



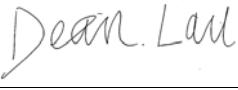
## FCC PART 22 and 90 TEST REPORT

For

**Sepura plc**

Radio House, St. Andrews Road, Cambridge CB4 1GR UK

**FCC ID: XX6SEM8050**

<b>Report Type:</b> Original Report	<b>Product Type:</b> DMR Mobile Radio
<b>Test Engineer:</b> <u>Dean Liu</u> 	
<b>Report Number:</b> <u>RDG1150803009-00</u>	
<b>Report Date:</b> <u>2015-12-10</u>	
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

The *Sepura plc*'s product, model: *SEM8050 (FCC ID: XX6SEM8050)* (the "EUT") in this report is a *DMR Mobile Radio*, which was measured approximately: 17.8 cm (L) x 19.5 cm (W) x 5.8 cm (H), rated input voltage: 13.6VDC or 15VDC powered from AC/DC adapter.

Adapter information:

Model: GS220A15

Input: AC100-240V, 50/60Hz, 4.0A

Output: DC 15V, 13.4A, 201W max

*\* All measurement and test data in this report was gathered from production sample serial number: 7PR101525GD0001. The EUT was received on 2015-08-06.*

### Objective

This test report is prepared on behalf of *Sepura plc* in accordance with Part 2, Part 22 and Part 90 of the Federal Communications Commission rules.

### Related Submittal(s)/Grant(s)

No related submittal(s).

### Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 22 – Public Mobile Service

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA-603-D.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

### Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industrial Zone, Tangxia, Dongguan, Guangdong, China

Test site at Bay Area Compliance Laboratories Corp. (Dongguan) has been fully described in reports submitted to the Federal Communications Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 06, 2015.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 273710. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in a test mode.

### EUT Specification:

Operating Frequency Band	450-520 MHz
Modulation Mode	FM/4FSK
Channel Spacing	12.5 kHz
Rated Output Power	High power level: 25W Low power level: 1W

### Equipment Modifications

No modifications were made to the unit tested.

### Support Equipment List and Details

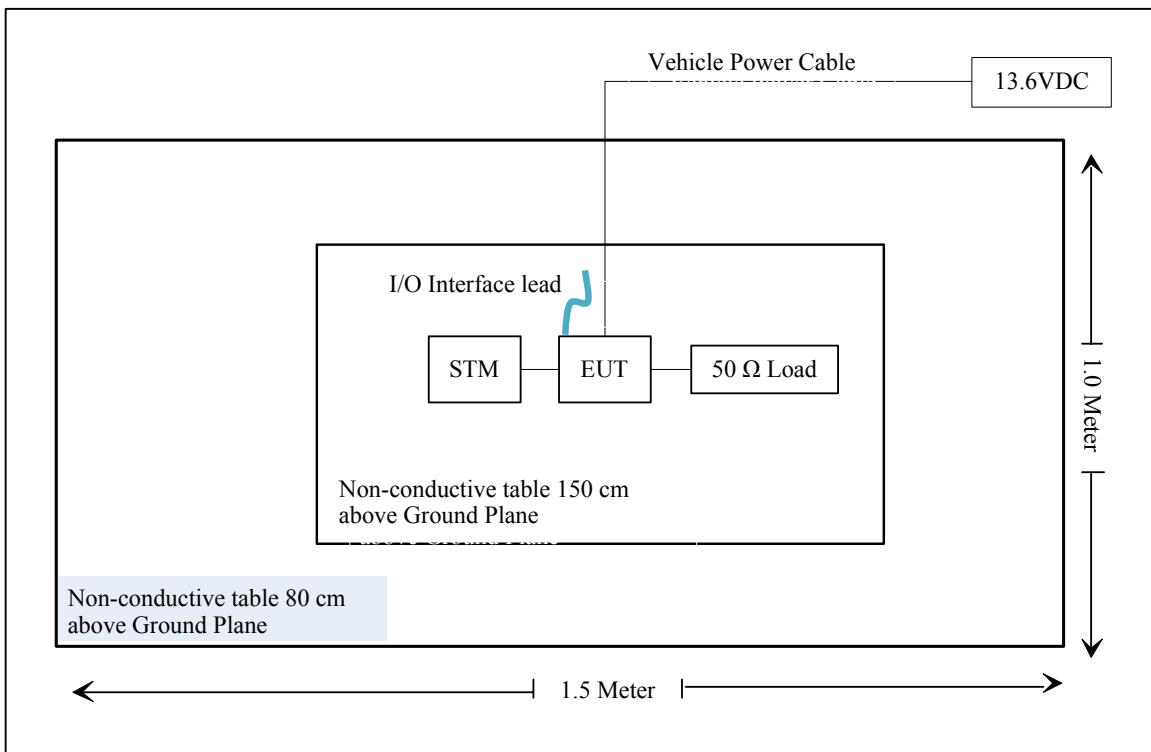
Manufacturer	Description	Model	Serial Number
Desktop			
MEAN WELL	Desktop PSU includes adaptor cable	GS220A15	EB42200946
Sepura	Desk Mounting bracket	300-01063	/
Sepura	DDM/Desktop Mic with PTT)	300-01065	/
Sepura	USB Data Lead	300-01164	/
Sepura	Programming Cable	300-01075	/
Vehicle Installation			
Pro instrument	DC Power Supply	pps3300	N/A
Sepura	STM(Std. Fist Mic.)	300-01077	7PR201530D30201
Sepura	Keypad Mic	300-01064	/
Sepura	I/O Interface lead	300-01165	/
Sepura	Vehicle Power Cable	300-01066	/
Sepura	Programming Cable	300-01075	/

### External Cable

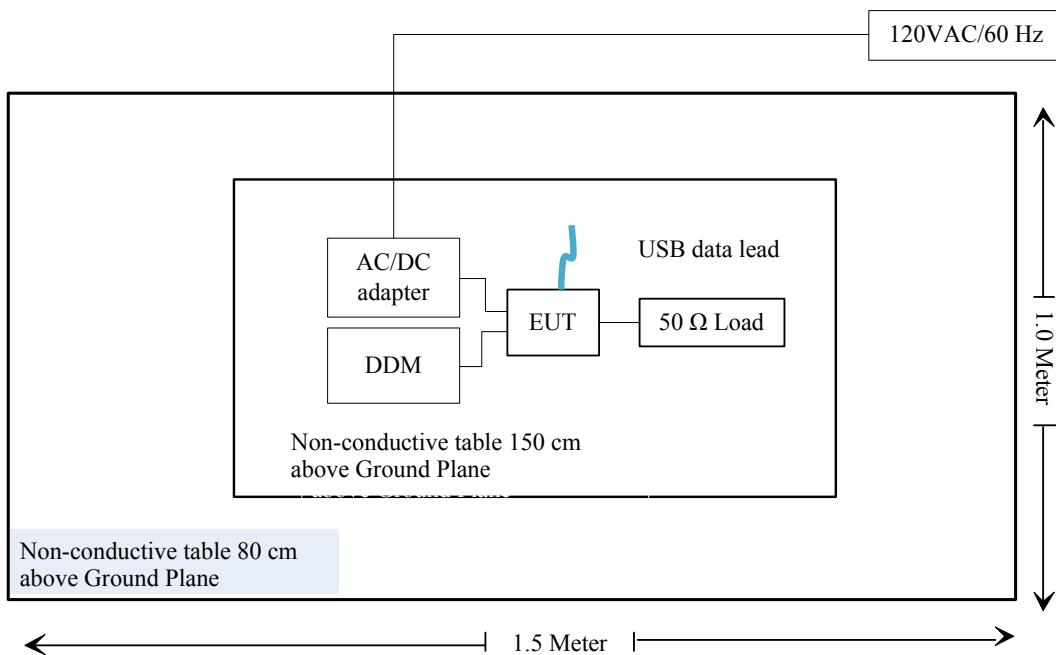
Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
DC Cable	no	no	5.0	Connector	DC power supply
Adapter Cable	no	no	1.5	Adapter	EUT

## Block Diagram of Test Setup

### Vehicle Installation



### Desktop



**SUMMARY OF TEST RESULTS**

FCC Rules	Description of Test	Results
§2.1091	Maximum Permissible Exposure	Compliance
§2.1046; § 22.727;§90.205	RF Output Power	Compliance
§2.1047;§90.207	Modulation Characteristic	Compliance
§2.1049;§22.357;§ 22.731;§90.209, §90.210	Occupied Bandwidth & Emission Mask	Compliance
§2.1051; §22.861;§90.210	Spurious Emission at Antenna Terminal	Compliance
§2.1053; §22.861;§90.210	Spurious Radiated Emissions	Compliance
§2.1055; § 22.355;§90.213	Frequency Stability	Compliance
§90.214	Transient Frequency Behavior	Compliance

## FCC §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### Applicable Standard

According to 1.1307 (b)(1), 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

#### Limits for Maximum Permissible Exposure (MPE)

Limits for Occupational/Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time  E ,  H  or S (minutes)
0.3- 3.0	614	1.63	(100)*	6
3.0 - 30	1842/f	4.89/f	(900/f <sup>2</sup> )*	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	f/300	6
1500-100,000	/	/	5	6

f = frequency in MHz;

\* = Plane-wave equivalent power density;

### MPE Calculation

#### Predication of MPE limit at a given distance

$$S = PG/4\pi R^2$$

Where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

**Calculated Data:**

Frequency	Conducted Output Power	Duty Cycle	Antenna Cable Loss	Typical Antenna Gain		Distance	Power Density	Limit
				dB	dB <sub>i</sub>	numeric	cm	mW/cm <sup>2</sup>
450.0125	28183	50%	0	0	1.0	120	0.078	1.50

Note1: The manufacturer does not specify an antenna to be used with this device, but a typical installation has a gain up to 0 dB<sub>i</sub>.

Note2: The target power is 25W (44.0 dBm)  $\pm 0.5$ dB = 28183mW (44.5dBm)

**Radio Exposure Statement:**

Using the parameters given in the above calculation, a minimum antenna to person distance of 120 cm is required to meet the limits for occupational/controlled exposure.

Result: Compliant.

**FCC §2.1046 &§ 22.727 & §90.205- RF OUTPUT POWER****Applicable Standard**

FCC §2.1046, § 22.727 and §90.205.

**Test Procedure**

Conducted RF Output Power:

TIA-603-D section 2.2.1

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

Spectrum Analyzer setting:

RBW	VBW
100 kHz	300 kHz

**Test Equipment List and Details**

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2015-05-09	2016-05-09
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-08	2016-05-08
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06

**\* Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

**Test Data****Environmental Conditions**

Temperature:	27.1 °C
Relative Humidity:	58 %
ATM Pressure:	100kPa

*The testing was performed by Dean Liu on 2015-08-25.*

*Test Result: Compliance. Please refer to following tables.*

FCC Part 90:

Modulation mode	Channel Spacing (kHz)	f <sub>c</sub> (MHz)	Conducted Output Power (W)		Note
			High	Low	
FM	12.5	450.0125	25.03	1.00	/
		485	25.06	1.02	/
		519.9875	25.03	1.01	Not for FCC Review
4FSK	12.5	450.0125	25.06	1.02	/
		485	25.06	1.02	/
		519.9875	25.11	1.01	Not for FCC Review

FCC Part 22:

Modulation mode	Channel Spacing (kHz)	f <sub>c</sub> (MHz)	Conducted Output Power (W)	
			High	Low
FM	12.5 kHz	454.0125	25.03	1.03
		454.0125	25.06	1.02

## FCC §2.1047 & §90.207 - MODULATION CHARACTERISTIC

### Applicable Standard

FCC§2.1047 & §90.207:

- (a) Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.
- (b) Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

### Test Procedure

Test Method: TIA/EIA-603 2.2.3

### Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
HP	RF Communications Test Set	8920A	00 235	2015-05-09	2016-05-09
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-08	2016-05-08
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-01	/	2015-05-06	2016-05-06

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

### Test Data

#### Environmental Conditions

<b>Temperature:</b>	27.1 °C
<b>Relative Humidity:</b>	58 %
<b>ATM Pressure:</b>	100 kPa

