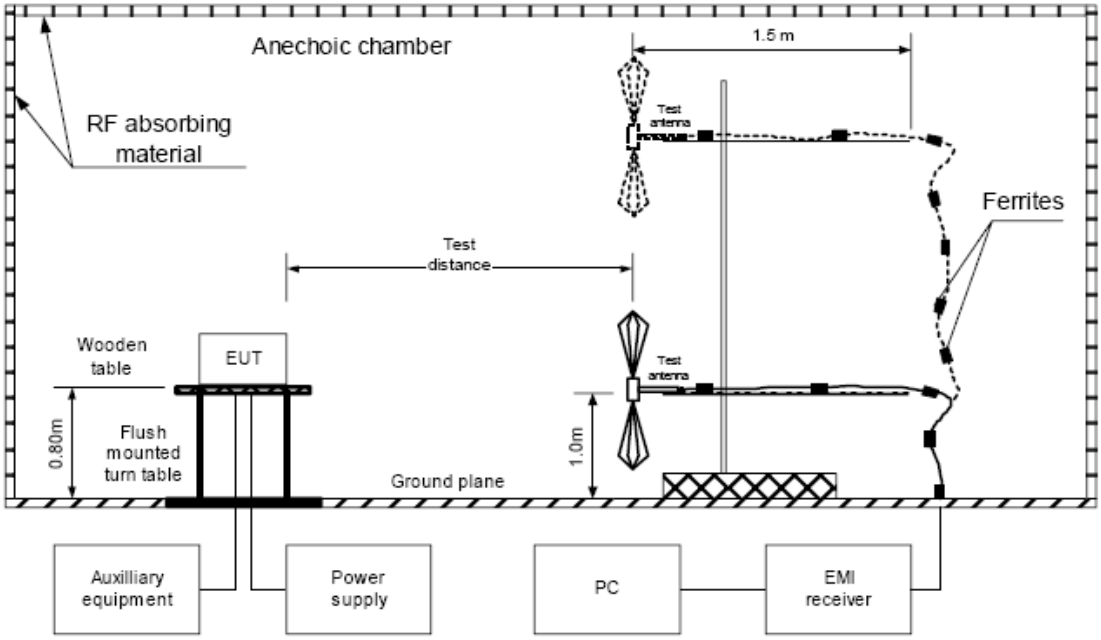
The procedure used was ANSI/TIA-603-D:2010. Substitution antenna with RF signal generator was used.
The transmitter was set up to the normal operational mode with maximum output power and connected to standard transmitter load.

1) The spurious emissions were observed in the band of +50 kHz from the edge of the authorized bandwidth to frequency equal 10 times the carrier frequency.
2) The transmitter to be tested was placed on the turntable in the test site compliant with ANSI C63.4-2001 clause 5.4.
3) Measurement antenna was placed at the distance of 3m away from the EUT with vertical polarization.
4) The spurious emissions were observed in the band of +50 kHz from the edge of the authorized bandwidth to the tenth harmonic of the carrier.
The spectrum analyzer was adjusted for the following settings:
Resolution Bandwidth = 10 kHz for spurious emission below 1 GHz, and 1 MHz for spurious emission above 1 GHz.
Video Bandwidth = 300 kHz for spurious emission below 1 GHz, and 3 MHz for spurious emission above 1 GHz.
Sweep Speed slow enough to maintain measurement calibration.
Detector Mode = Positive Peak.
5) The height of measurement antenna was changed from 1m to 4m in 10 cm steps to obtain maximum result on the spectrum analyzer.
6) The turntable was rotated around its axis to obtain maximum result on the spectrum analyzer.
7) Highest possible readings of the spectrum analyzer were recorded.
8) Measurements were repeated for horizontal polarization of measurement antenna.
9) The transmitter was replaced with a substitution antenna connected to RF signal generator.
10) The power into a reference ideal half-wave dipole antenna is calculated by reducing the reading from RF signal generator by the power loss in the cable between the generator and the substitution antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna:

$$P_d\ (dBm) = P_g\ (dBm) - \text{cable loss (dB)} + \text{antenna gain (dBd)},$$

where:
P_d is the dipole equivalent power,
P_g is the generator output power into the substitution antenna.
11) Radiated spurious emissions (dB) = TX power (dBm) - P_d (dBm).

3.3.3 Test setup layout



3.3.4 Test result

Temperature: +22 ^{o}C Relative humidity: 69 %

Table 3.3.1 Radiated Spurious Emissions (Frequency 470 MHz, vertical polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
470					**32.9**			
940	-28.6	3.2	-7.3	-9.44	-41.24	74.14	60	**Pass**
1410	-47.2	3.9	3.9	1.75	-49.35	82.25	60	**Pass**
1880	-48.4	5.6	4.3	2.15	-51.85	84.75	60	**Pass**
2350	-49.6	5.9	4.6	2.45	-53.05	85.95	60	**Pass**
2820	-45.9	7.2	5.5	3.35	-49.75	82.65	60	**Pass**
3290	-48.0	7.6	6.8	4.65	-50.95	83.85	60	**Pass**
3760	-48.5	8.2	7.5	5.35	-51.35	84.25	60	**Pass**
4230	-52.2	8.9	7.6	5.45	-55.65	88.55	60	**Pass**
4700	-57.4	9.5	7.9	5.75	-61.15	94.05	60	**Pass**

Table 3.3.2 Radiated Spurious Emissions (Frequency 460 MHz, vertical polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
460					**32.5**			
920	-26.8	3.2	-7.1	-9.27	-39.27	71.77	60	**Pass**
1380	-40.7	3.9	3.8	1.65	-42.95	75.45	60	**Pass**
1840	-51.0	5.7	4.2	2.05	-54.65	87.15	60	**Pass**
2300	-45.2	5.9	4.5	2.35	-48.75	81.25	60	**Pass**
2760	-52.5	7.2	5.4	3.25	-56.45	88.95	60	**Pass**
3220	-47.6	7.5	6.5	4.35	-50.75	83.25	60	**Pass**
3680	-50.8	8.2	7.5	5.35	-53.65	86.15	60	**Pass**
4140	-52.9	8.9	7.7	5.55	-56.25	88.75	60	**Pass**
4600	-55.2	9.5	7.6	5.45	-59.25	91.75	60	**Pass**

Table 3.3.3 Radiated Spurious Emissions (Frequency 450 MHz, vertical polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
450					**32.4**			
900	-27.5	3.1	-6.9	-9.05	-39.65	72.1	60	**Pass**
1350	-44.1	3.9	3.6	1.45	-46.55	79.0	60	**Pass**
1800	-46.2	5.7	4.3	2.15	-49.75	82.2	60	**Pass**
2250	-47.2	5.9	4.4	2.25	-50.85	83.3	60	**Pass**
2700	-47.8	7.2	5.3	3.15	-51.85	84.3	60	**Pass**
3150	-48.4	7.5	6.3	4.15	-51.75	84.2	60	**Pass**
3600	-46.9	8.1	7.3	5.15	-49.85	82.3	60	**Pass**
4050	-50.3	8.9	7.8	5.65	-53.55	86.0	60	**Pass**
4500	-52.1	9.5	7.4	5.25	-56.35	88.8	60	**Pass**

Table 3.3.4 Radiated Spurious Emissions (Frequency 470 MHz, horizontal polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
470					**32.9**			
940	-32.7	3.2	-7.3	-9.44	-45.34	78.24	60	**Pass**
1410	-46.3	3.9	3.9	1.75	-48.45	81.35	60	**Pass**
1880	-54.1	5.6	4.3	2.15	-57.55	90.45	60	**Pass**
2350	-48.5	5.9	4.6	2.45	-51.95	84.85	60	**Pass**
2820	-54.8	7.2	5.5	3.35	-58.65	91.55	60	**Pass**
3290	-49.6	7.6	6.8	4.65	-52.55	85.45	60	**Pass**
3760	-56.2	8.2	7.5	5.35	-59.05	91.95	60	**Pass**
4230	-55.3	8.9	7.6	5.45	-58.75	91.65	60	**Pass**
4700	-50.6	9.5	7.9	5.75	-54.35	87.25	60	**Pass**

Table 3.3.5 Radiated Spurious Emissions (Frequency 460 MHz, horizontal polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
460					**32.5**			
920	-34.6	3.2	-7.1	-9.27	-47.07	79.57	60	**Pass**
1380	-53.9	3.9	3.8	1.65	-56.15	88.65	60	**Pass**
1840	-54.5	5.7	4.2	2.05	-58.15	90.65	60	**Pass**
2300	-49.2	5.9	4.5	2.35	-52.75	85.25	60	**Pass**
2760	-50.0	7.2	5.4	3.25	-53.95	86.45	60	**Pass**
3220	-53.5	7.5	6.5	4.35	-56.65	89.15	60	**Pass**
3680	-55.3	8.2	7.5	5.35	-58.15	90.65	60	**Pass**
4140	-54.8	8.9	7.7	5.55	-58.15	90.65	60	**Pass**
4600	-55.9	9.5	7.6	5.45	-59.95	92.45	60	**Pass**

Table 3.3.6 Radiated Spurious Emissions (Frequency 450 MHz, horizontal polarization):

F, MHz	Gen. Output, dBm	Coax Loss, dB	Ant. Gain, dBi	Ant. Gain, dBd	Dipole Eq. Power, dBm	Diffe-rence, dBc	Limit, dBc	Test result (Pass, Fail, N/A)
450					**32.4**			
900	-34.9	3.1	-6.9	-9.05	-47.05	79.5	60	**Pass**
1350	-56.4	3.9	3.6	1.45	-58.85	91.3	60	**Pass**
1800	-57.8	5.7	4.3	2.15	-61.35	93.8	60	**Pass**
2250	-52.1	5.9	4.4	2.25	-55.75	88.2	60	**Pass**
2700	-54.8	7.2	5.3	3.15	-58.85	91.3	60	**Pass**
3150	-49.8	7.5	6.3	4.15	-53.15	85.6	60	**Pass**
3600	-52.6	8.1	7.3	5.15	-55.55	88.0	60	**Pass**
4050	-54.7	8.9	7.8	5.65	-57.95	90.4	60	**Pass**
4500	-56.1	9.5	7.4	5.25	-60.35	92.8	60	**Pass**

3.4 Conducted Emission

3.4.1 Test requirements of 15.207

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

	Conducted limit (dBμV)	
Frequency of emission (MHz)	**Quasi-peak**	**Average**
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

3.4.2 Test procedure (ANSI C63.10-2013, Sections 6.3)

The EUT emitted a BEACON (Info + Reading value + Alarm Status) every 11sec.
The EUT was placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. All other surfaces of tabletop or floor-standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.
The measurements were performed on the line under test in a 2m x 2m x 2m screened enclosure by means of an Impedance Stabilization Network (ISN) bonded to the ground plane and connected to the spectrum analyzer. The EUT was placed on a non-metallic table, 0.8m above the ground reference plane and was configured, arranged and operated in a manner consistent with typical application and load conditions. Normal performance of the EUT was verified.
Conducted common mode (asymmetric mode) disturbance at the tested port was investigated in the appropriate frequency range using the resolution-bandwidth per CISPR16-1, Table 7, and QP and Average readings were taken.
Worst-case results were recorded.

