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FCC PART 90
AND IC RSS-119, RSS-GEN
TEST REPORT

APPLICANT	DAMM CELLULAR SYSTEMS A/S
	MOLLEGADE 68 6400 SONDERBORG
FCC ID	Z5W-104013
IC CERTIFICATION	10159A-104013
MODEL NUMBER	TR412 Transceiver 450-460/ 460-470 MHz
PRODUCT DESCRIPTION	TX Module
DATE SAMPLE RECEIVED	1/25/2012
DATE TESTED	1/26/2012
TESTED BY	Joe Scoglio
APPROVED BY	Mario R. de Aranzeta
TIMCO REPORT NO.	213AT12TestReport.doc
TEST RESULTS	☒ PASS ☐ FAIL

ACCREDITED

Testing Certificate #0955-01

TABLE OF CONTENTS

GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

The test results relate only to the items tested.

Summary

The device under test does:
☒ fulfill the general approval requirements as identified in this test report
☐ not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025: 2005 requirements.

Testing Certificate # 0955-01

I attest that the necessary measurements were made, under my supervision, at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, Fl 32669

Authorized Signatory Name:

Mario de Aranzeta C.E.T.
Compliance Engineer/ Lab. Supervisor

Date: 01/26/2012

GENERAL INFORMATION
DUT Specification

DUT Description	TX module
FCC ID	Z5W-104013
IC Certification	10159A-104013
Model Number	TR412 Transceiver 450-460/460-470 MHz
Serial Number	N/A
Operating Frequency	TX: 450 – 460 - 470 MHz
Test Frequencies	460, 465, and 470 MHz
Type of Emission	0.35 TETRA and 0.20 modified TETRA
	21K0D1W 20K0D1W
Modulation	π/4DQPSK
DUT Power Source	☒ 110–120Vac/50– 60Hz
	☐ DC Power 12V
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☒ Pre-Production
	☐ Production
Type of Equipment	☒ Fixed
	☐ Mobile
	☐ Portable
Test Conditions	The temperature was 26°C with a relative humidity of 50%.
Modification to the DUT	None
Test Exercise	The DUT was placed in continuous transmit mode.
Applicable Standards	ANSI/TIA 603-C:2004, FCC CFR 47 Part 90, IC RSS-119, RSS-GEN
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA.

GENERAL INFORMATION (cont'd)
DUT Specification

The system as tested consists of the transceiver module combined with a power supply module, CPU module, and broadband filter assembly. This is combined in a single 19inch rack assembly. The unit is detailed in the user's manual.

GENERAL INFORMATION (cont'd)
DUT Specification

TR-412 Transceiver

TEST PROCEDURES

Power Line Conducted Interference: The procedure used was ANSI/TIA 603-C: 2004 using a 50uH LISN. Both lines were observed with the DUT transmitting. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

Bandwidth 20 dB: The measurements were made with the spectrum analyzer's resolution bandwidth (RBW) = 1 MHz and the video bandwidth (VBW) = 3 MHz and the span set as shown on plot.

Power Output: The RF power output was measured at the antenna feed point using a peak power meter.

Antenna Conducted Emissions: The RBW = 100 kHz, VBW = 300 kHz and the span set to 10 MHz and the spectrum was scanned from 30 MHz to the 10^{th} harmonic of the fundamental. Above 1 GHz the resolution bandwidth was 1 MHz and the VBW = 3 MHz
and the span to 50 MHz.

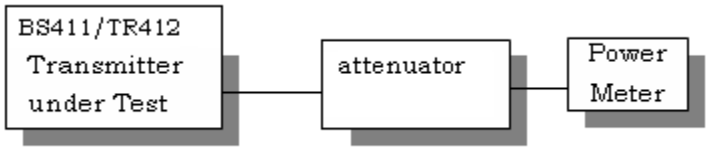
Radiation Interference: The test procedure used was ANSI/TIA 603-C: 2004 using an Agilent spectrum receiver with pre-selector. The bandwidth (RBW) of the spectrum receiver was 100 kHz up to 1 GHz and 1 MHz above 1 GHz with an appropriate sweep speed. The VBW above 1 GHz was 3 MHz. The analyzer was calibrated in dB above a micro volt at the output of the antenna.

RF POWER OUTPUT

Rule Part No.: FCC Part 2.1046(a), IC RSS-119 4.1 and 5.4, RSS-GEN 4.8

Method of Measurement: RF power is measured by connecting a 50-ohm, resistive wattmeter through an attenuator to the RF output connector. The transmitter was properly adjusted for the maximum power output available and the minimum power available and the RF output measures:

Test Setup Diagram:



Test Data:

OUTPUT POWER: TR412 transceiver module

Frequency	High	Low
mode	0.20/ 0.35 TETRA	0.20/ 0.35 TETRA
460	25.0/ 25.0	1.0/ 1.0
465	25.0/ 24.9	1.0/ 1.0
470	24.8/ 24.8	1.0/ 1.0

The output power is continuously variable by software selection.