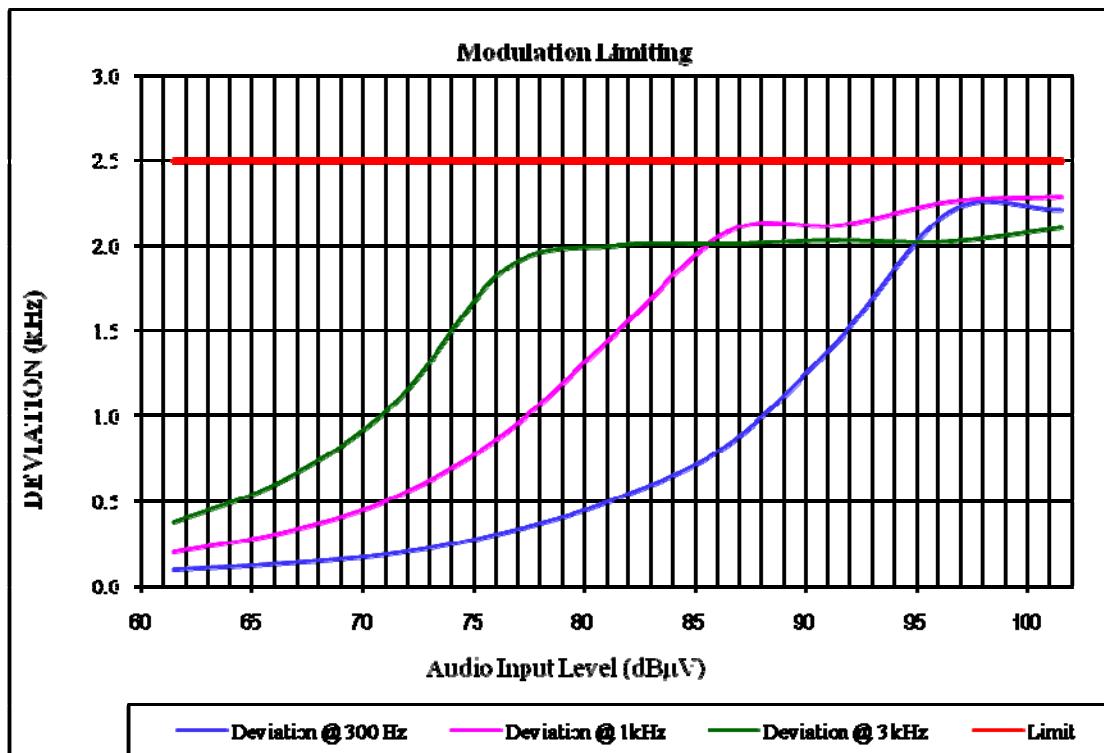
The testing was performed by Dean Liu on 2015-08-25.

Test Result: Compliance. Please refer to following tables and plots.

### MODULATION LIMITING

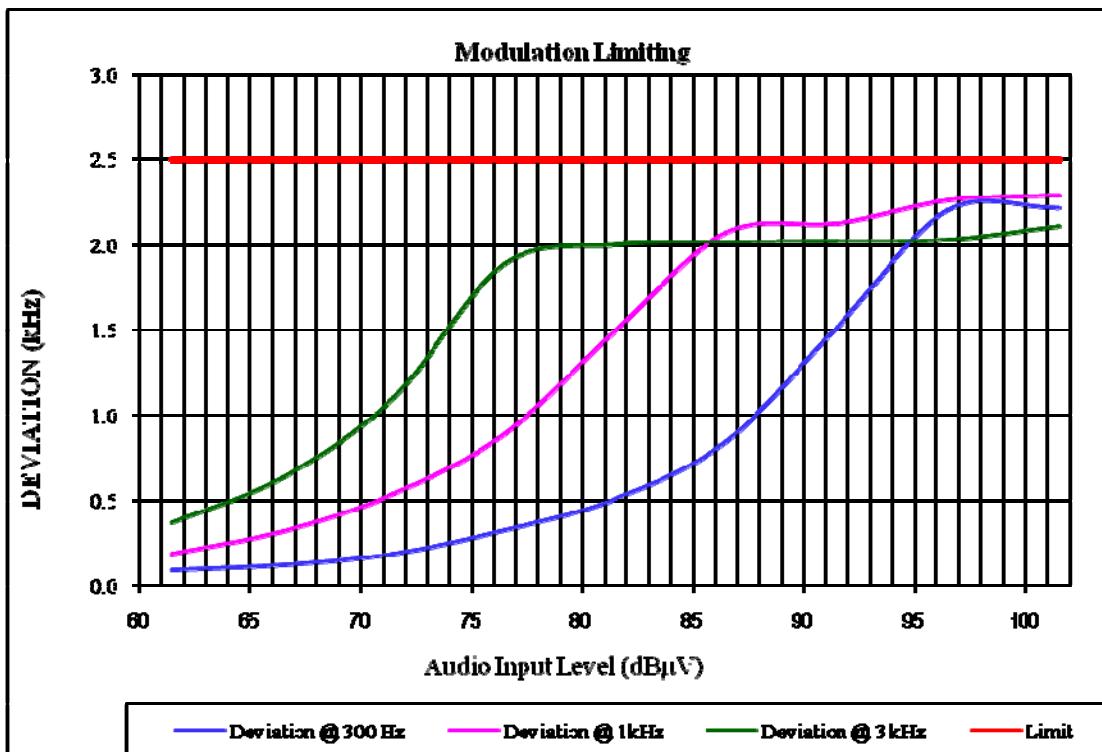
Carrier Frequency: 485MHz, Channel Spacing = 12.5 kHz, high power level

AUDIO INPUT LEVEL	DEVIATION (@300Hz)	DEVIATION (@ 1kHz)	DEVIATION (@ 3kHz)	Limit
<b>dB<math>\mu</math>V</b>	<b>kHz</b>	<b>kHz</b>	<b>kHz</b>	<b>kHz</b>
101.5	2.214	2.288	2.106	2.5
96.5	2.203	2.261	2.022	2.5
91.5	1.453	2.122	2.028	2.5
86.5	0.832	2.086	2.011	2.5
81.5	0.515	1.500	2.003	2.5
76.5	0.317	0.904	1.874	2.5
71.5	0.195	0.523	1.081	2.5
66.5	0.138	0.318	0.625	2.5
61.5	0.103	0.203	0.378	2.5



Carrier Frequency: 485MHz, Channel Spacing = 12.5 kHz, low power level

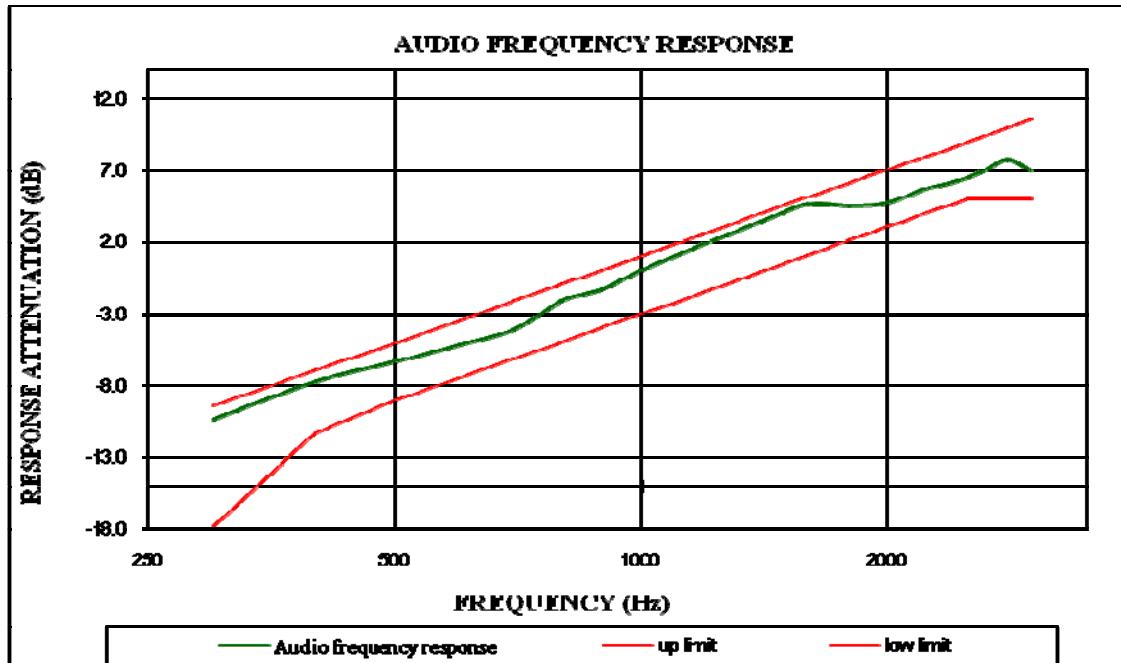
AUDIO INPUT LEVEL dB $\mu$ V	DEVIATION (@300Hz) kHz	DEVIATION (@ 1kHz) kHz	DEVIATION (@ 3kHz) kHz	Limit kHz
101.5	2.221	2.296	2.114	2.5
96.5	2.209	2.266	2.031	2.5
91.5	1.516	2.130	2.021	2.5
86.5	0.844	2.074	2.016	2.5
81.5	0.509	1.500	2.001	2.5
76.5	0.328	0.893	1.889	2.5
71.5	0.189	0.541	1.103	2.5
66.5	0.126	0.323	0.636	2.5
61.5	0.097	0.192	0.371	2.5



**Audio Frequency Response**

Carrier Frequency: 485MHz, Channel Spacing = 12.5 kHz, high power level

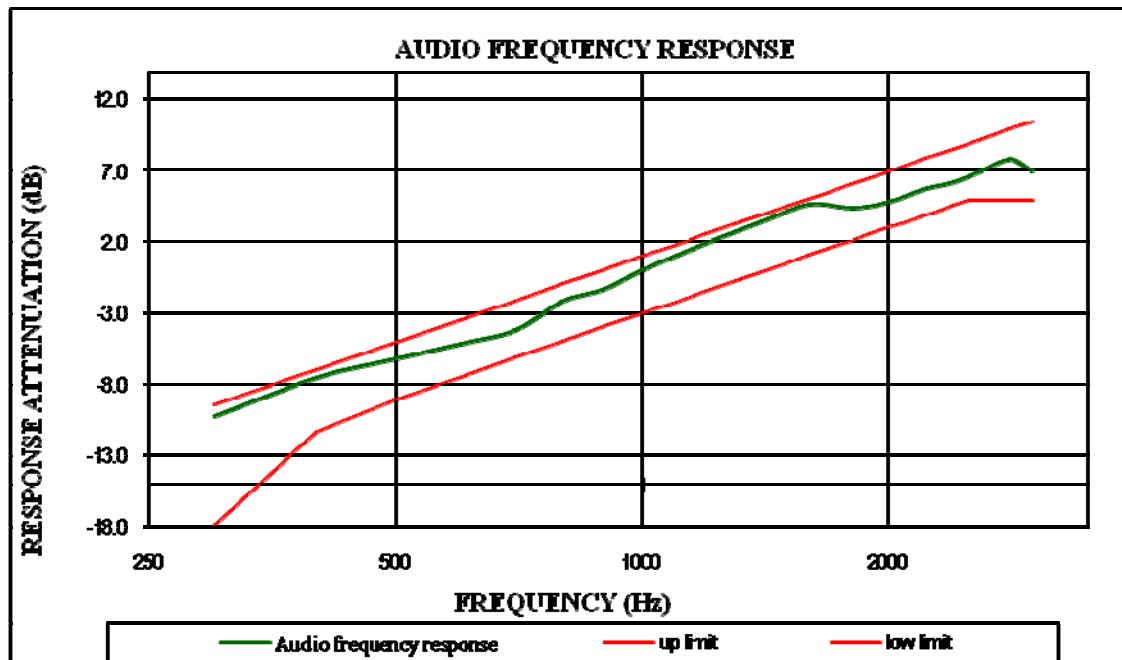
Audio Frequency	Response Attenuation
Hz	dB
300	-10.35
400	-7.68
500	-6.31
600	-5.16
700	-4.07
800	-2.13
900	-1.28
1000	0.00
1200	1.86
1400	3.35
1600	4.55
1800	4.47
2000	4.63
2200	5.57
2400	6.11
2600	6.81
2800	7.71
3000	6.91