3.4.3 Test result

Temperature: +20°C Relative humidity: 63%

EUT OPERATING MODE: Transmit

Table 3.4.1 Conducted emission test result "Phase" (450 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.20143	41.1	63.5	22.4	**Pass**
0.40937	41.5	57.7	16.2	**Pass**
0.61954	41.4	56.0	14.6	**Pass**
1.69080	35.4	56.0	20.6	**Pass**
2.66283	33.7	56.0	22.3	**Pass**
7.09559	30.2	60.0	29.8	**Pass**
8.06041	29.1	60.0	30.9	**Pass**
19.05877	35.5	60.0	24.5	**Pass**

Table 3.4.2 Conducted emission test result "Phase" (450 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	36.1	53.5	17.4	**Pass**
0.40937	31.7	47.7	16.0	**Pass**
0.60974	29.1	46.0	16.9	**Pass**
1.53662	19.3	46.0	26.7	**Pass**
2.40080	17.8	46.0	28.2	**Pass**
6.87301	14.6	50.0	35.4	**Pass**
8.06041	14.0	50.0	36.0	**Pass**
19.05877	20.2	50.0	29.8	**Pass**

Table 3.4.3 Conducted emission test result "Neutral" (450 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.19825	40.3	63.6	23.3	**Pass**
0.40937	41.2	57.7	16.5	**Pass**
0.59534	37.1	56.0	18.9	**Pass**
1.46488	33.6	56.0	22.4	**Pass**
2.45888	33.6	56.0	22.4	**Pass**
4.29512	30.1	56.0	25.9	**Pass**
8.06041	26.7	60.0	33.3	**Pass**
19.99208	36.5	60.0	23.5	**Pass**

Table 3.4.4 Conducted emission test result "Neutral" (450 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20467	35.7	53.4	17.7	**Pass**
0.40937	31.8	47.7	15.9	**Pass**
0.60010	27.8	46.0	18.2	**Pass**
1.10837	20.4	46.0	25.6	**Pass**
2.49838	17.7	46.0	28.3	**Pass**
6.98341	14.8	50.0	35.2	**Pass**
7.99644	12.7	50.0	37.3	**Pass**
19.36493	21.1	50.0	28.9	**Pass**

Table 3.4.5 Conducted emission test result "Phase" (460 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.19825	52.6	63.6	11.0	**Pass**
0.29764	41.5	60.3	18.8	**Pass**
0.60010	40.9	56.0	15.1	**Pass**
1.61187	36.8	56.0	19.2	**Pass**
2.70561	34.0	56.0	22.0	**Pass**
7.09559	31.9	60.0	28.1	**Pass**
8.52278	29.9	60.0	30.1	**Pass**
18.90751	36.9	60.0	23.1	**Pass**

Table 3.4.6 Conducted emission test result "Phase" (460 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	42.1	53.5	11.4	**Pass**
0.30484	33.3	50.1	16.8	**Pass**
0.60490	28.4	46.0	17.6	**Pass**
1.59908	18.5	46.0	27.5	**Pass**
2.40080	17.0	46.0	29.0	**Pass**
7.44307	14.6	50.0	35.4	**Pass**
8.52278	13.9	50.0	36.1	**Pass**
19.05877	22.4	50.0	27.6	**Pass**

Table 3.4.7 Conducted emission test result "Neutral" (460 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.20796	49.0	63.3	14.3	**Pass**
0.30728	40.0	60.0	20.0	**Pass**
0.61462	40.6	56.0	15.4	**Pass**
1.70433	37.0	56.0	19.0	**Pass**
2.49838	33.8	56.0	22.2	**Pass**
4.46970	30.9	56.0	25.1	**Pass**
8.18990	25.5	60.0	34.5	**Pass**
19.36493	36.3	60.0	23.7	**Pass**

Table 3.4.8 Conducted emission test result "Neutral" (460 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	40.2	53.5	13.3	**Pass**
0.30484	32.9	50.1	17.2	**Pass**
0.60490	28.7	46.0	17.3	**Pass**
1.13518	19.1	46.0	26.9	**Pass**
2.59993	16.7	46.0	29.3	**Pass**
7.20958	14.9	50.0	35.1	**Pass**
8.45513	12.6	50.0	37.4	**Pass**
20.15202	20.9	50.0	29.1	**Pass**

Table 3.4.9 Conducted emission test result "Phase" (470 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.20304	45.9	63.5	17.6	**Pass**
0.30003	40.7	60.2	19.5	**Pass**
0.70378	40.2	56.0	15.8	**Pass**
1.70433	38.3	56.0	17.7	**Pass**
2.55883	35.4	56.0	20.6	**Pass**
7.20958	32.6	60.0	27.4	**Pass**
8.25541	30.8	60.0	29.2	**Pass**
20.47574	38.2	60.0	21.8	**Pass**

Table 3.4.10 Conducted emission test result "Phase" (470 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	38.4	53.5	15.1	**Pass**
0.30243	32.3	50.2	17.9	**Pass**
0.60490	30.4	46.0	15.6	**Pass**
1.31026	19.8	46.0	26.2	**Pass**
2.49838	18.7	46.0	27.3	**Pass**
7.20958	15.8	50.0	34.2	**Pass**
8.25541	15.8	50.0	34.2	**Pass**
20.47574	21.1	50.0	28.9	**Pass**

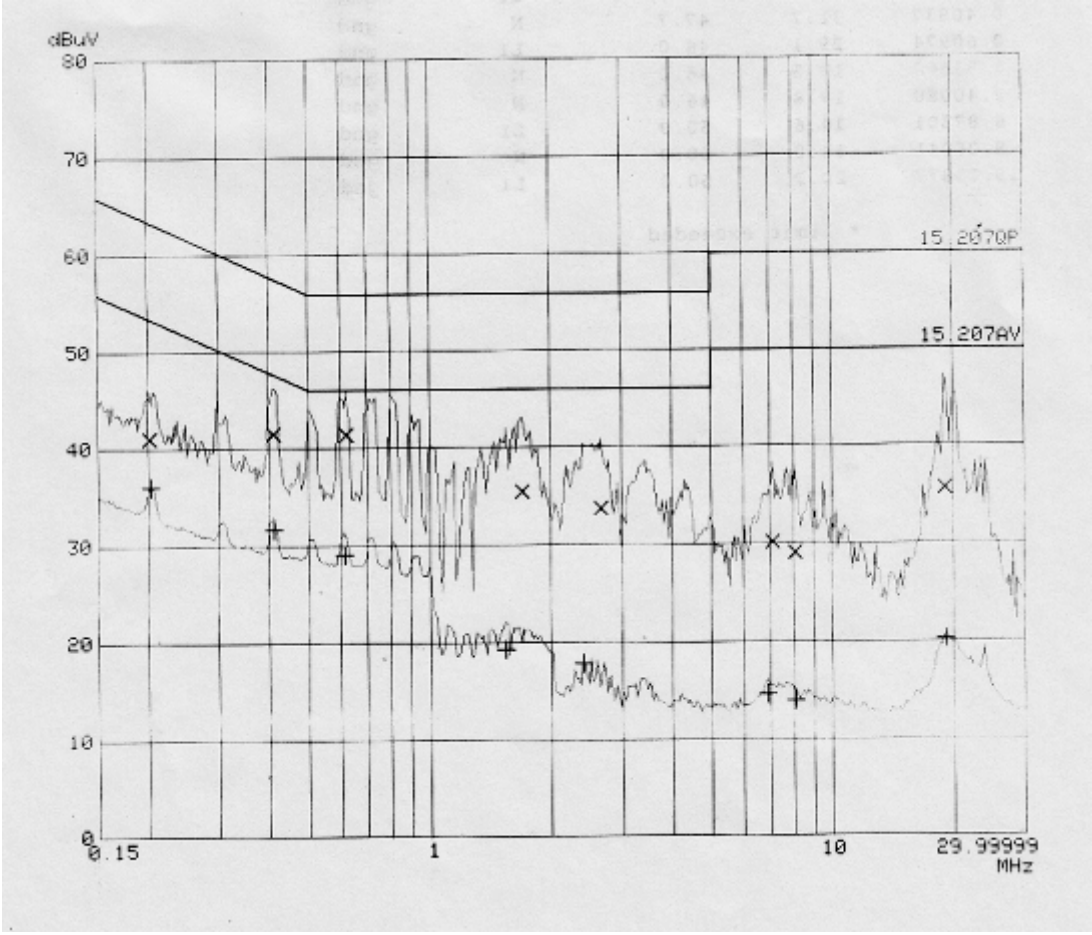
Table 3.4.11 Conducted emission test result "Neutral" (470 MHz, QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.20467	48.5	63.4	14.9	**Pass**
0.29528	38.3	60.3	22.0	**Pass**
0.59534	44.4	56.0	11.6	**Pass**
1.69080	40.2	56.0	15.8	**Pass**
2.53852	35.0	56.0	21.0	**Pass**
6.65740	30.6	60.0	29.4	**Pass**
9.52859	29.6	60.0	30.4	**Pass**
20.15202	40.3	60.0	19.7	**Pass**