Part 2.1033 (C)(8) DC Input into the final amplifier

HIGH POWER SETTING INPUT POWER: (26 V)*(3 A) = 78 Watts

	High	Low
mode	0.20/ 0.35 TETRA	0.20/ 0.35 TETRA
Volts	Amps	Amps
26	3/ 3	1.7/1.6

MODULATION CHARACTERISTICS

Part 2.1033(c)
Part 2.1033(c) (4) Type of Emission:

Type of Emission: π/4DQPSK TETRA as defined in EN 300 392-2.
TETRA is a digital, trunked radio technology that operates with Time Division Multiple Access (TDMA) in four-slot channels within a twenty-five kilohertz bandwidth.

This unit has two distinct and different but similar modulation schemes. One being as defined above and the second mode which is similar and implemented through a software change only where:
Description of the modified modulation:

From ETSI EN 300 392-2 part 5.5 the requirement for the output spectrum of a TETRA signal G(f) is:

$$G(f) = 1 \quad \text{for} \quad |f| \le (1-\alpha)/2T$$

$$G(f) = \sqrt{0.5\left(1 - \sin\left(\pi\left(2|f|T - 1\right)/2\alpha\right)\right)} \quad \text{for} \quad (1-\alpha)/2T \le |f| \le (1+\alpha)/2T$$

$$G(f) = 0 \quad \text{for} \quad |f| \ge (1+\alpha)/2T$$

Where α is the roll-off factor, which determines the width of the transmission band at a given symbol rate. For TETRA the value of α shall be 0.35.

This spectrum can't fulfill the requirement of the FCC. Therefore the shape of the output spectrum has been modified by changing *a* from 0.35 to 0.20. This gives a narrowed spectrum that meets the FCC requirements for the 20 kHz bandwidth.

The TETRA and modified modulation meets the spectrum efficiency requirements of Part 90.

AUDIO FREQUENCY RESPONSE

Rule Part No.: FCC Part 2.1047(a)(b), IC RSS-119 5.2

Test Requirements:

Method of Measurement:

The audio frequency response was measured in accordance with ANSI/TIA 603-C: 2004. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 – 5000Hz shall be submitted. The audio frequency response curve is shown below.

AUDIO FREQUENCY RESPONSE PLOT

Digitally encoded voice

AUDIO LOW PASS FILTER

VOICE MODULATED COMMUNICATION EQUIPMENT

Part 2.1047(a) Voice modulated communication equipment: For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all the circuitry installed between the modulation limiter and the modulated stage shall be submitted.

AUDIO LOW PASS FILTER

Digitally encoded voice

AUDIO INPUT VERSUS MODULATION

Rule Part No.: FCC Part 2.1047(b) & 90, IC RSS-119 5.2

Test Requirements:

Method of Measurement: **Modulation cannot exceed 100%,** The audio input level needed for a particular percentage of modulation was measured in accordance with ANSI/TIA 603-C: 2004. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 2500 Hz.

Test data:

Modulation Limiting Plot

N/A

Digitally encoded voice

OCCUPIED BANDWIDTH

FCC Part 2.1049(c), RSS-GEN 4.6 EMISSION BANDWIDTH
FCC Part 90.210(b) RSS-119 4.2 25 kHz Channel Spacing

Data in the plots show that on any frequency removed from the assigned frequency by more than 50%, but not more than 100%: At least 25dB. On any frequency removed from the assigned frequency by more than 100%, but not more than 250%: At least 35 dB. On any frequency removed from the assigned frequency by more than 250%, of the authorized bandwidth: At least 43 + 10log(P)dB.

Part 90.210(c) 25 kHz Channel Spacing Not Equipped with a Low Pass Filter

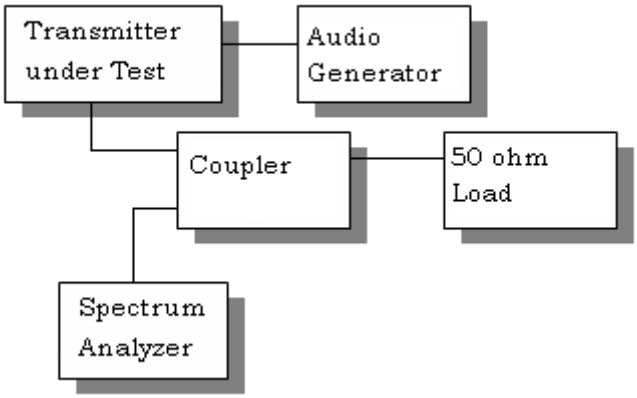
For transmitters that are not equipped with an audio low pass filter pursuant to S90.211 (b), the power of any emission must be attenuated below the un-modulated carrier output power as follows; (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz but not more than10 kHz: At least 83 log (fd/5) dB; (2) ON any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250% of the authorized bandwidth: At least 29 log(fd2/11)dB or 50 dB, whichever is the lesser attenuation; (3) On any frequency removed from the center of the authorized bandwidth by more than 250% of the authorized bandwidth: At least 43+10 log(Po)dB.