**Audio Frequency Response**

Carrier Frequency: 485MHz, Channel Spacing = 12.5 kHz, low power level

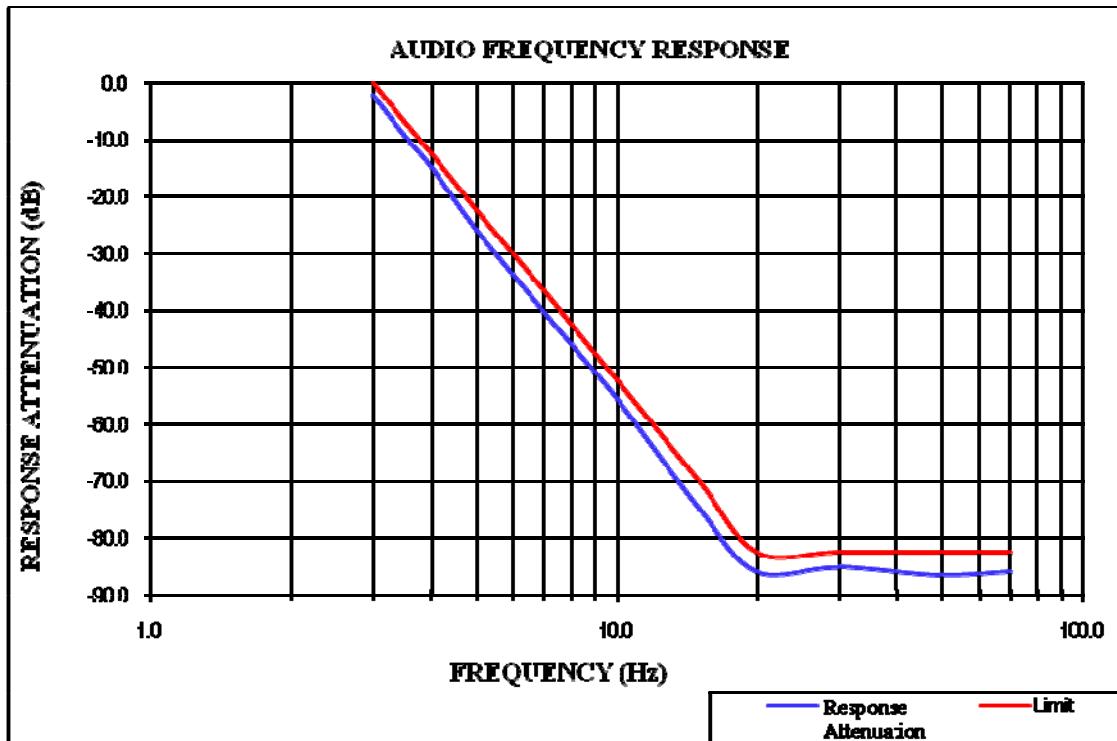
Audio Frequency	Response Attenuation
Hz	dB
300	-10.25
400	-7.48
500	-6.22
600	-5.13
700	-4.21
800	-2.19
900	-1.32
1000	0.00
1200	1.95
1400	3.41
1600	4.66
1800	4.42
2000	4.79
2200	5.66
2400	6.21
2600	6.97
2800	7.84
3000	7.05



**Audio Frequency Low Pass Filter Response**

Carrier Frequency: 485 MHz, Channel Spacing = 12.5 kHz

Audio Frequency	Response Attenuation	Limit
kHz	dB	dB
3.0	-2.2	0.0
3.5	-9.2	-6.7
4.0	-14.8	-12.5
5.0	-25.7	-22.2
7.0	-40.5	-36.8
10.0	-55.6	-52.3
15.0	-74.7	-69.9
20.0	-85.9	-82.5
30.0	-85.2	-82.5
50.0	-86.6	-82.5
70.0	-85.9	-82.5



## FCC §2.1049 & §22.357 & § 22.731 & §90.209 & §90.210 – OCCUPIED BANDWIDTH & EMISSION MASK

### Applicable Standard

FCC §2.1049, §22.357, § 22.731, §90.209 and §90.210

Applicable Emission Masks

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25	A or B	A or C
25-50	B	C
72-76	B	C
150-174	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854	B	H
809-824/854-869	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		
All other bands	B	C

**Emission Mask D**—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel 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  $f_0$  to 5.625 kHz removed from  $f_0$ : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $fd$  in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least  $7.27(fd - 2.88 \text{ kHz})$  dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $fd$  in kHz) of more than 12.5 kHz: At least  $50 + 10 \log (P)$  dB or 70 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 or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission 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 (o) 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, an alternate procedure may be used provided prior Commission approval is obtained.

§22.357 Emission types.

Any authorized station in the Public Mobile Services may transmit emissions of any type(s) that comply with the applicable emission rule, i.e. §22.359, §22.861 or §22.917

§22.731 Emission limitations.

Upon application for multichannel operation, the FCC may authorize emission bandwidths wider than those specified in §22.357, provided that spectrum utilization is equal to or better than that achieved by single channel operation.

## Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2015-05-09	2016-05-09
HP	RF Communications Test Set	8920A	00 235	2015-05-09	2016-05-09
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-08	2016-05-08
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-01	/	2015-05-06	2016-05-06

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

## Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

## Test Data

### Environmental Conditions

<b>Temperature:</b>	27.1~27.5 °C
<b>Relative Humidity:</b>	58~61 %
<b>ATM Pressure:</b>	100~100.3 kPa

*The testing was performed by Dean Liu on 2015-08-14 and 2015-09-16.*

*Test Result: Compliance. Please refer to the following tables and plots.*

FCC Part 90:

Modulation Mode	Channel Spacing	$f_c$	26 dB Bandwidth	99% Bandwidth	Power Level
	kHz	MHz	kHz	kHz	
FM	12.5	485	10.256	9.921	High
4FSK			9.587	7.469	
FM			10.256	9.921	Low
4FSK			9.252	7.246	

FCC Part 22:

Modulation Mode	Channel Spacing	$f_c$	26 dB Bandwidth	99% Bandwidth	Power Level
	kHz	MHz	kHz	kHz	
FM	12.5	454.0125	10.256	9.921	High
4FSK			9.698	7.469	
FM			10.367	9.921	Low
4FSK			9.698	7.58	

Emission Designator

Per CFR 47 §2.201& §2.202&, Bn = 2M + 2D

#### For FM Mode (Channel Spacing: 12.5 kHz)

Emission Designator 11K0F3E

In this case, the maximum modulating frequency is 3.0 kHz with a 2.5 kHz deviation.

$BW = 2(M+D) = 2*(3.0 \text{ kHz} + 2.5 \text{ kHz}) = 11 \text{ kHz} \Rightarrow 11K0$

F3E portion of the designator represents an FM voice transmission

Therefore, the entire designator for 12.5 kHz channel spacing FM mode is 11K0F3E.

#### For Digital Mode (Channel Spacing: 12.5 kHz)

Emission Designator 7K60FXD and 7K60FXW

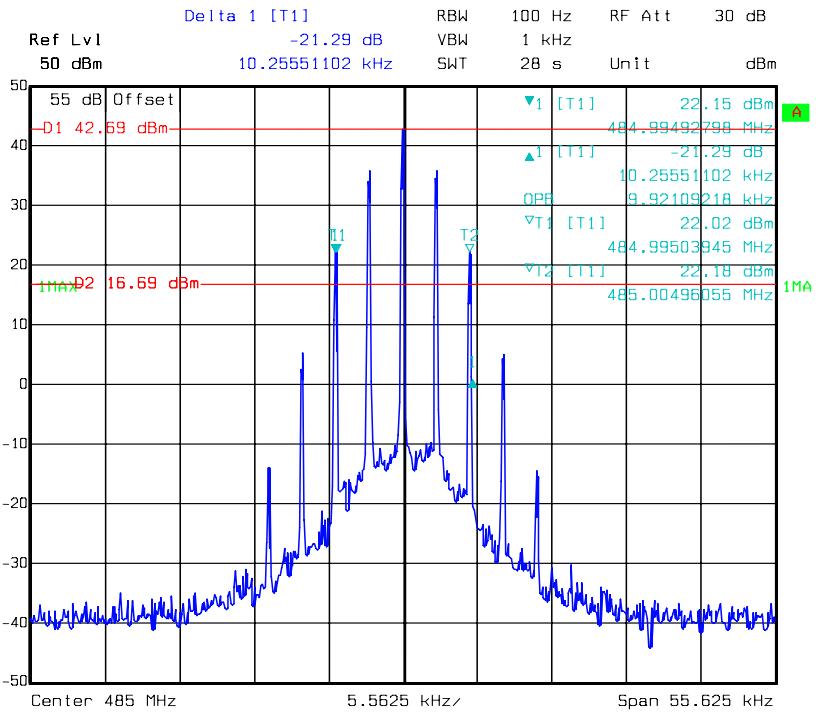
The 99% energy rule (title 47CFR 2.1049) was used for digital mode. It basically states that 99% of the modulation energy falls within X kHz, in this case, 7.58 kHz. The emission mask was obtained from 47CFR 90.210(d).

FXD and FXW portion of the designator indicates digital information.

Therefore, the entire designator for 12.5 kHz channel spacing digital mode is 7K60FXD and 7K60FXW.

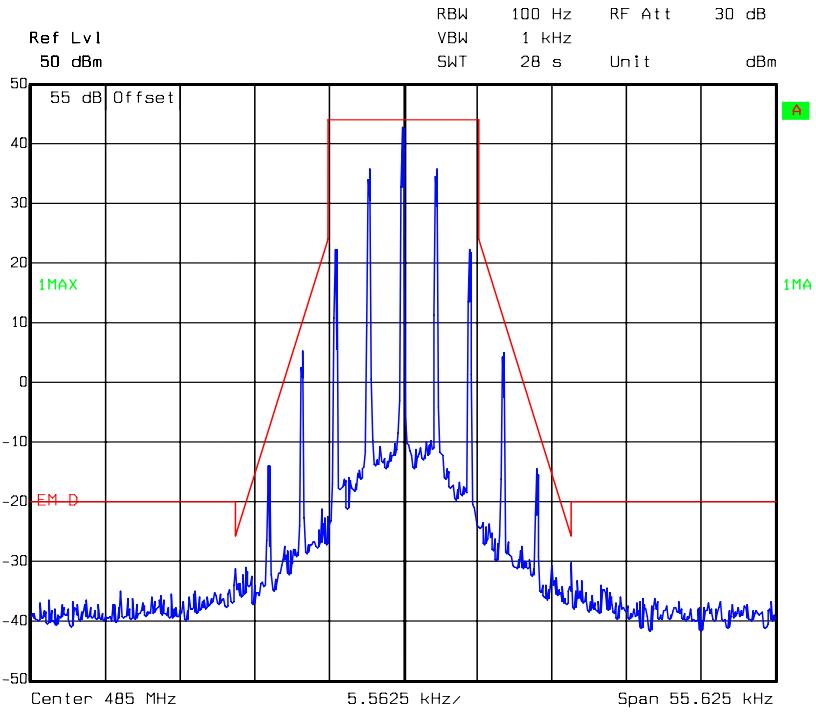
Part 90:

## Occupied Bandwidth – FM, 485 MHz, High Power Level



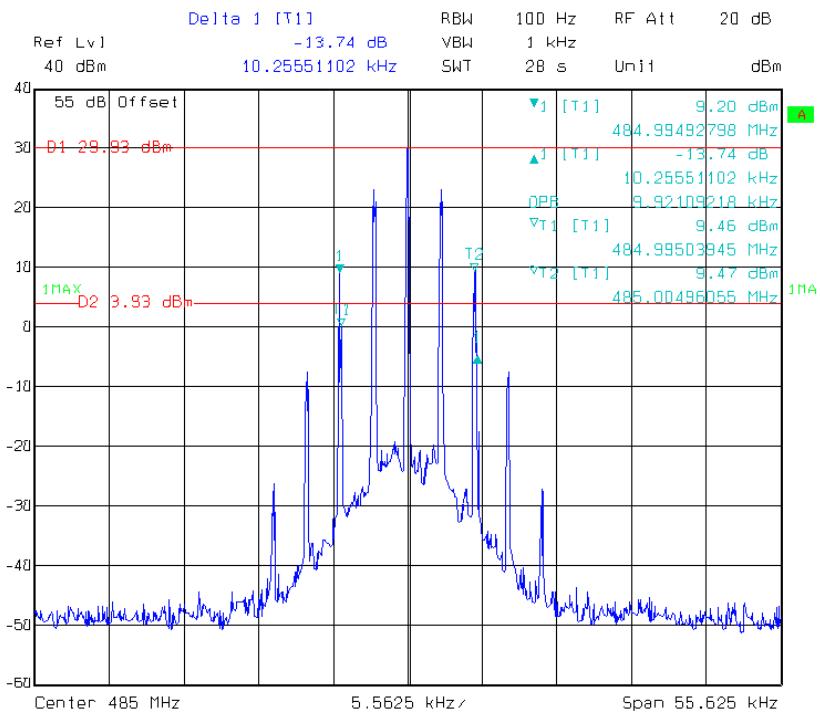
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## Emission Mask - Type D