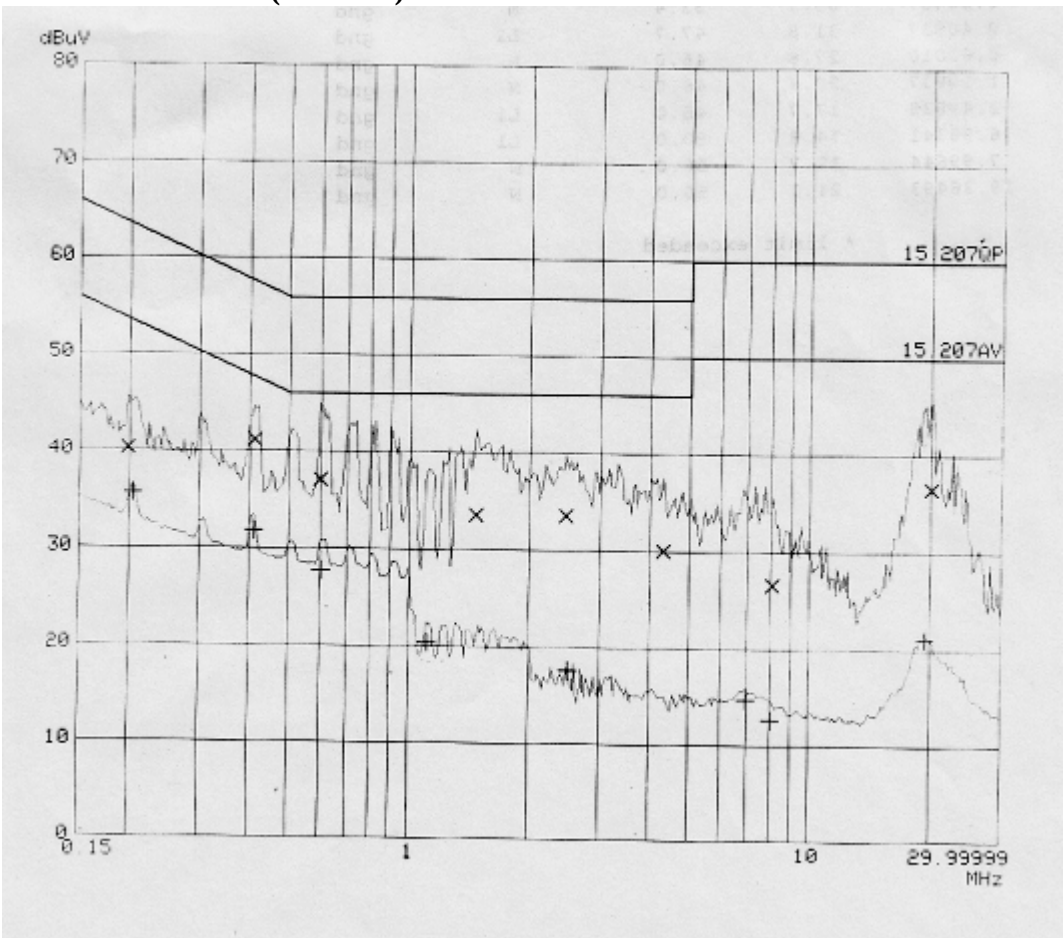
Table 3.4.12 Conducted emission test result "Neutral" (470 MHz, AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20467	39.9	53.4	13.5	**Pass**
0.30003	34.3	50.2	15.9	**Pass**
0.60490	32.7	46.0	13.3	**Pass**
1.41893	21.4	46.0	24.6	**Pass**
2.49838	17.6	46.0	28.4	**Pass**
6.65740	17.7	50.0	32.3	**Pass**
10.23701	16.2	50.0	33.8	**Pass**
20.15202	24.2	50.0	25.8	**Pass**

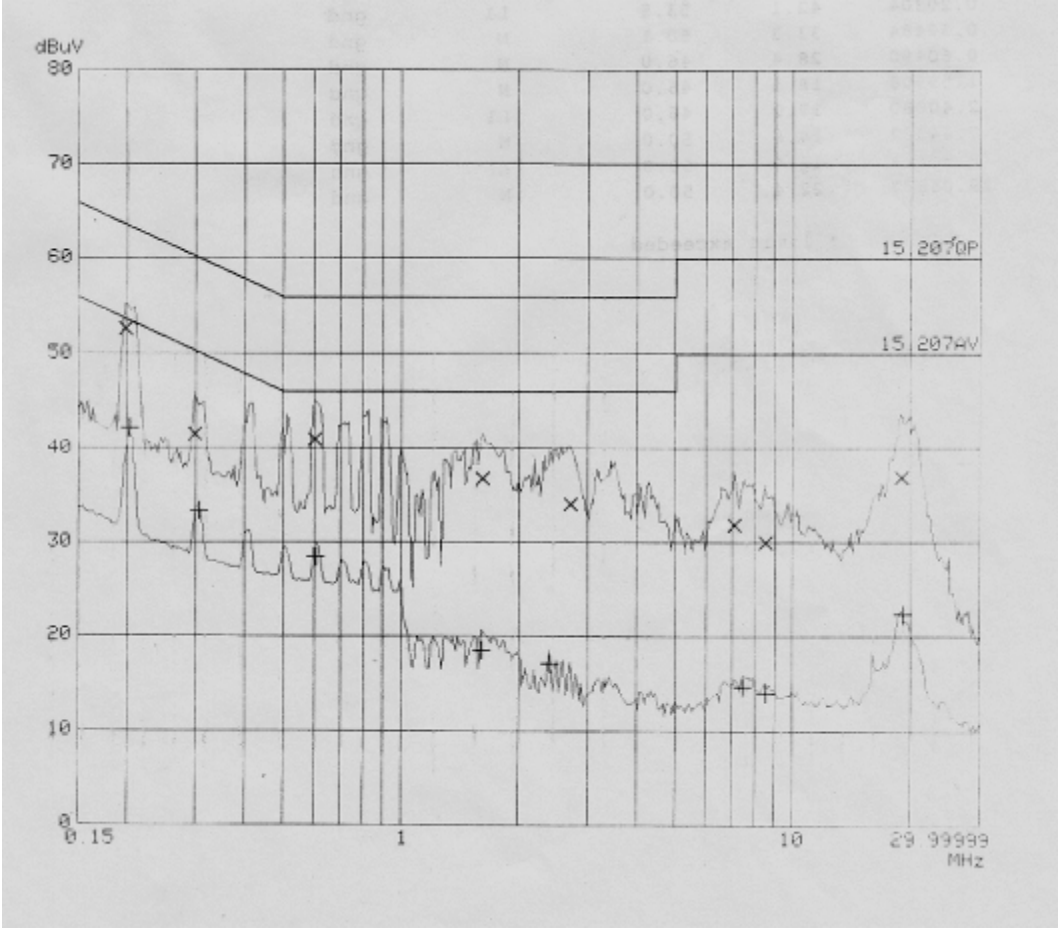
Plot 3.4.1 "Phase" (450 MHz)



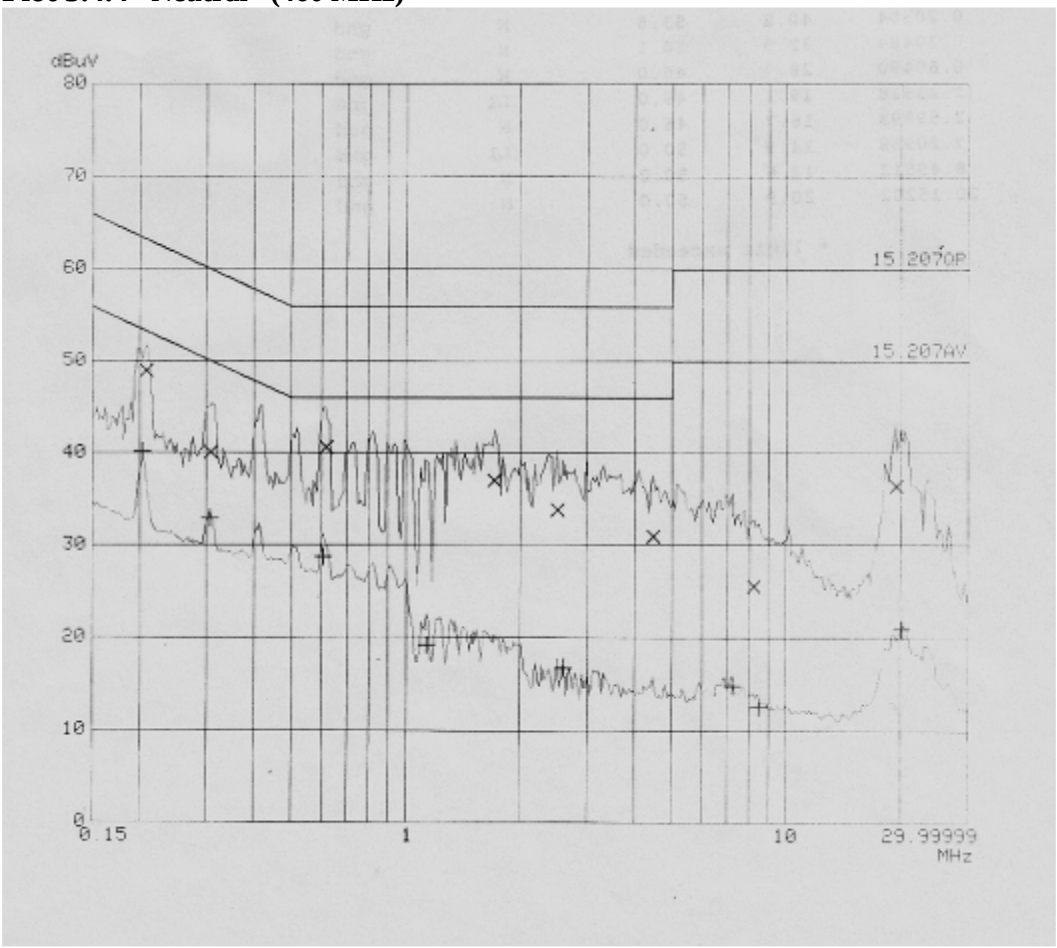
Plot 3.4.2 "Neutral" (450 MHz)