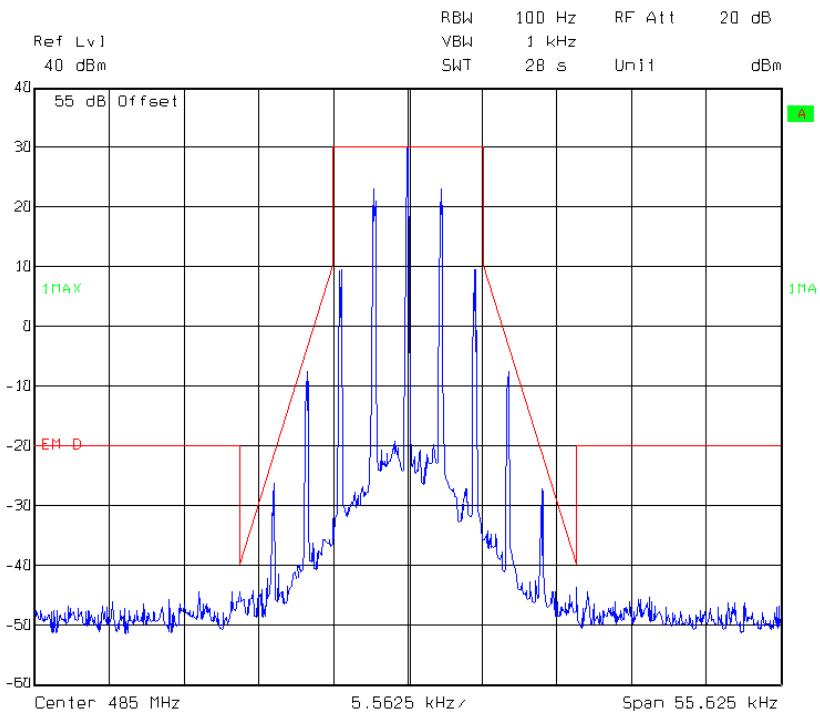
Date: 14.AUG.2015 18:39:54

## Occupied Bandwidth – FM, 485 MHz, Low Power Level



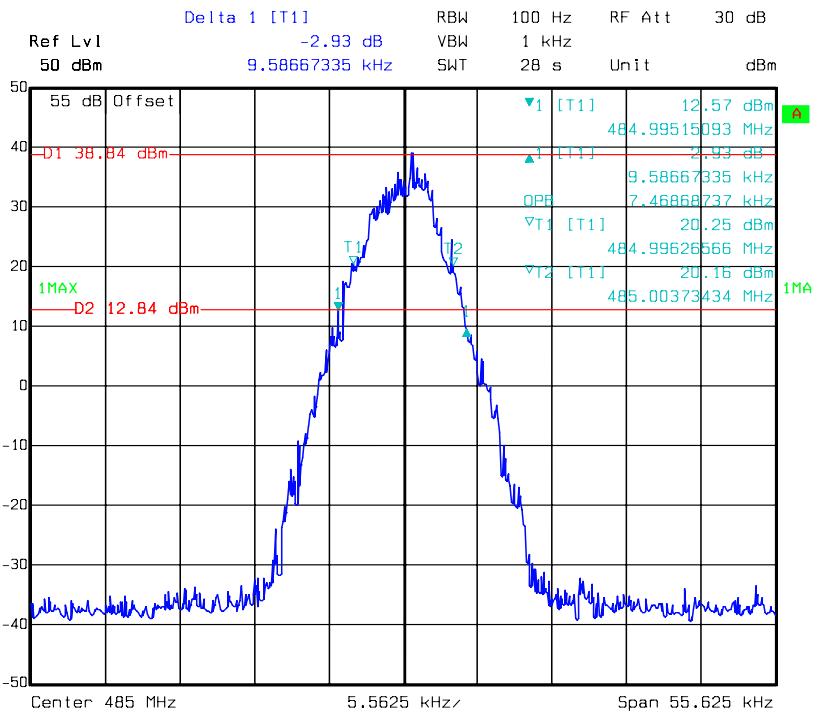
Date: 16.SEP.2015 16:58:35

## Emission Mask - Type D



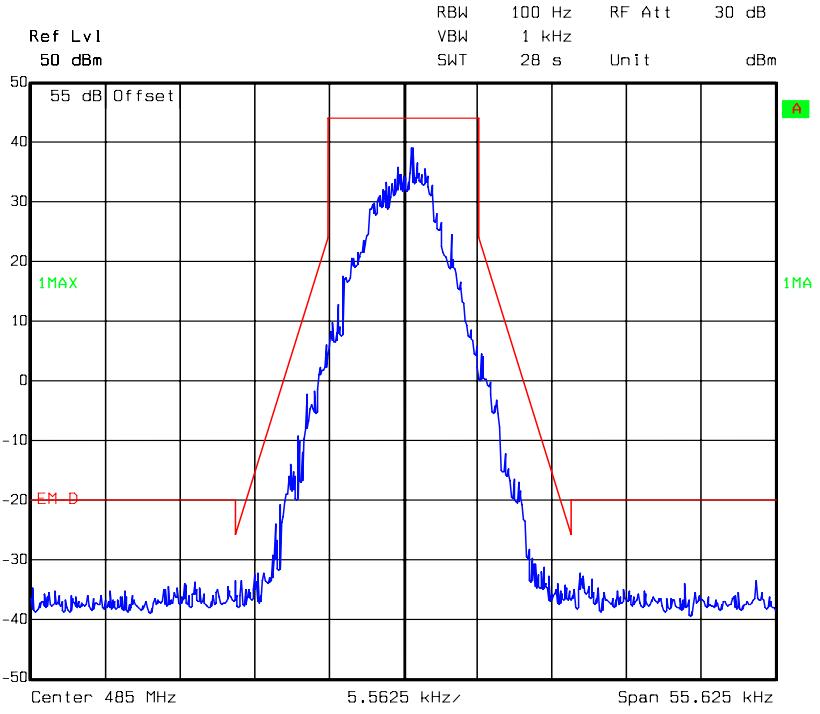
Date: 16.SEP.2015 16:57:38

## Occupied Bandwidth -4FSK, 485 MHz, High Power Level



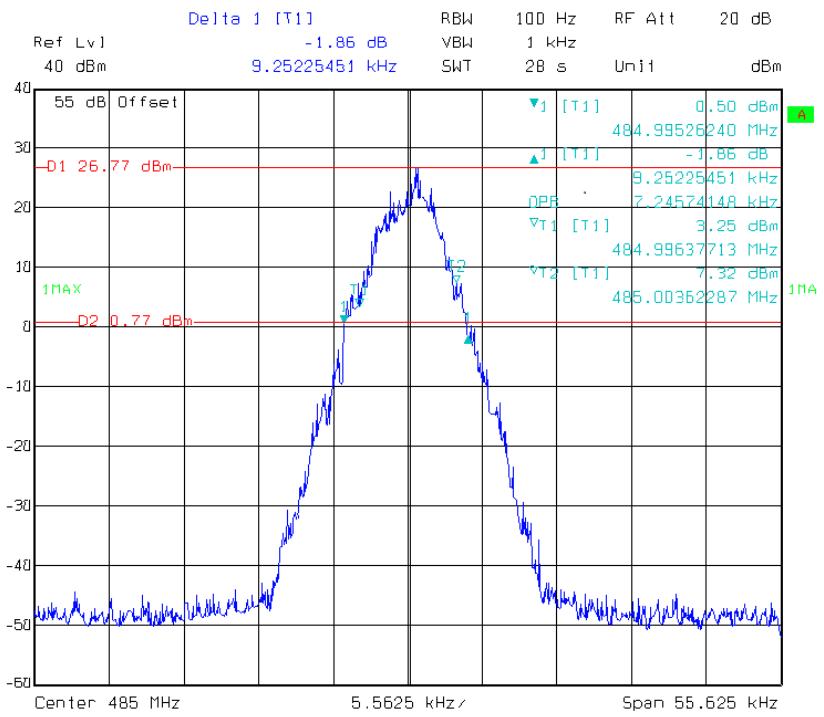
Date: 14.AUG.2015 17:19:41

## Emission Mask - Type D



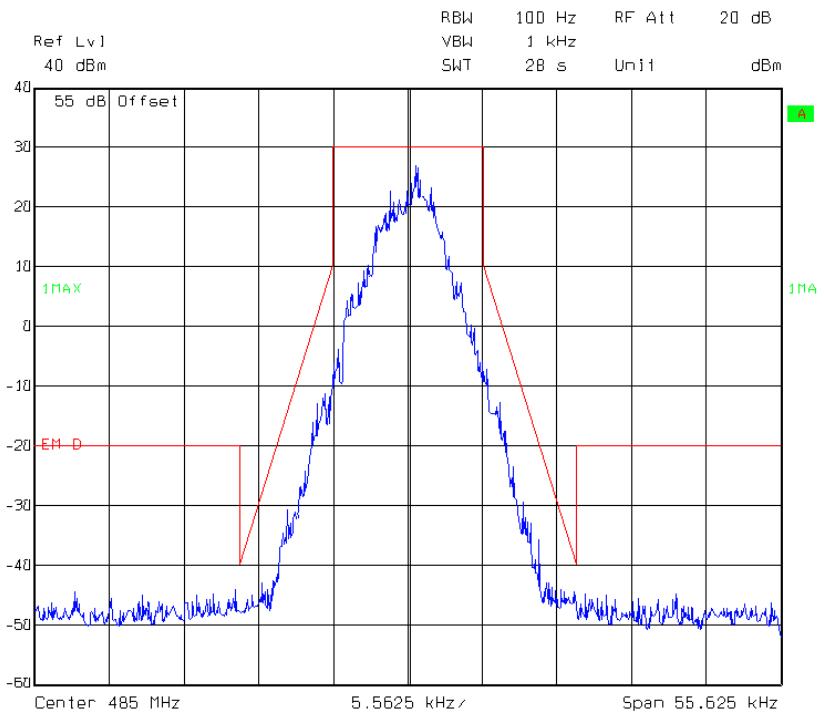
Date: 14.AUG.2015 17:20:15

## Occupied Bandwidth – 4FSK, 485 MHz, Low Power Level



Date: 16.SEP.2015 16:31:37

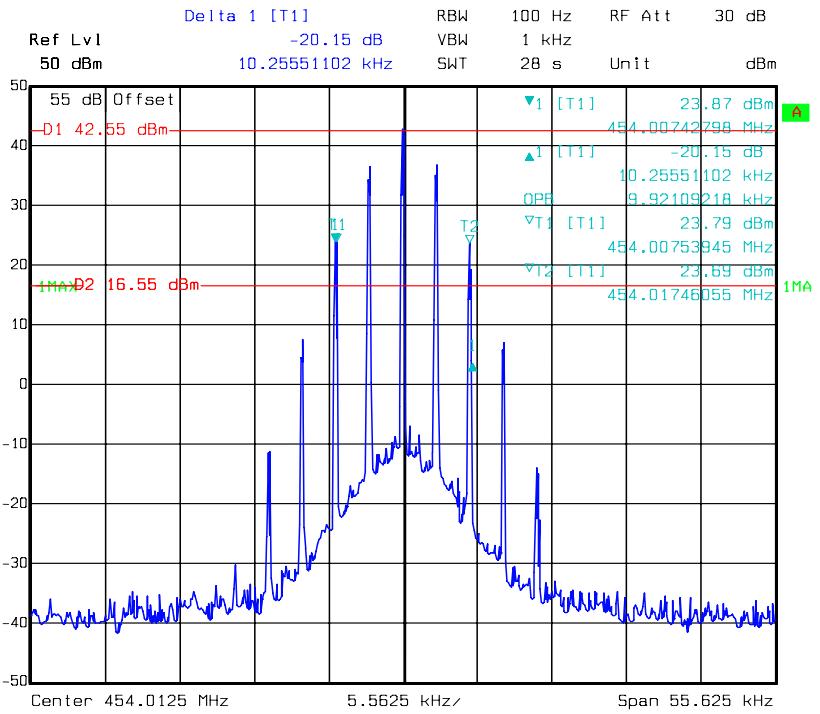
## Emission Mask - Type D



Date: 16.SEP.2015 16:32:10

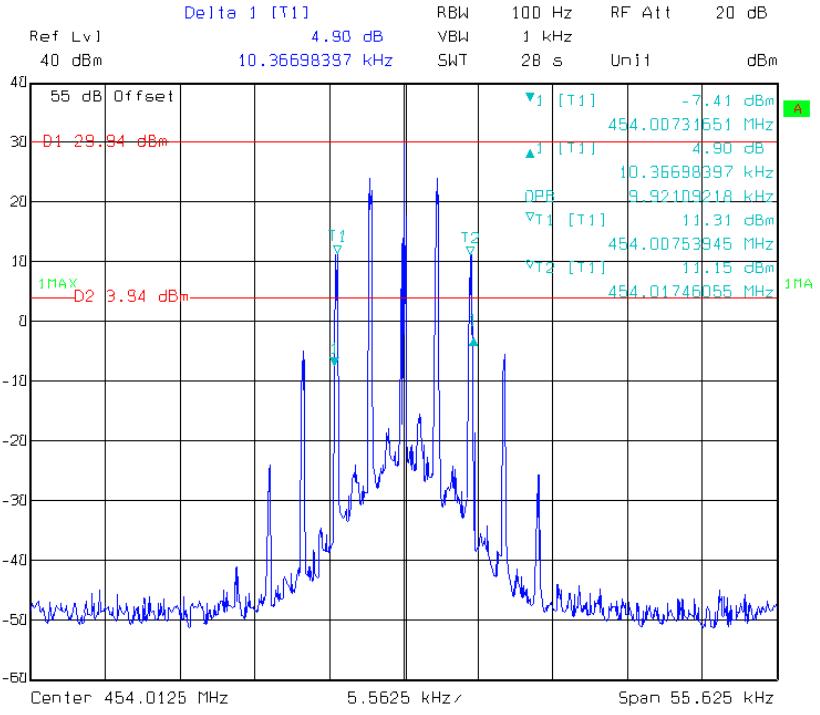
Part 22:

## Occupied Bandwidth – FM, 454.0125MHz, High Power Level

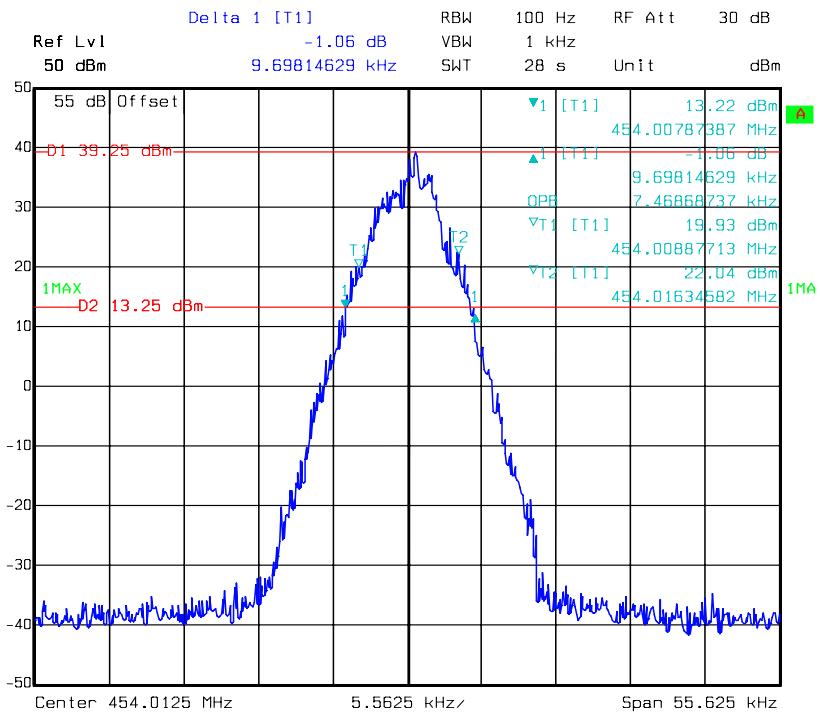


Date: 14.AUG.2015 18:29:39

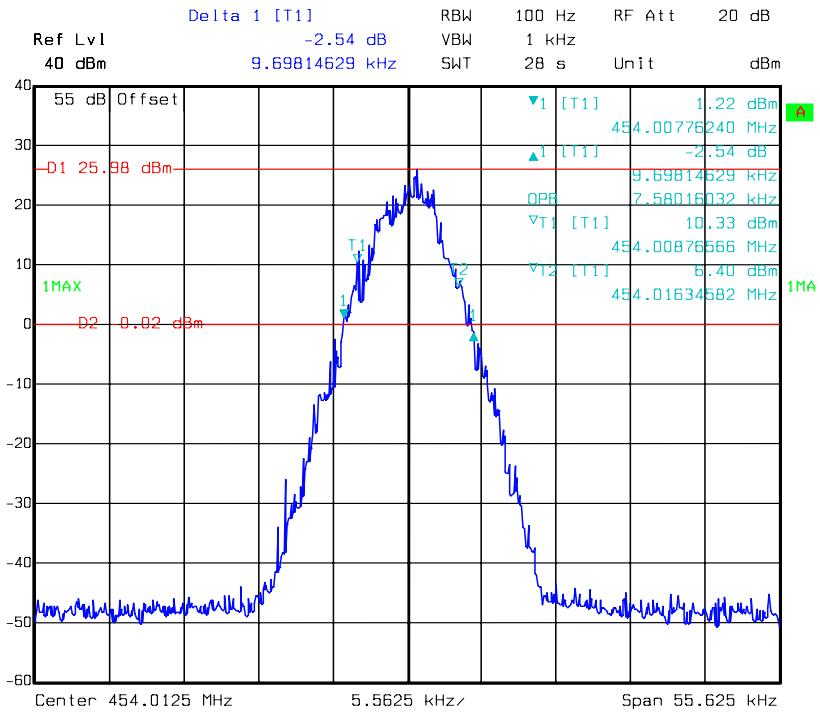
## Occupied Bandwidth – FM, 454.0125MHz, Low Power Level



Date: 16.SEP.2015 16:54:29

**Occupied Bandwidth -4FSK, 454.0125 MHz, High Power Level**

Date: 14.AUG.2015 16:59:22

**Occupied Bandwidth -4FSK, 454.0125 MHz, Low Power Level**

Date: 16.SEP.2015 16:27:58

## FCC §2.1051 & §22.861 & §90.210 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

### Applicable Standard

**Emission Mask D**—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel 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  $f_0$  to 5.625 kHz removed from  $f_0$ : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least  $7.27(f_d - 2.88 \text{ kHz})$  dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 12.5 kHz: At least  $50 + 10 \log (P)$  dB or 70 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 or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission 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 (o) 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, an alternate procedure may be used provided prior Commission approval is obtained.

§22.861 Emission limitations.

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least  $43 + 10 \log (P)$  dB.

### Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2015-05-09	2016-05-09
HP	RF Communications Test Set	8920A	00 235	2015-05-09	2016-05-09
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-08	2016-05-08
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06
Mini-Circuits	HIGH PASS FILTER	BHP-550+	YZU15801121	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-01	/	2015-05-06	2016-05-06

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

## Test Procedure

Adjust the spectrum analyzer for the following settings:

- 1) Resolution Bandwidth = 100 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1 GHz.
- 2) Video Bandwidth  $\geq 3$  times the resolution bandwidth.
- 3) Sweep Speed  $\leq 2000$  Hz per second.
- 4) Detector Mode = mean or average power.

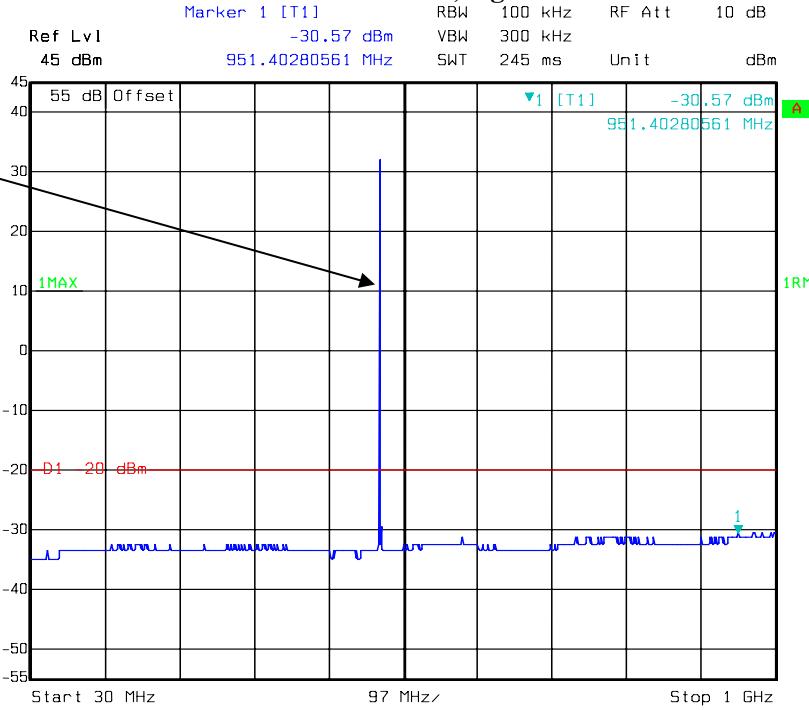
## Test Data

### Environmental Conditions

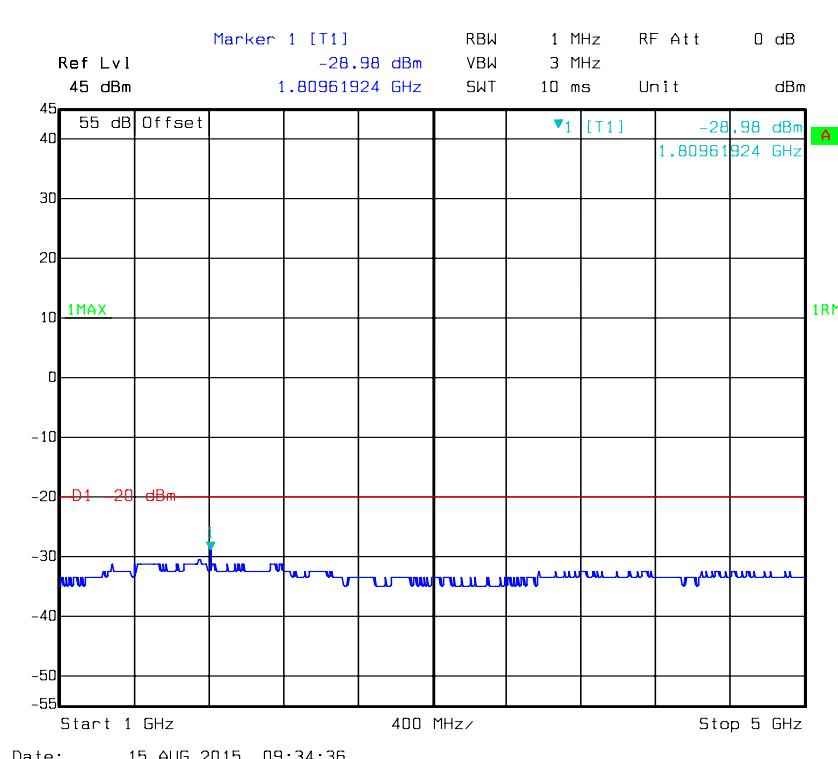
<b>Temperature:</b>	27.1 °C
<b>Relative Humidity:</b>	58 %
<b>ATM Pressure:</b>	100 kPa