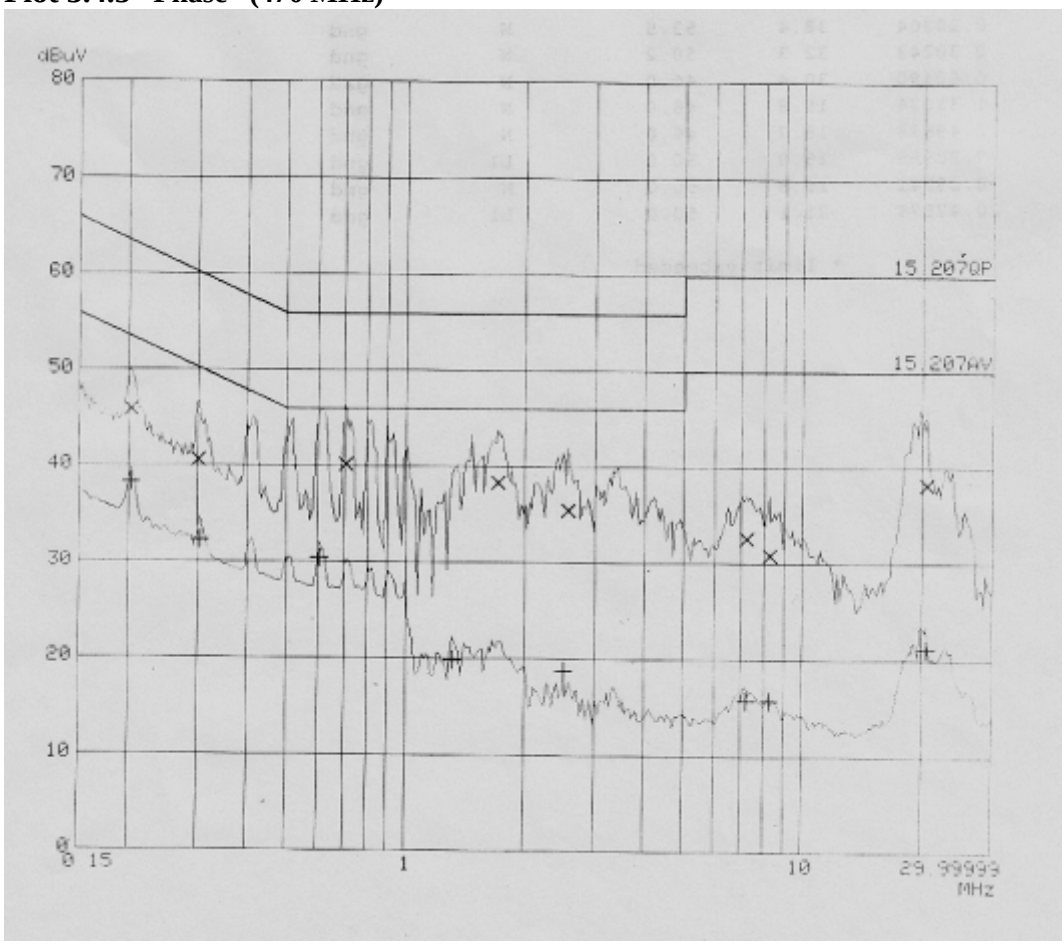
Plot 3.4.3 "Phase" (460 MHz)



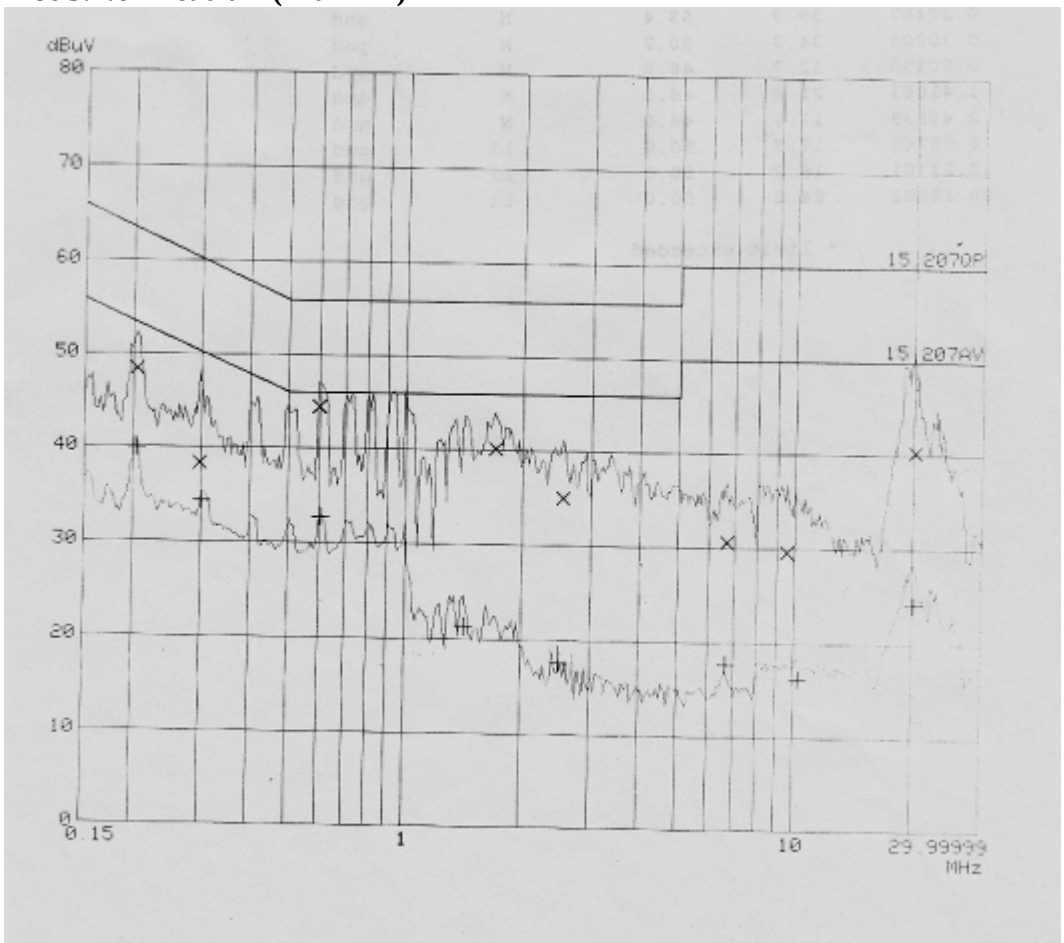
Plot 3.4.4 "Neutral" (460 MHz)



Plot 3.4.5 "Phase" (470 MHz)



Plot 3.4.6 "Neutral" (470 MHz)



3.5 Conducted Emission

3.5.1 Test requirements of 15.107

a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency of emission (MHz)	**Conducted limit (dBμV)**	
	Quasi-peak	**Average**
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

3.5.2 Test procedure (ANSI C63.10-2013, Sections 6.3)

The EUT is in stand-by mode.
The EUT was placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. All other surfaces of tabletop or floor-standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.
The measurements were performed on the line under test in a 2m x 2m x 2m screened enclosure by means of an Impedance Stabilization Network (ISN) bonded to the ground plane and connected to the spectrum analyzer. The EUT was placed on a non-metallic table, 0.8m above the ground reference plane and was configured, arranged and operated in a manner consistent with typical application and load conditions. Normal performance of the EUT was verified.
Conducted common mode (asymmetric mode) disturbance at the tested port was investigated in the appropriate frequency range using the resolution-bandwidth per CISPR16-1, Table 7, and QP and Average readings were taken.

Worst-case results were recorded.

3.5.3 Test result

Table 3.5.1 Conducted emission test result "Phase" (QP detector)

Frequency, MHz	**Measured Result, dBμV**	**Limit, dBμV**	**Margin, dB**	**Result (Pass, Fail, N/A)**
	QP	QP	QP	
0.15363	40.1	65.8	25.7	**Pass**
0.41265	42.6	57.6	15.0	**Pass**
0.59534	39.9	56.0	16.1	**Pass**
1.69080	36.0	56.0	20.0	**Pass**
2.55883	36.1	56.0	19.9	**Pass**
7.32539	32.2	60.0	27.8	**Pass**
8.06041	29.0	60.0	31.0	**Pass**
19.36793	37.5	60.0	22.5	**Pass**

Table 3.5.2 Conducted emission test result "Phase" (AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	36.4	53.5	17.1	**Pass**
0.40937	32.9	47.7	14.8	**Pass**
0.60974	30.5	46.0	15.5	**Pass**
1.62476	20.8	46.0	25.2	**Pass**
2.59993	19.0	46.0	27.0	**Pass**
6.87301	15.9	50.0	34.1	**Pass**
7.99644	14.6	50.0	35.4	**Pass**
19.67600	21.3	50.0	28.7	**Pass**