*The testing was performed by Dean Liu on 2015-08-15.*

**FCC PART 90**  
**485MHz – FM Mode, High Power**



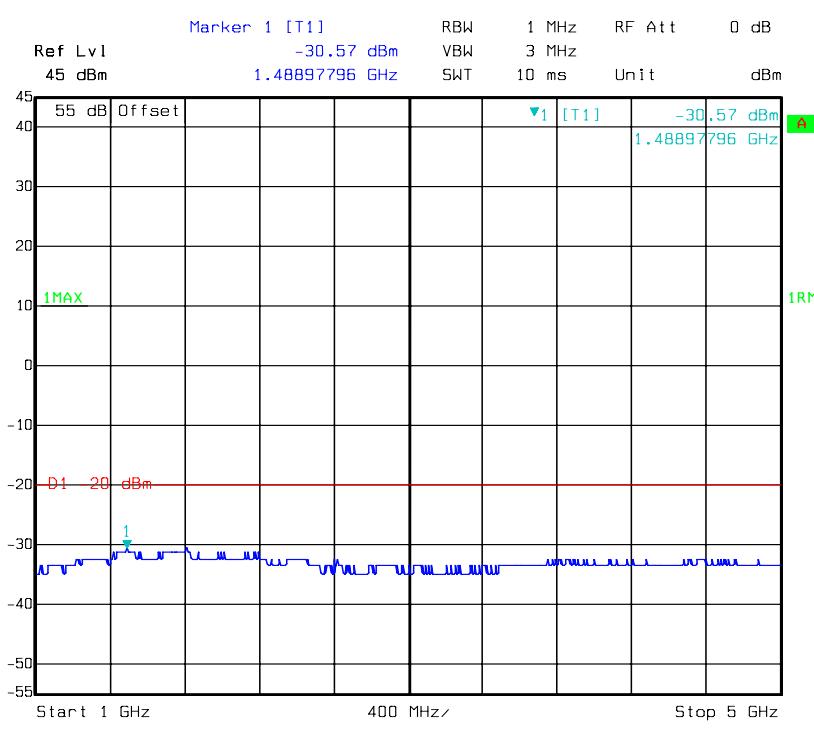
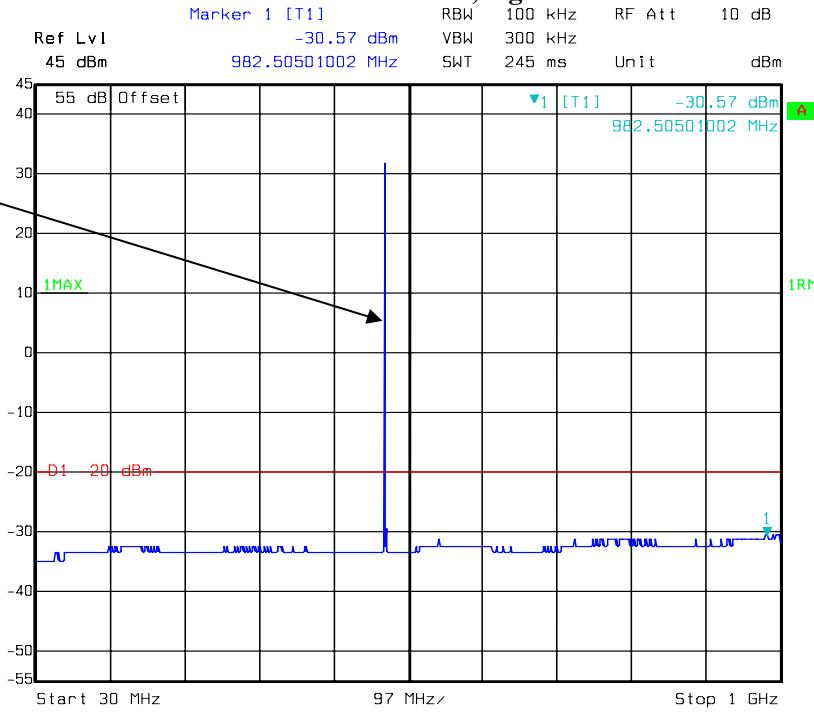
Fundamental test with Band Reject Filter



Date: 15.AUG.2015 09:29:23

Date: 15.AUG.2015 09:34:36

**FCC PART 90**  
**485 MHz -4FSK Mode,High Power**



**FCC PART 22**  
**454.0125 MHz -FM Mode,High Power**



Fundamental test  
with Band Reject  
Filter

Date: 15.AUG.2015 09:27:37



Date: 15.AUG.2015 09:32:57

**FCC PART 22**  
**454.0125 MHz -4FSK Mode,High Power**



Date: 15.AUG.2015 09:37:01



Date: 15.AUG.2015 09:39:01

## FCC §2.1053 & §22.861 & §90.210 - RADIATED SPURIOUS EMISSIONS

### Applicable Standard

FCC §2.1053 and §22.861 and §90.210

### Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
HP	Signal Generator	8648A	3426A00831	2014-11-06	2015-11-06
Sunol Sciences	Antenna	JB3	A060611-1	2012-09-06	2015-09-05
EMCO	Adjustable Dipole Antenna	3121C	9109-753	N/A	N/A
HP	Amplifier	8447E	2434A02181	2014-09-06	2015-09-06
R&S	EMI Test Receiver	ESCI	100224	2015-05-09	2016-05-09
Agilent	Signal Generator	E8247C	MY43321350	2013-10-15	2015-10-15
Mini-Circuit	Amplifier	ZVA-213-S+	054201245	2015-02-19	2016-02-19
TDK RF	Horn Antenna	HRN-0118	130 084	2012-09-06	2015-09-06
ETS LINDGREN	Horn Antenna	3115	000 527 35	2012-09-06	2015-09-06
R&S	Spectrum Analyzer	FSEM	DE31388	2015-05-09	2016-05-09
N/A	Coaxial Cable	14m	N/A	2015-05-06	2016-05-06
N/A	Coaxial Cable	8m	N/A	2015-05-06	2016-05-06
Mini-Circuits	HIGH PASS FILTER	BHP-550+	YZU15801121	2015-05-06	2016-05-06
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-06	2016-05-06
Weinschel Corp	Terminal Load(100W)	1440-3	MD447	/	/

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

### Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load, which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to teeth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

For part 90:

Spurious emissions in dB = $10 \log_{10} (\text{TXpwr in Watts}/0.001)$  - the absolute level

Spurious attenuation limit in dB = $50 + 10 \log_{10} (\text{power out in Watts})$  for EUT with a 12.5 kHz channel bandwidth.

For part 22:

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least  $43 + 10 \log (P)$  dB.

## Test Data

### Environmental Conditions

Temperature:	27.1°C
Relative Humidity:	58 %
ATM Pressure:	100 kPa

*The testing was performed by Dean Liu on 2015-08-25.*

*Test Mode: Transmitting (FM mode, high power level, powered from 13.6VDC)*

Frequency (MHz)	Polar (H/V)	Receiver Reading (dB $\mu$ V)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			S.G. Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
<b>Frequency: 485.000 MHz for FCC PART 90</b>								
1455.000	H	35.22	-65.9	9.3	1.3	-57.9	-20.0	37.9
1455.000	V	33.76	-67.4	9.3	1.3	-59.4	-20.0	39.4
1940.000	H	35.99	-62.8	11.9	1.4	-52.3	-20.0	32.3
1940.000	V	33.94	-64.0	11.9	1.4	-53.5	-20.0	33.5
970.000	H	38.41	-51.8	0.0	1.0	-52.8	-20.0	32.8
970.000	V	33.22	-58.5	0.0	1.0	-59.5	-20.0	39.5
<b>Frequency: 454.0125 MHz for FCC PART 22</b>								
1362.038	H	35.82	-64.5	8.7	1.4	-57.2	-13.0	44.2
1362.038	V	34.19	-66.1	8.7	1.4	-58.8	-13.0	45.8
1816.050	H	37.35	-62.7	11.2	1.3	-52.8	-13.0	39.8
1816.050	V	35.01	-65.3	11.2	1.3	-55.4	-13.0	42.4
908.025	H	39.93	-52.7	0.0	1	-53.7	-13.0	40.7
908.025	V	35.29	-59.3	0.0	1	-60.3	-13.0	47.3

*Test Mode: Transmitting (4FSK mode, high power level, powered from 13.6VDC)*

Frequency (MHz)	Polar (H/V)	Receiver Reading (dB $\mu$ V)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			S.G. Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
<b>Frequency: 485.000 MHz for FCC PART 90</b>								
1455.000	H	37.19	-63.9	9.3	1.3	-55.9	-20.0	35.9
1455.000	V	36.08	-65.1	9.3	1.3	-57.1	-20.0	37.1
1940.000	H	36.56	-62.3	11.9	1.4	-51.8	-20.0	31.8
1940.000	V	34.93	-63	11.9	1.4	-52.5	-20.0	32.5
970.000	H	37.69	-52.5	0.0	1.0	-53.5	-20.0	33.5
970.000	V	34.31	-57.4	0.0	1.0	-58.4	-20.0	38.4
<b>Frequency: 454.0125 MHz for FCC PART 22</b>								
1362.038	H	36.64	-63.7	8.7	1.4	-56.4	-13.0	43.4
1362.038	V	34.30	-66	8.7	1.4	-58.7	-13.0	45.7
1816.050	H	37.32	-62.7	11.2	1.3	-52.8	-13.0	39.8
1816.050	V	35.38	-64.9	11.2	1.3	-55.0	-13.0	42.0
908.025	H	38.30	-54.3	0.0	1	-55.3	-13.0	42.3
908.025	V	33.49	-61.1	0.0	1	-62.1	-13.0	49.1

*Test Mode: Transmitting (FM mode, high power level, powered from AC/DC Adapter)*

Frequency (MHz)	Polar (H/V)	Receiver Reading (dB $\mu$ V)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			S.G. Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
<b>Frequency: 485.000 MHz for FCC PART 90</b>								
1455.000	H	34.85	-66.3	9.3	1.3	-58.3	-20.0	38.3
1455.000	V	33.40	-67.8	9.3	1.3	-59.8	-20.0	39.8
1940.000	H	36.12	-62.7	11.9	1.4	-52.2	-20.0	32.2
1940.000	V	33.74	-64.2	11.9	1.4	-53.7	-20.0	33.7
970.000	H	37.96	-52.3	0.0	1.0	-53.3	-20.0	33.3
970.000	V	33.34	-58.4	0.0	1.0	-59.4	-20.0	39.4
<b>Frequency: 454.0125 MHz for FCC PART 22</b>								
1362.038	H	35.65	-64.7	8.7	1.4	-57.4	-13.0	44.4
1362.038	V	34.62	-65.7	8.7	1.4	-58.4	-13.0	45.4
1816.050	H	36.81	-63.2	11.2	1.3	-53.3	-13.0	40.3
1816.050	V	34.57	-65.7	11.2	1.3	-55.8	-13.0	42.8
908.025	H	40.15	-52.5	0.0	1.0	-53.5	-13.0	40.5
908.025	V	35.11	-59.5	0.0	1.0	-60.5	-13.0	47.5

*Test Mode: Transmitting (4FSK mode, high power level, powered from AC/DC Adapter)*

Frequency (MHz)	Polar (H/V)	Receiver Reading (dB $\mu$ V)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			S.G. Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
<b>Frequency: 485.000 MHz for FCC PART 90</b>								
1455.000	H	36.65	-64.5	9.3	1.3	-56.5	-20.0	36.5
1455.000	V	35.99	-65.2	9.3	1.3	-57.2	-20.0	37.2
1940.000	H	36.41	-62.4	11.9	1.4	-51.9	-20.0	31.9
1940.000	V	35.37	-62.6	11.9	1.4	-52.1	-20.0	32.1
970.000	H	37.58	-52.6	0.0	1.0	-53.6	-20.0	33.6
970.000	V	34.79	-56.9	0.0	1.0	-57.9	-20.0	37.9
<b>Frequency: 454.0125 MHz for FCC PART 22</b>								
1362.038	H	36.73	-63.6	8.7	1.4	-56.3	-13.0	43.3
1362.038	V	34.06	-66.3	8.7	1.4	-59.0	-13.0	46.0
1816.050	H	36.70	-63.3	11.2	1.3	-53.4	-13.0	40.4
1816.050	V	35.40	-64.9	11.2	1.3	-55.0	-13.0	42.0
908.025	H	37.67	-55	0.0	1.0	-56.0	-13.0	43.0
908.025	V	33.34	-61.2	0.0	1.0	-62.2	-13.0	49.2

**Note:**

- 1) The unit of Antenna Gain is dBd for frequency below 1GHz, and the unit of Antenna Gain is dBi for frequency above 1GHz.
- 2) Absolute Level = SG Level - Cable loss + Antenna Gain
- 3) Margin = Limit-Absolute Level

## FCC §2.1055 & § 22.355 & §90.213- FREQUENCY STABILITY

### Applicable Standard

FCC §2.1055, § 22.355, §90.213

### Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSP 38	100478	2015-05-09	2016-05-09
Dongzhixu	High Temperature Test Chamber	DP1000	201105083-4	2015-08-11	2016-08-11
UNI-T	Multimeter	UT39A	M130199938	2015-04-10	2016-04-10
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-06	2016-05-06
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-01	/	2015-05-06	2016-05-06

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

### Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The power leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

The frequency stability shall be measured with variation of primary supply voltage as follows:

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value.
- (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

### Test Data

#### Environmental Conditions

<b>Temperature:</b>	27.1 °C
<b>Relative Humidity:</b>	58 %
<b>ATM Pressure:</b>	100kPa

*The testing was performed by Dean Liu on 2015-08-25*

Note: The EUT may be used in a base station or a mobile station configuration, the strict limits were applied.

*Test Mode: Transmitting*

FCC PART 90

Reference Frequency: 485 MHz, Limit: 1.5 ppm			
Temerature	Voltage	Reading	Frequency Error
°C	V <sub>DC</sub>	MHz	ppm
-30	13.6	484.9995	-1.03
-20	13.6	484.9997	-0.62
-10	13.6	484.9995	-1.03
0	13.6	484.9996	-0.82
10	13.6	484.9997	-0.62
20	13.6	484.9996	-0.82
30	13.6	484.9999	-0.21
40	13.6	484.9998	-0.41
50	13.6	484.9996	-0.82
25	10.8	484.9996	-0.82
	15.6	484.9997	-0.62

Reference Frequency: 485 MHz, Limit: 1.5 ppm			
Temerature	Voltage	Reading	Frequency Error
°C	V <sub>AC</sub>	MHz	ppm
-30	120	484.9997	-0.62
-20	120	484.9996	-0.82
-10	120	484.9997	-0.62
0	120	484.9995	-1.03
10	120	484.9998	-0.41
20	120	484.9996	-0.82
30	120	484.9997	-0.62
40	120	484.9999	-0.21
50	120	484.9997	-0.62
25	102	484.9998	-0.41
	138	484.9995	-1.03

## FCC PART 22

Reference Frequency:454.0125 MHz, Limit: 2.5 ppm			
Temerature	Voltage	Reading	Frequency Error
°C	V <sub>DC</sub>	MHz	ppm
-30	13.6	454.0122	-0.66
-20	13.6	454.0121	-0.88
-10	13.6	454.0123	-0.44
0	13.6	454.0122	-0.66
10	13.6	454.0120	-1.10
20	13.6	454.0124	-0.22
30	13.6	454.0124	-0.22
40	13.6	454.0123	-0.44
50	13.6	454.0121	-0.88
25	10.8	454.0123	-0.44
	15.6	454.0122	-0.66

Reference Frequency:454.0125 MHz, Limit: 2.5 ppm			
Temerature	Voltage	Reading	Frequency Error
°C	V <sub>AC</sub>	MHz	ppm
-30	120	454.0124	-0.22
-20	120	454.0121	-0.88
-10	120	454.0126	0.22
0	120	454.0124	-0.22
10	120	454.0122	-0.66
20	120	454.0123	-0.44
30	120	454.0122	-0.66
40	120	454.0127	0.44
50	120	454.0124	-0.22
25	102	454.0126	0.22
	138	454.0123	-0.44

## FCC §90.214 - TRANSIENT FREQUENCY BEHAVIOR

### Applicable Standard

Regulations: FCC §90.214

Test method: ANSI/TIA-603-D 2010, section 2.2.19.3

### Test Equipment List and Details

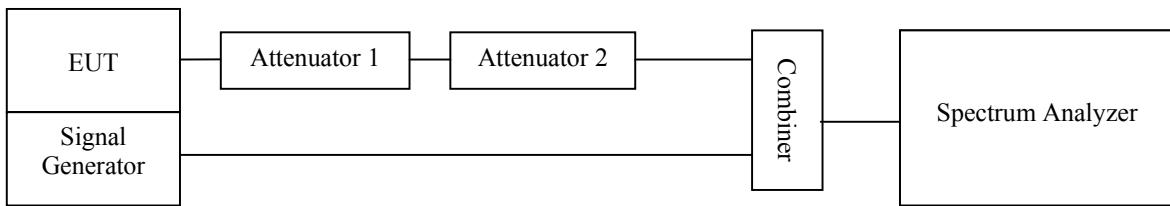
Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSEM	DE31388	2015-05-09	2016-05-09
HP	Signal Generator	8648A	3426A00831	2014-11-06	2015-11-06
AA-MCS	Attenuator(40dB)	CAT-50-40-200-Nm-Nf	0602-010	2015-05-06	2016-05-06
E-Microwave	DC Blocking	EMDCB-00036	0E01201047	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-01	/	2015-05-06	2016-05-06
Pasternack	RF Coaxial Cable	RF-02	/	2015-05-06	2016-05-06

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

### Test Procedure

- a) Connect the EUT and test equipment as shown on the following block diagram.
- b) Set the Spectrum Analyzer to measure FM deviation, and tune the RF frequency to the transmitter assigned frequency.
- c) Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at  $\pm 12.5$  kHz deviation and set its output level to -100dBm.
- d) Turn on the transmitter.
- e) Supply sufficient attenuation via the RF attenuator to provide an input level to the Spectrum Analyzer that is 40 dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on the Spectrum Analyzer as  $P_0$ .
- f) Turn off the transmitter.
- g) Adjust the RF level of the signal generator to provide RF power equal to  $P_0$ . This signal generator RF level shall be maintained throughout the rest of the measurement.
- h) Remove the attenuation 1, so the input power to the Spectrum Analyzer is increased by 30 dB when the transmitter is turned on.
- i) Adjust the vertical amplitude control of the spectrum analyzer to display the 1000 Hz at  $\pm 4$  divisions vertically centered on the display. Set trigger mode of the Spectrum Analyzer to "Video", and tune the "trigger level" on suitable level. Then set the "tiger offset" to -10ms for turn on and -15ms for turn off.
- j) Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 kHz test signal is completely suppressed is considered to be  $t_{on}$ . The trace should be maintained within the allowed divisions during the period  $t_1$  and  $t_2$ .

k) Then turn off the transmitter, and another transient wave will be captured on the screen of Spectrum Analyzer. The trace should be maintained within the allowed divisions during the period  $t_3$ .



## Test Data

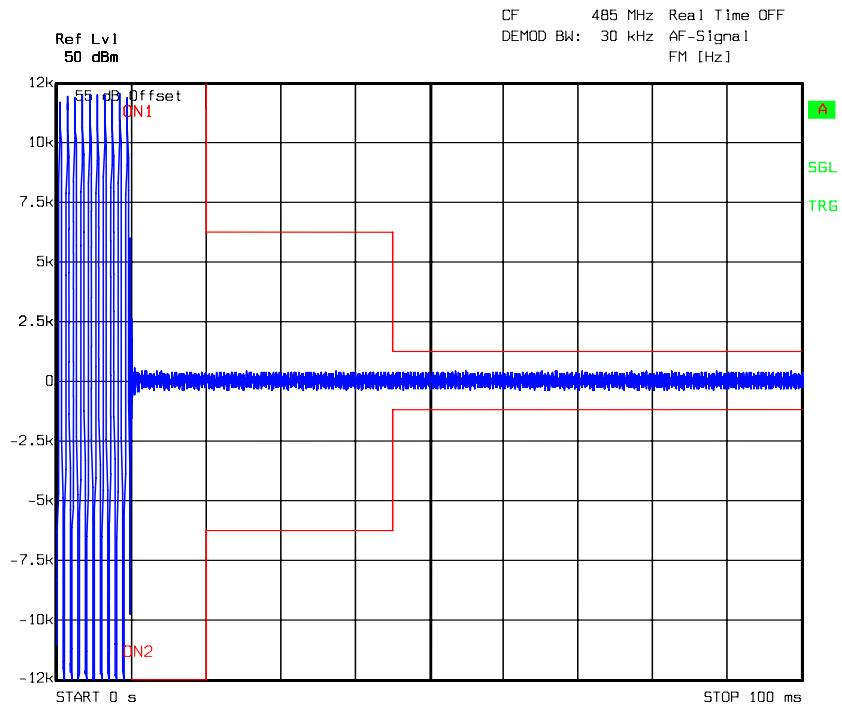
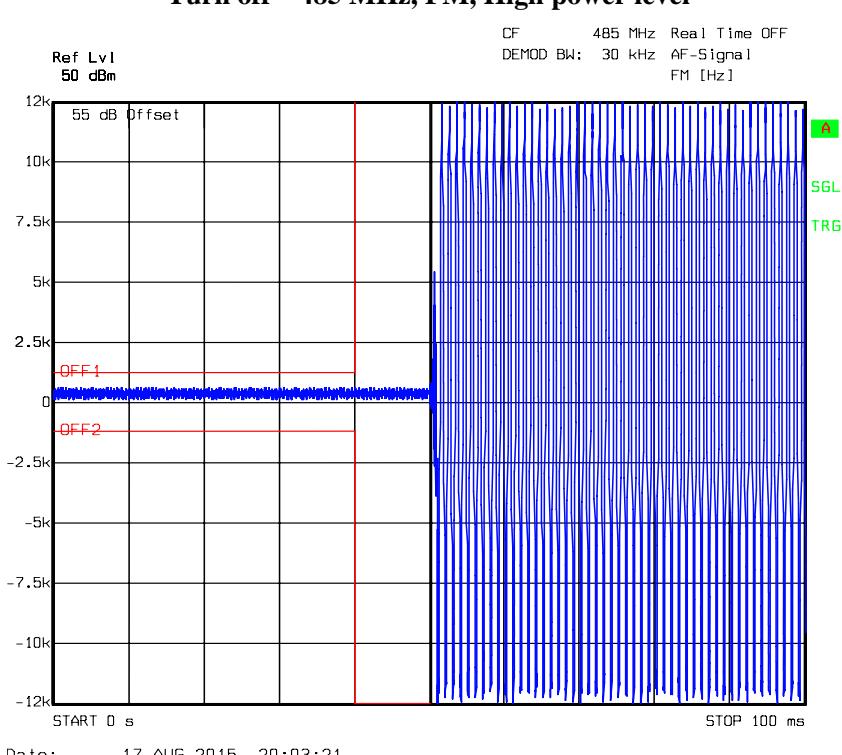
### Environmental Conditions

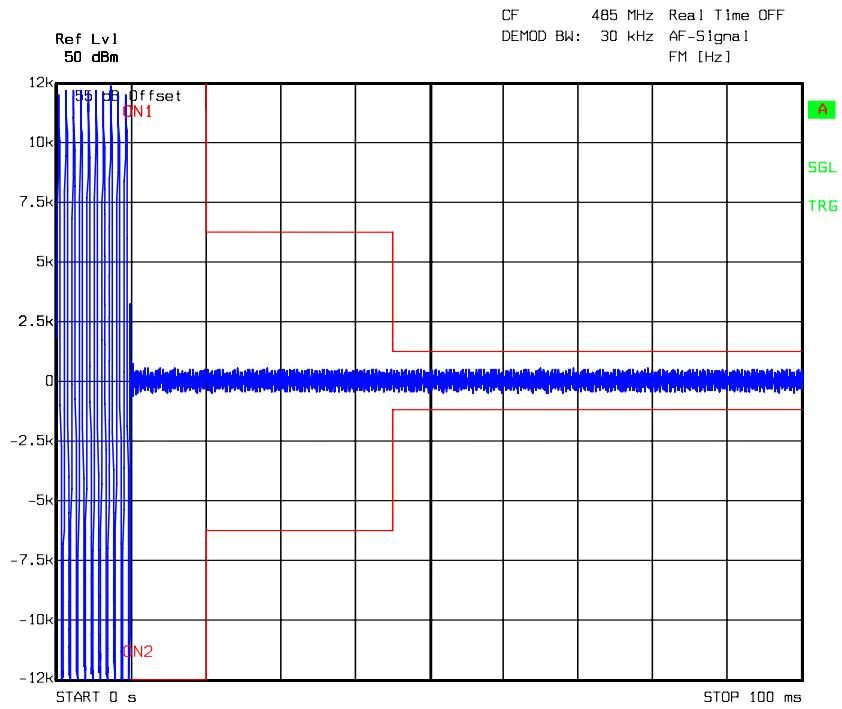
Temperature:	27.1 °C
Relative Humidity:	58 %
ATM Pressure:	100 kPa

The testing was performed by Dean Liu on 2015-08-25 and 2015-11-04.