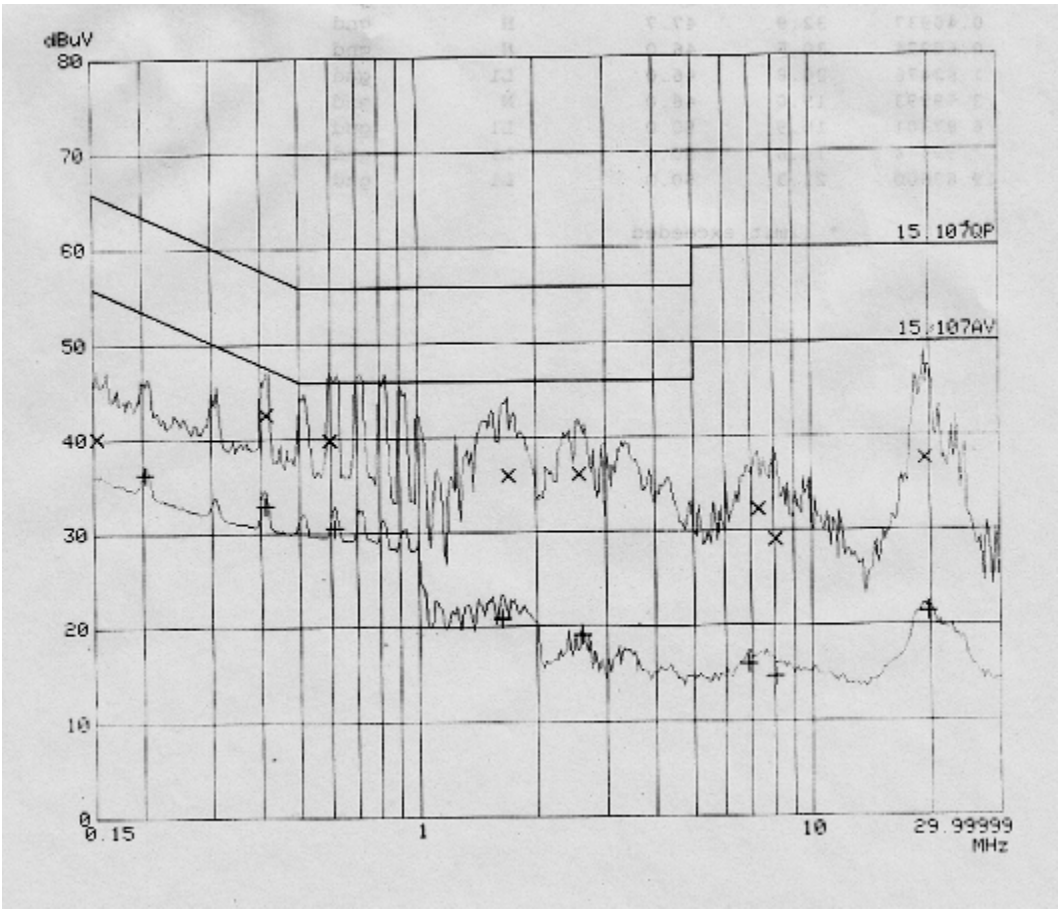
Table 3.5.3 Conducted emission test result "Neutral" (QP detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	QP	QP	QP	
0.19983	41.4	63.6	22.2	**Pass**
0.29764	37.3	60.3	23.0	**Pass**
0.60490	40.0	56.0	16.0	**Pass**
1.46488	34.4	56.0	21.6	**Pass**
2.40080	35.5	56.0	20.5	**Pass**
7.32539	30.4	60.0	29.6	**Pass**
8.06041	27.4	60.0	32.6	**Pass**
19.36493	38.3	60.0	21.7	**Pass**

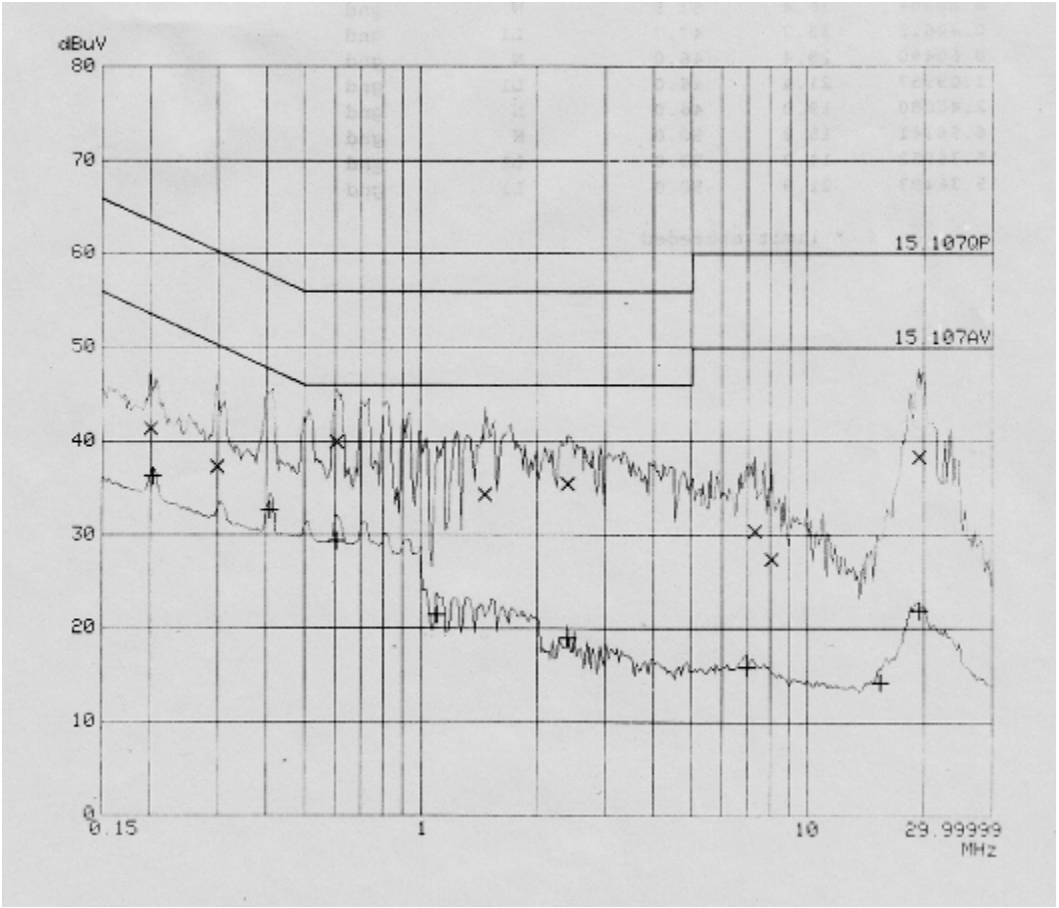
Table 3.5.4 Conducted emission test result "Neutral" (AV detector)

Frequency, MHz	Measured Result, dBµV	Limit, dBµV	Margin, dB	Result (Pass, Fail, N/A)
	AV	AV	AV	
0.20304	36.4	53.5	17.1	**Pass**
0.40612	32.7	47.7	15.0	**Pass**
0.60490	29.4	46.0	16.6	**Pass**
1.09957	21.4	46.0	24.6	**Pass**
2.40080	19.0	46.0	27.0	**Pass**
6.98341	15.8	50.0	34.2	**Pass**
15.36952	14.2	50.0	35.8	**Pass**
19.36493	21.9	50.0	28.1	**Pass**

Plot 3.5.1 "Phase"



Plot 3.5.2 "Neutral"



3.6 Transient stability

3.6.1 Test requirements 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:

Table 3.6.1 Limit Transient Frequency Behavior

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
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1 [4]	±12.5 kHz	5.0 ms	10.0 ms
t_2	±6.25 kHz	20.0 ms	25.0 ms
t_3 [4]	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1 [4]	±6.25 kHz	5.0 ms	10.0 ms
t_2	±3.125 kHz	20.0 ms	25.0 ms
t_3 [4]	±6.25 kHz	5.0 ms	10.0 ms

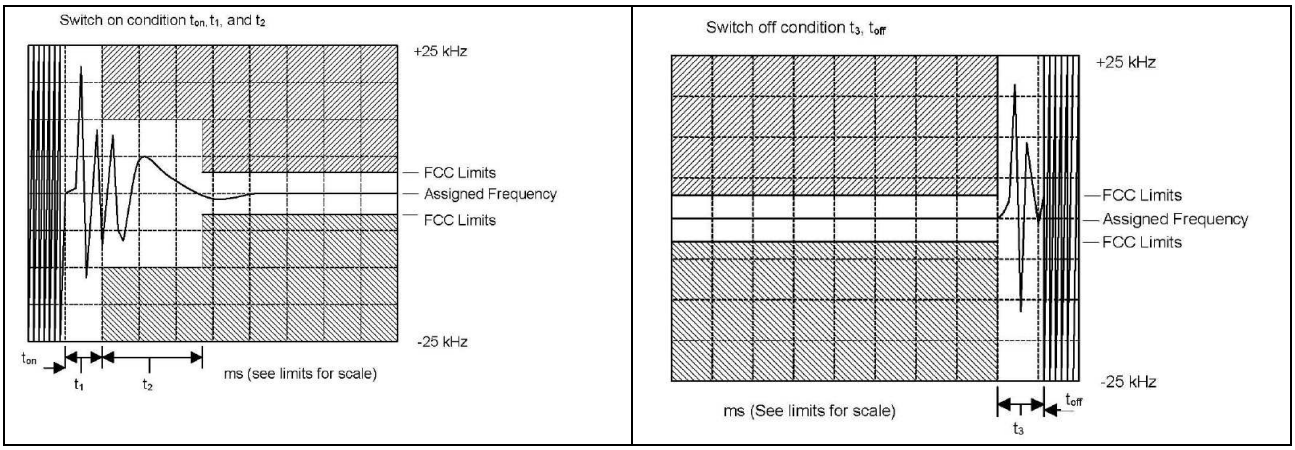
[1] t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

- 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.

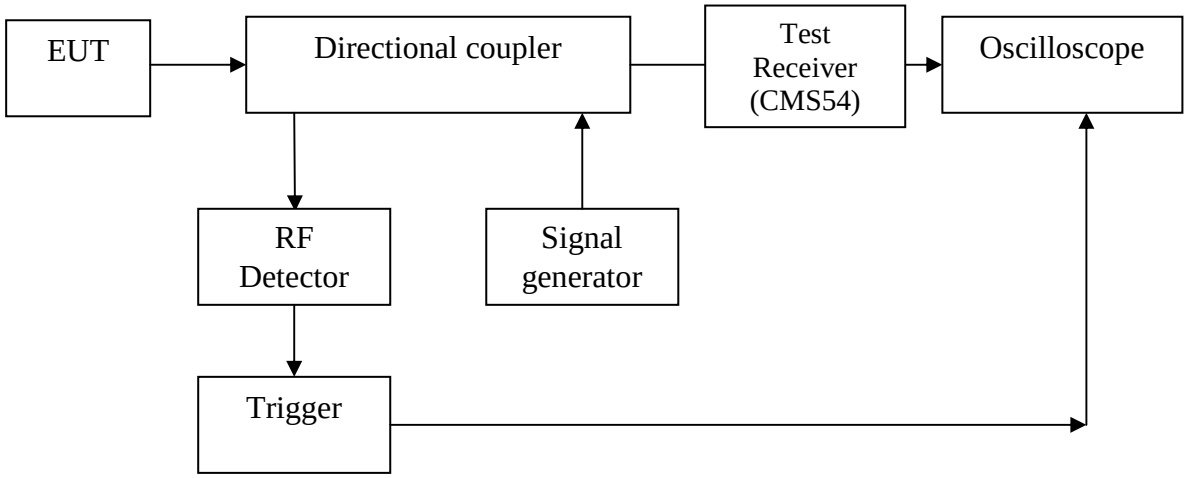
[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in § 90.213.
[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

3.6.2 Test procedure

1) The transmitter was connected to the universal radio tester CMS54.
2) The transmitter was set up to the normal operational mode at mid frequency with maximum output power.
3) The transient behavior of transmitter was observed in the moment of keying (TX-off to TX-on) and unkeying (TX-on to TX-off) using the special option of the CMS54 radio tester.



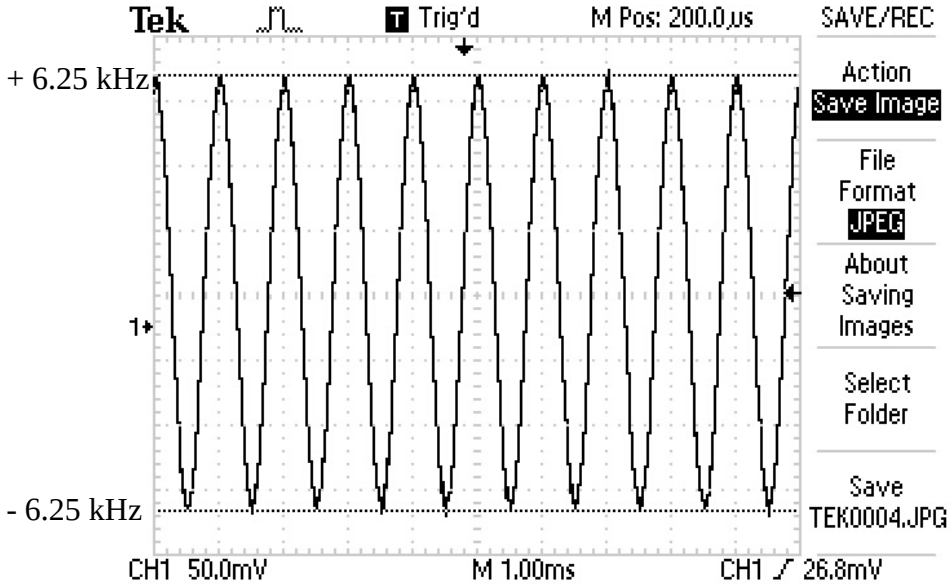
3.6.3 Test setup layout



3.6.4 Test result

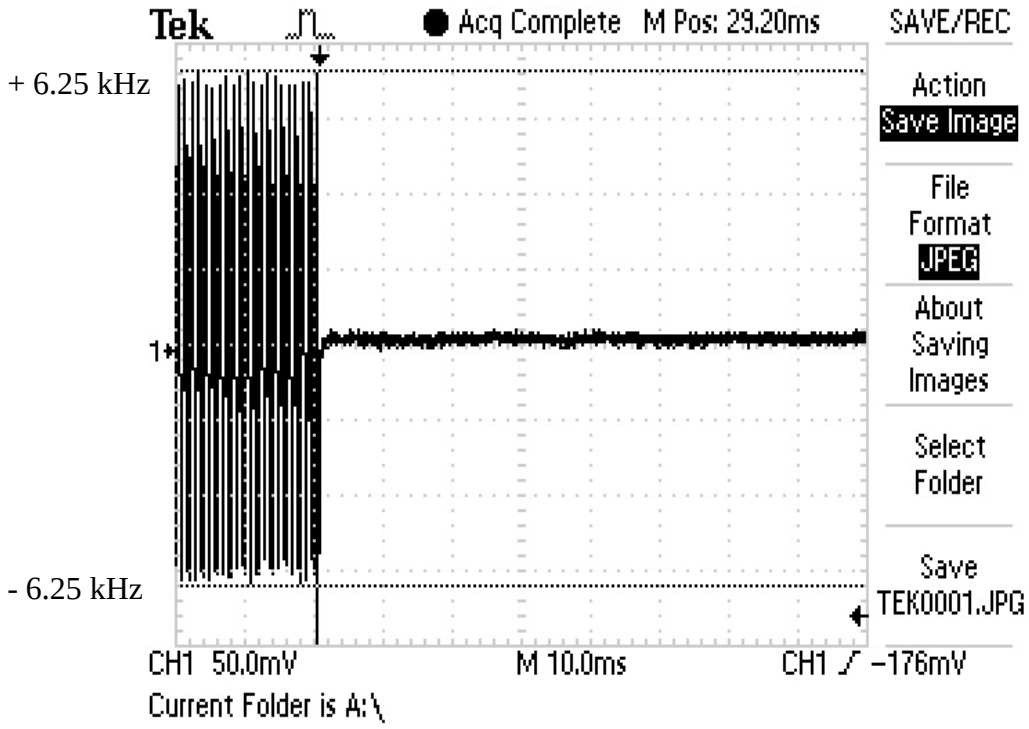
Temperature: +23 °C Relative humidity: 47 %