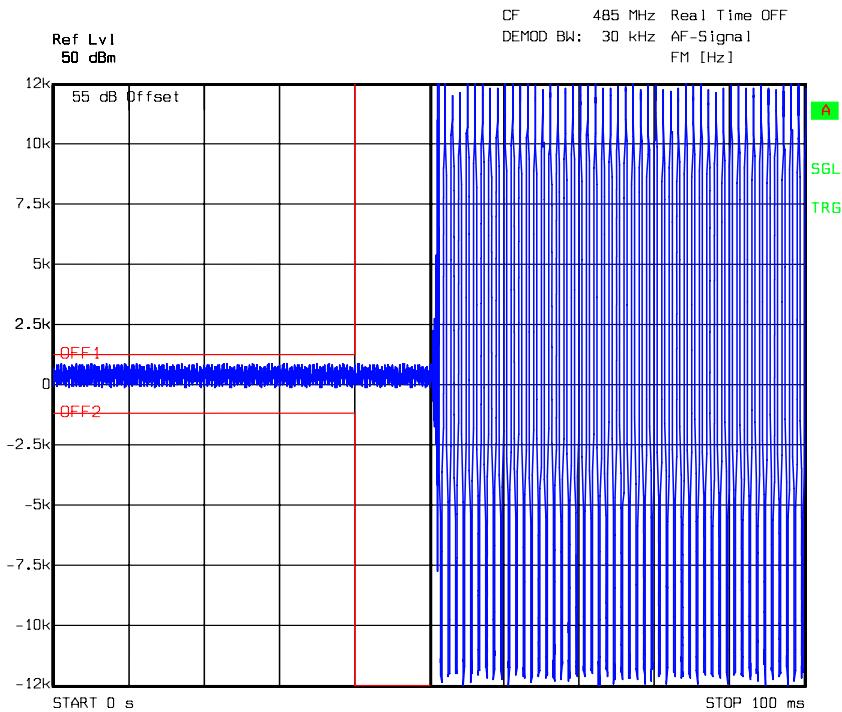
Channel Spacing (kHz)	Transient Period (ms)	Maximum frequency difference	Result
12.5	<10( $t_1$ )	± 12.5 kHz	Pass
	<25( $t_2$ )	± 6.25 kHz	
	<10 ( $t_3$ )	± 12.5 kHz	

Please refer to the following plots.

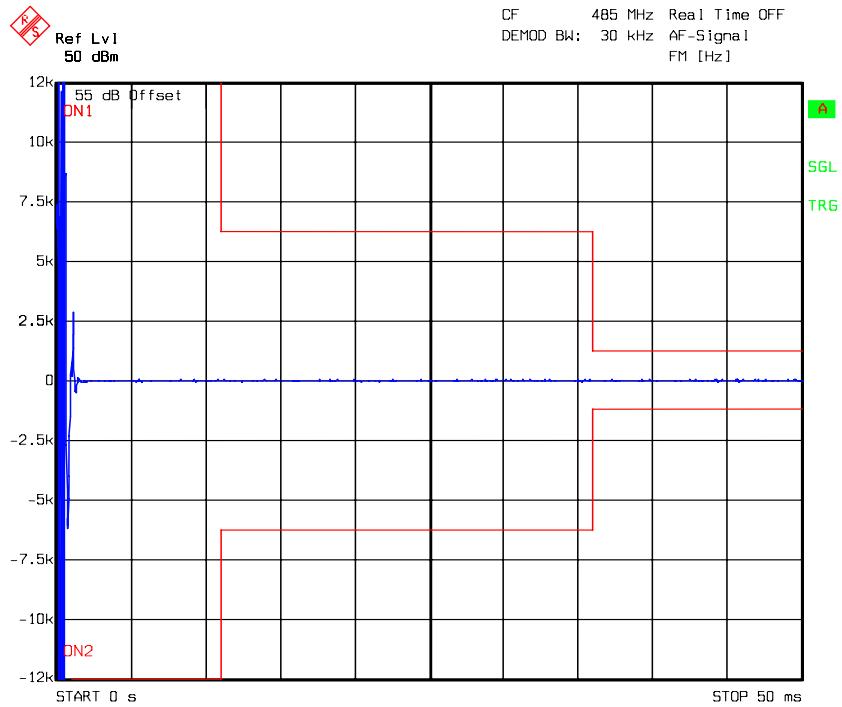
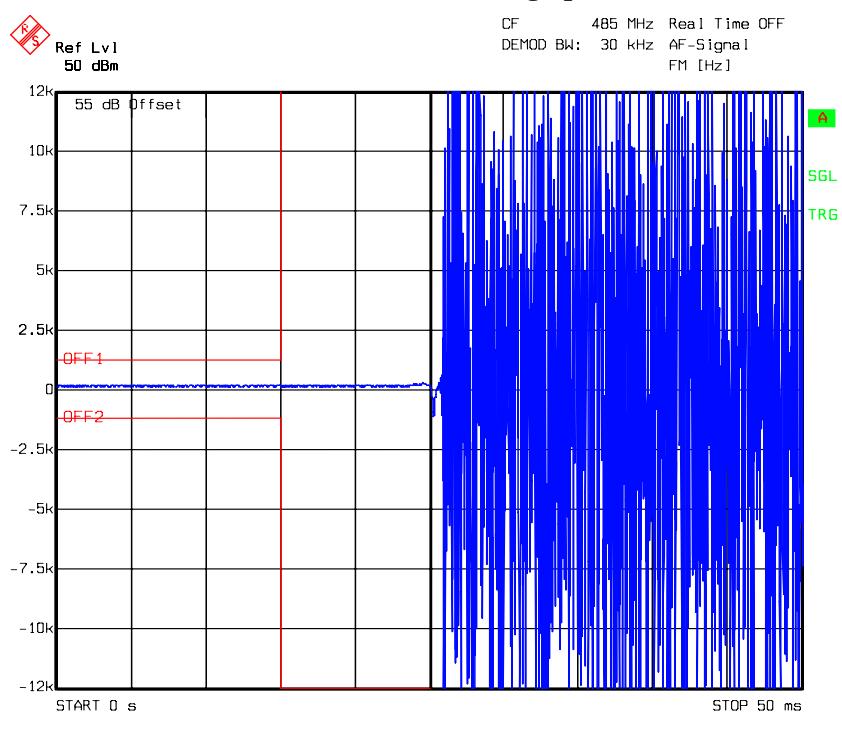
**Turn on – 485 MHz, FM, High power level****Turn off – 485 MHz, FM, High power level**

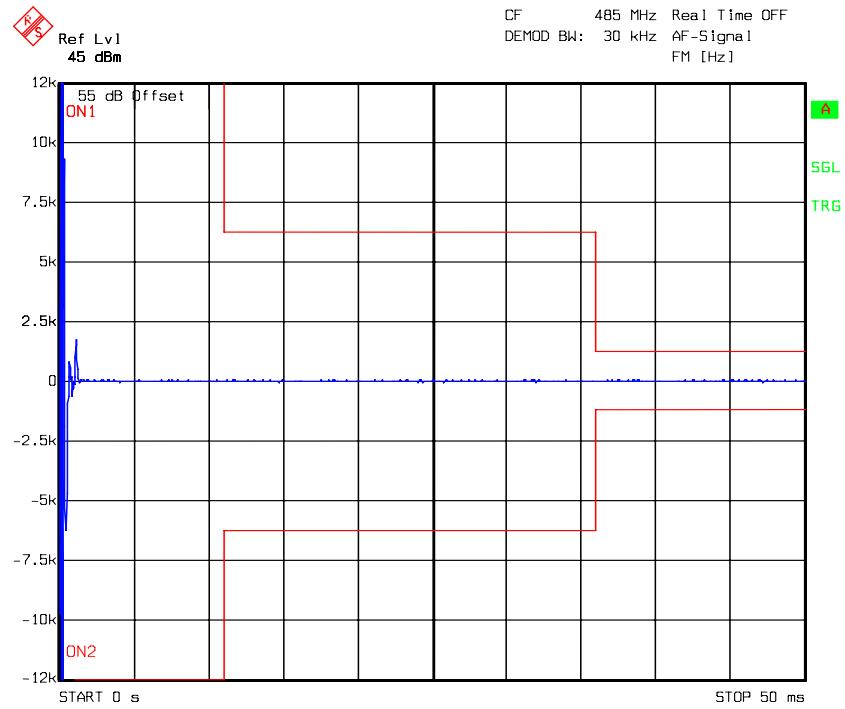
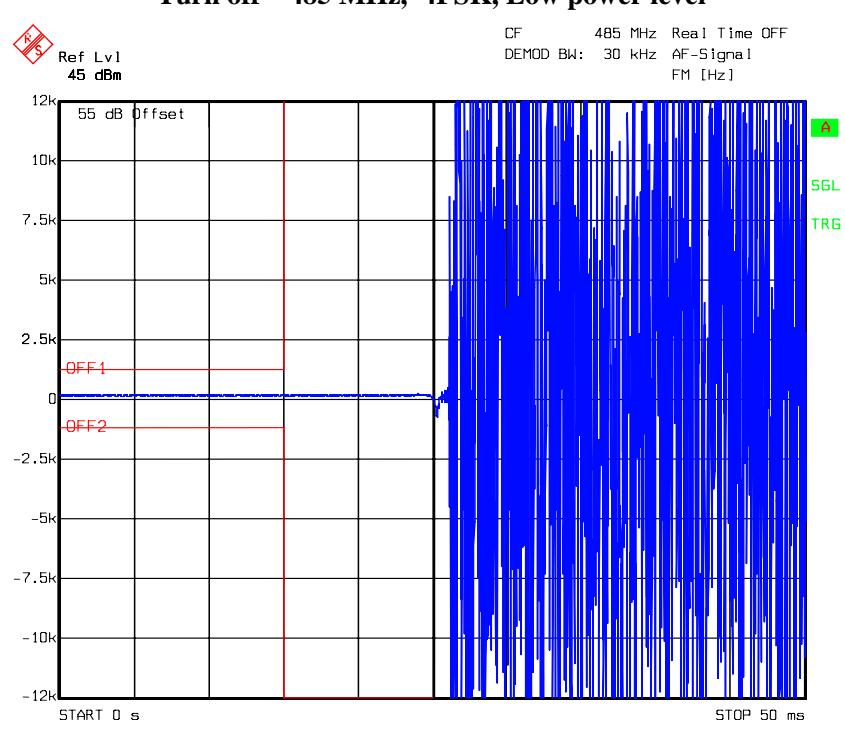
**Turn on – 485 MHz, FM, Low power level**

Date: 17.AUG.2015 19:58:46

**Turn off – 485 MHz, FM, Low power level**

Date: 17.AUG.2015 20:03:50

**Turn on – 485 MHz, 4FSK, High power level****Turn off – 485 MHz, 4FSK, High power level**

**Turn on – 485 MHz, 4FSK, Low power level****Turn off – 485 MHz, 4FSK, Low power level**

\*\*\*\*\* END OF REPORT \*\*\*\*\*