Plot 3.6.1

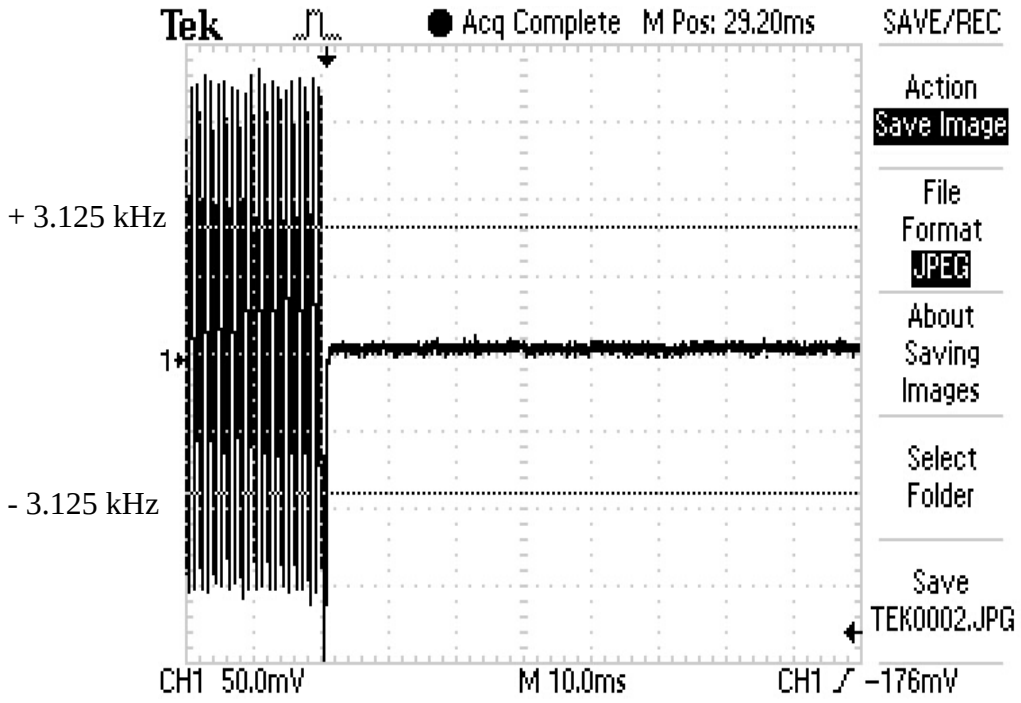


± 6.25 kHz = 346 mV
± 3.125 kHz = 173 mV
± 230 Hz (±0.5 ppm) = 12,7 mV

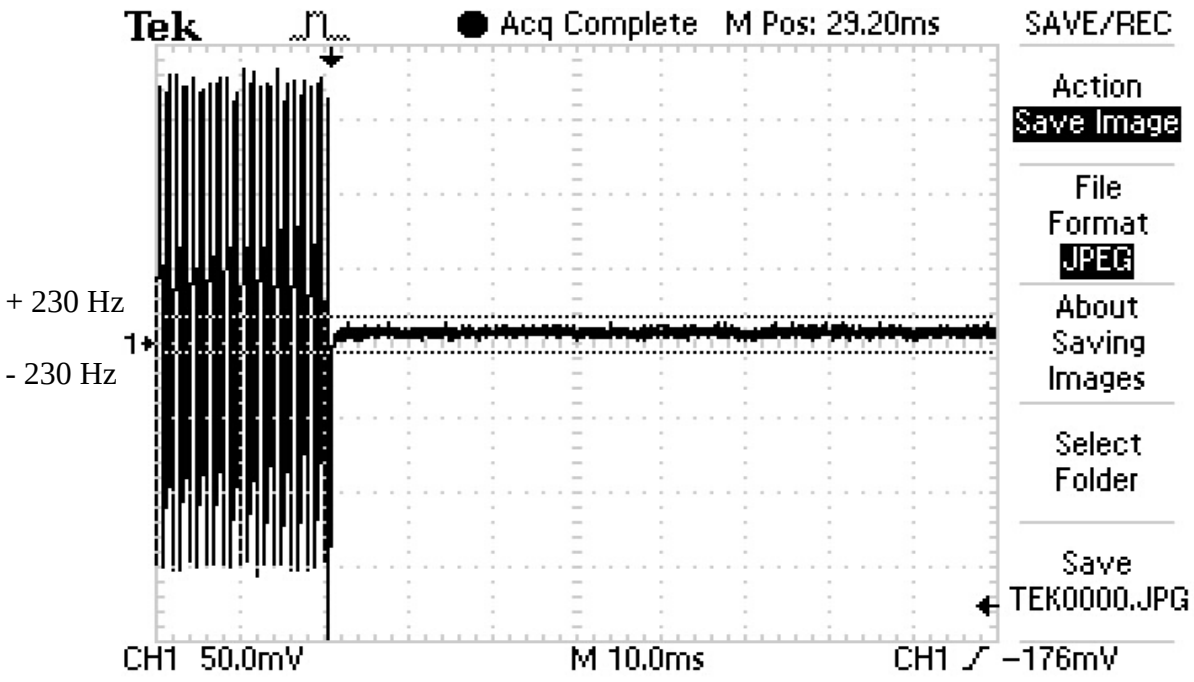
Plot 3.6.2: t_1 time period



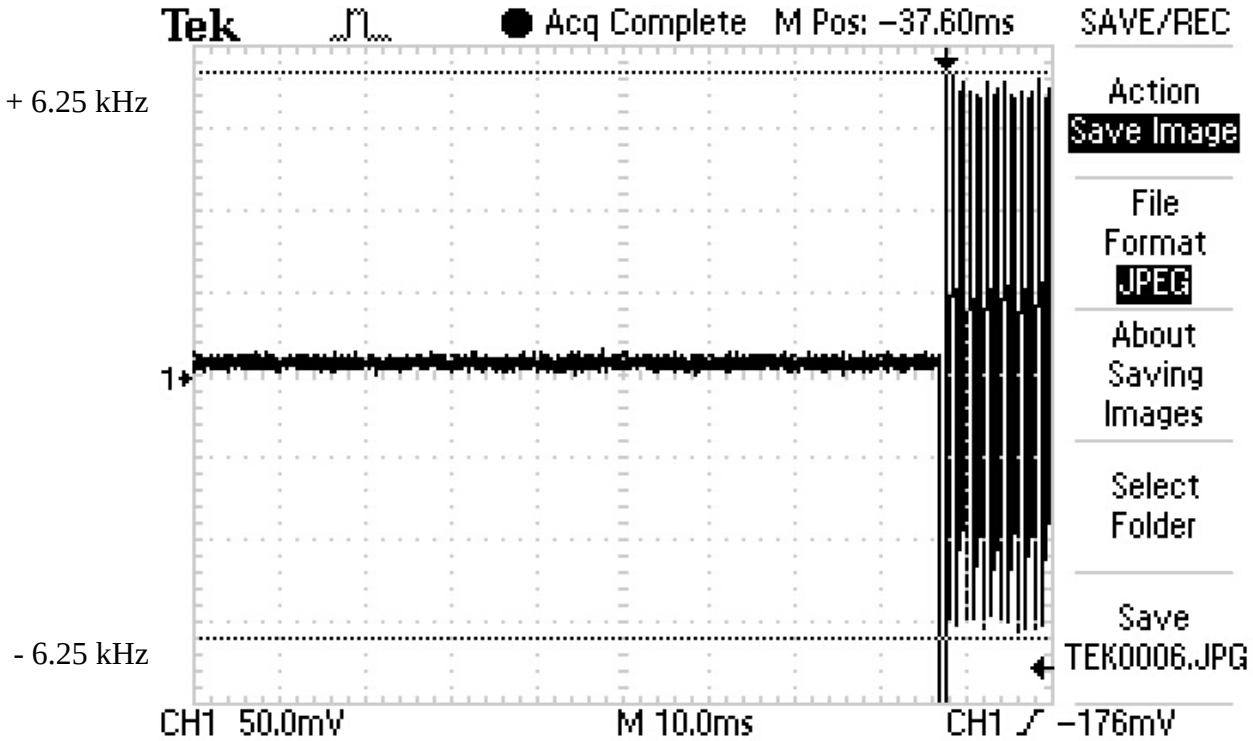
Plot 3.6.3: t_2 time period



Plot 3.6.4: t_2 - t_3 time period



Plot 3.6.5: t_3 time period



3.7 Frequency stability vs power supply

3.7.1 Test requirements 90.213

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

Table 3.7.1 Limit frequency stability vs power supply

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1,2,3] 100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5,11] 5	[6] 5	[4,6] 50
216-220	1.0		1.0
220-222 [12]	0.1	1.5	1.5
421-512	[7,11,14] 2.5	[8] 5	[8] 5
806-809	[14] 1.0	1.5	1.5
809-824	[14] 1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14] 0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928 [13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9] 300	300	300
Above 2450 [10]			

[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.

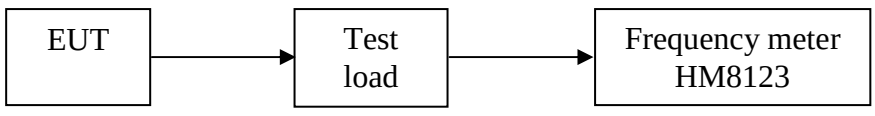
[8] In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

3.7.2 Test procedure

1) The transmitter was set up to the normal operational mode with maximum output power with no modulation signal applied.
2) The transmitter was connected to the frequency meter HM8123 for measuring the frequency.
3) The supply voltage was changed to observe the frequency stability across the power supply voltage range.

3.7.3 Test setup layout



3.7.4 Test result

Temperature: +23 ^{o}C Relative humidity: 47 %

Power Supply voltage, V	Frequency (MHz)	Deviation (Hz)	Deviation (ppm)	Limit, ppm	Result (Pass, Fail, N/A)
132.0	459.999965	- 35	-0.076	± 0.5	Pass
129.6	459.999965	- 35	-0.076	± 0.5	Pass
127.2	459.999976	- 24	-0.052	± 0.5	Pass
124.8	459.999987	- 13	-0.028	± 0.5	Pass
122.4	459.999987	- 13	-0.028	± 0.5	Pass
120.0	459.999987	- 13	-0.028	± 0.5	Pass
117.6	459.999987	- 13	-0.028	± 0.5	Pass
115.2	459.999965	- 35	-0.076	± 0.5	Pass
112.8	459.999965	- 35	-0.076	± 0.5	Pass
110.4	459.999960	- 40	-0.087	± 0.5	Pass
108.0	459.999960	- 40	-0.087	± 0.5	Pass

Reference frequency = 460.000000 MHz

3.8 Frequency stability vs temperature

3.8.1 Test requirements 90.213

(a) 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	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1,2,3] 100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5,11] 5	[6] 5	[4,6] 50
216-220	1.0		1.0
220-222 [12]	0.1	1.5	1.5
421-512	[7,11,14] 2.5	[8] 5	[8] 5
806-809	[14] 1.0	1.5	1.5
809-824	[14] 1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14] 0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928 [13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9] 300	300	300
Above 2450 [10]			

[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.

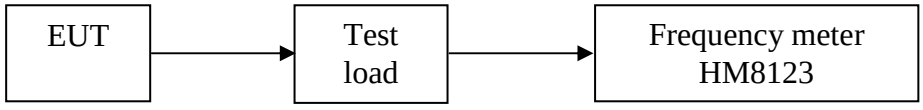
[8] In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

3.8.2 Test procedure

1) The transmitter was set up to the normal operational mode with maximum output power with no modulation signal applied.
2) The transmitter was connected to the Frequency meter HM8123 for measuring the frequency.
3) The transmitter was placed in the temperature chamber to observe the frequency stability across the temperature range.

3.8.3 Test setup layout



3.8.4 Test result

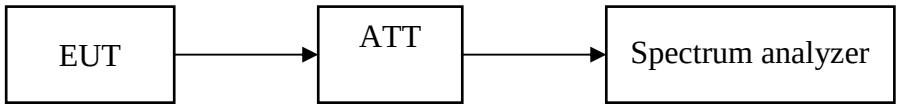
Temperature: +23 ^{o}C Relative humidity: 47 %

Temperature (°C)	Frequency (MHz)	Deviation (Hz)	Deviation (ppm)	Limit, ppm	Result (Pass, Fail, N/A)
+85	459.999958	- 42	- 0.091	0.5	Pass
+80	459.999958	- 42	- 0.091	0.5	Pass
+70	460.000006	6	0.013	0.5	Pass
+60	459.999960	- 40	- 0.086	0.5	Pass
+50	459.999946	- 54	- 0.117	0.5	Pass
+40	459.999926	- 74	- 0.161	0.5	Pass
+30	459.999951	- 49	- 0.106	0.5	Pass
+20	459.999987	- 13	- 0.028	0.5	Pass
+10	459.999932	- 68	- 0.147	0.5	Pass
0	459.999886	- 114	- 0.248	0.5	Pass
- 10	459.999867	- 133	- 0.289	0.5	Pass
- 20	459.999856	- 142	- 0.308	0.5	Pass
- 30	459.999902	- 98	- 0.213	0.5	Pass
- 40	No Transmission	-	-	-	N/A
+20	459.999976	- 24	+0.063	0.5	Pass

Reference frequency = 460.000000 MHz

3.9 99% Occupied Bandwidth

3.11.1 Test Setup



3.9.2 Limit

According to §90.209(b)(5) the maximum occupied bandwidth for a 6.25 kHz channel spacing is 6 kHz.

3.9.3 Test Procedure

The following procedure according to ANSI C63.10-2013 shall be used for measuring 99% power bandwidth.

Settings for the spectrum analyzer:

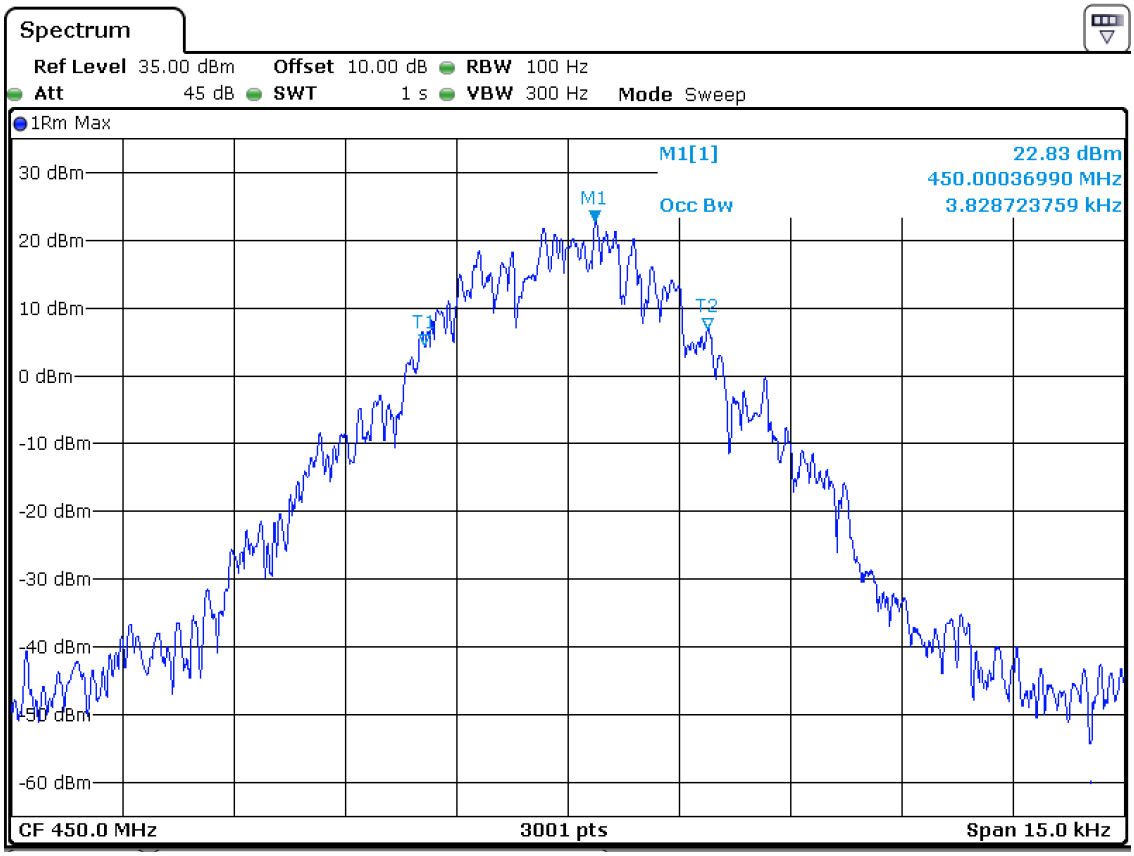
- center frequency is set to the nominal EUT channel center frequency;
- frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the occupied bandwidth (OBW);
- RBW shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW;
- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. The peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
- Peak detection and max hold mode (until the trace stabilizes) shall be used.
- The 99% power bandwidth function of the spectrum analyzer shall be used.

3.9.4 Test Results

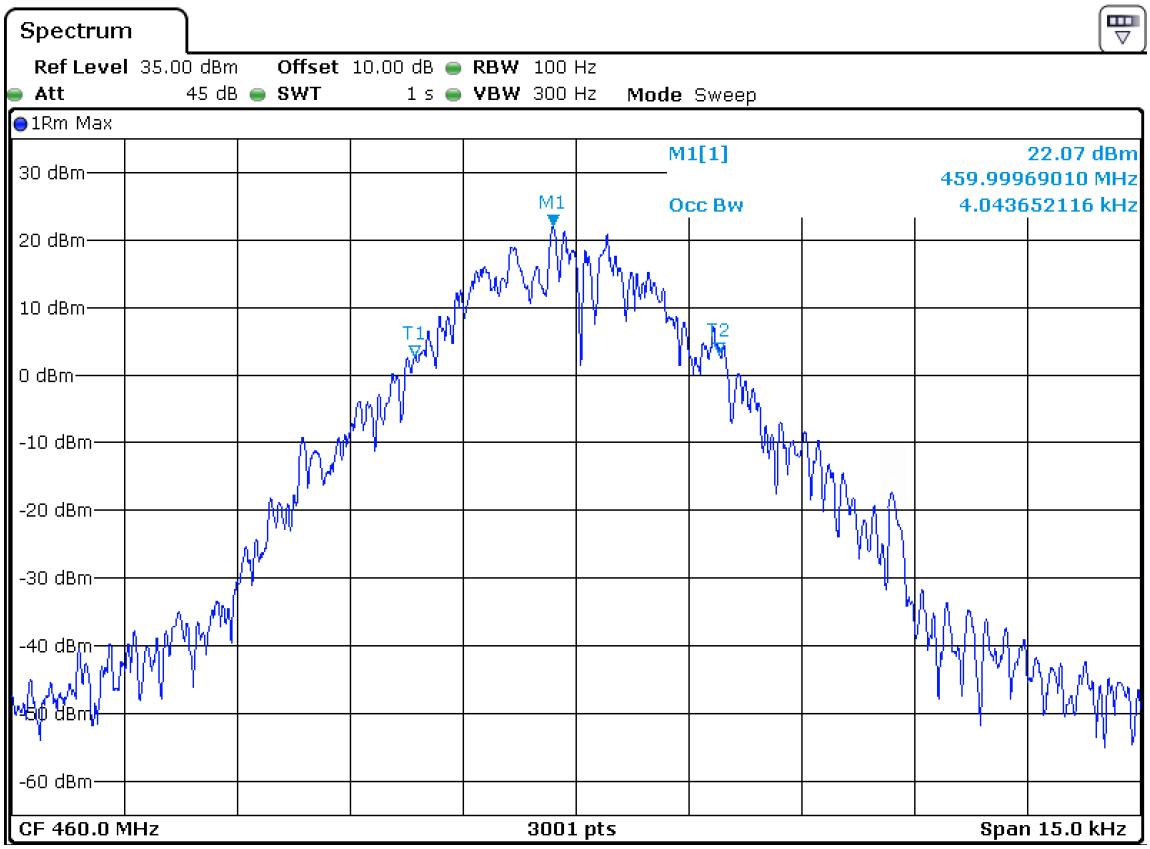
Temperature: +25 ^{o}C Relative humidity: 60 %

Channel Frequency, MHz	99% Occupied Bandwidth, kHz	Limit, kHz	Test Result (Pass, Fail, N/A)
450	3.82	6.00	Pass
460	4.04	6.00	Pass
470	3.98	6.00	Pass

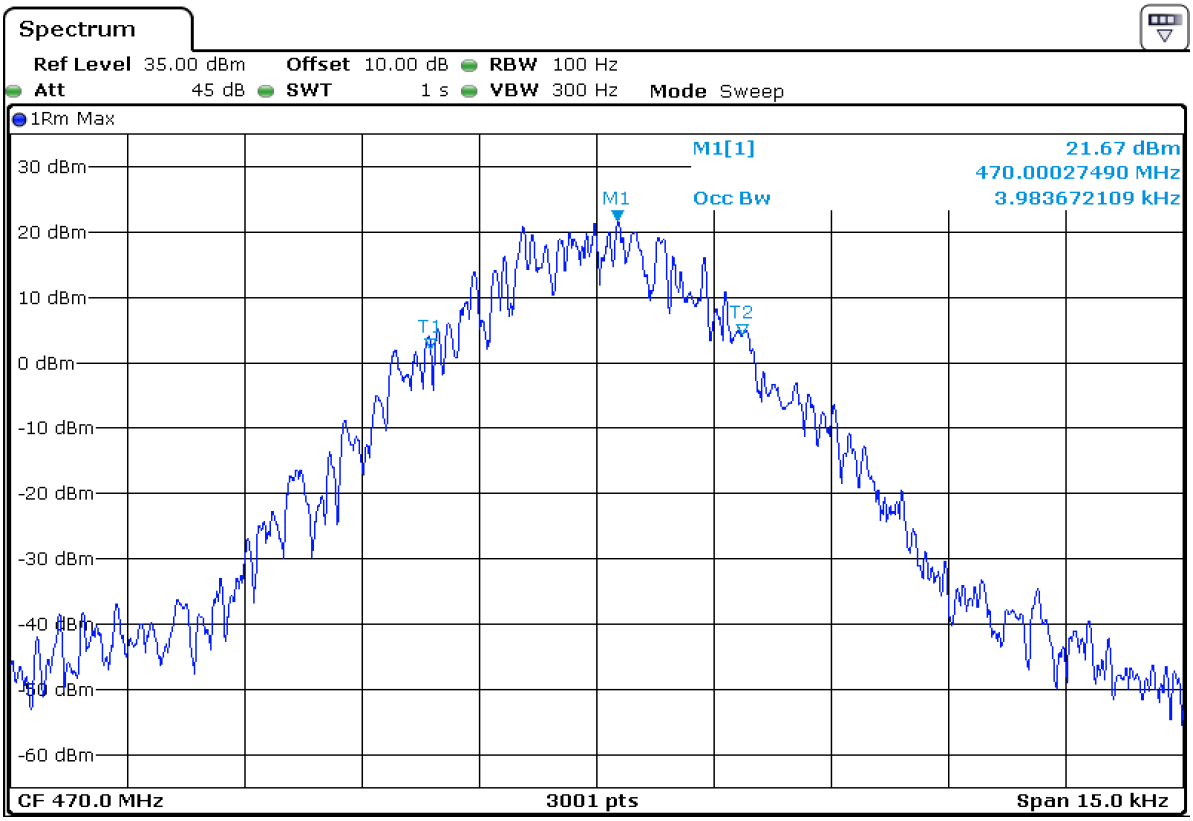
Plot 3.9.1 Low Channel



Plot 3.9.2 Middle Channel



Plot 3.9.3 High Channel



3.10 Operating Frequencies

Assignment and use of the frequencies in the band 450-470 MHz for fixed operations regulates by paragraph 47 CFR Part 90.261 and authorized in an individual license for the radio.