OCCUPIED BANDWIDTH MEASUREMENT

Test procedure: ANSI/TIA-603-C: 2004 paragraph 2.2.11.

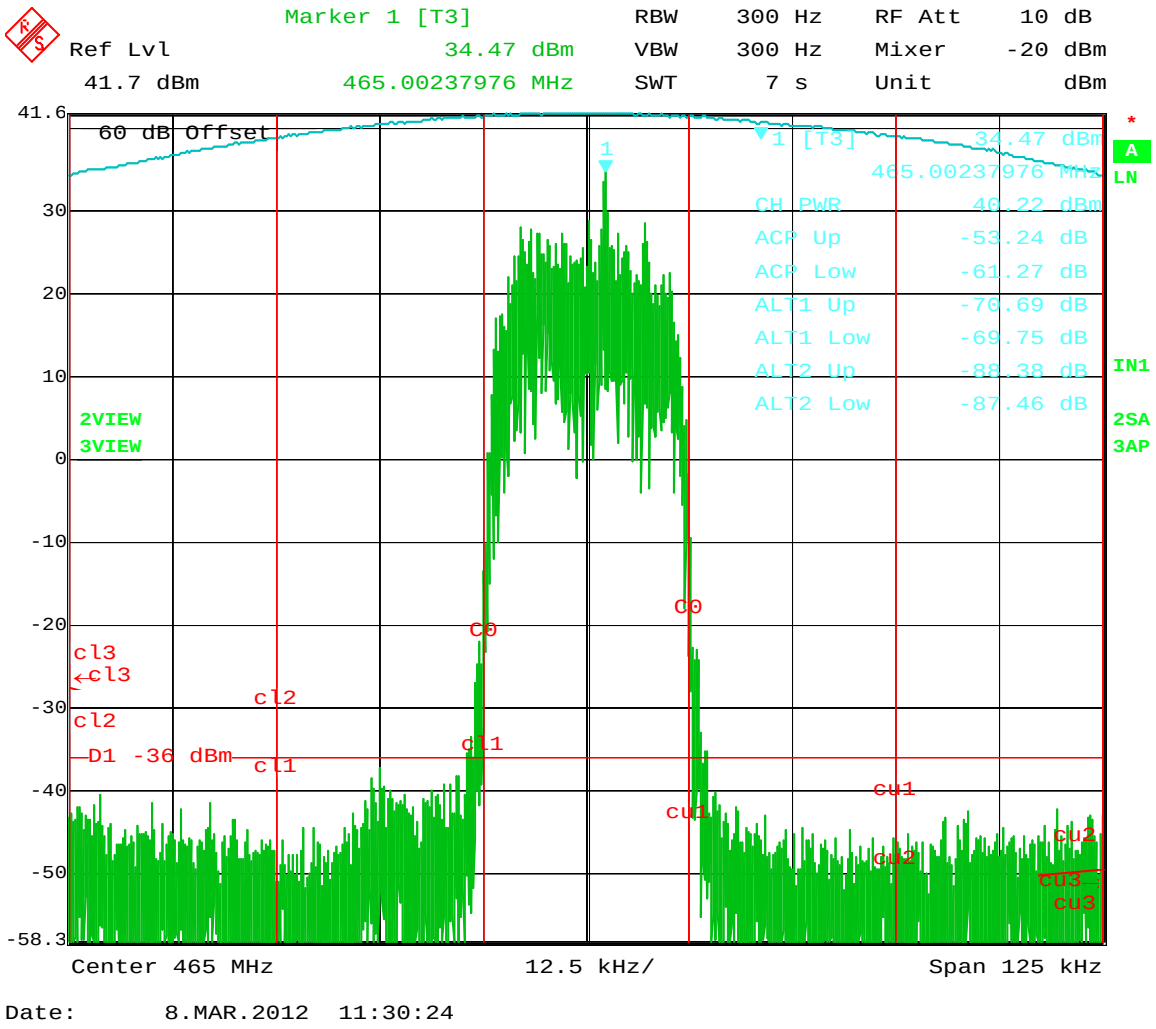
Test Setup Diagram:

OCCUPIED BANDWIDTH MEASUREMENT



Test Data: See the plots below
Three places in the band were measured and the worst case presented.

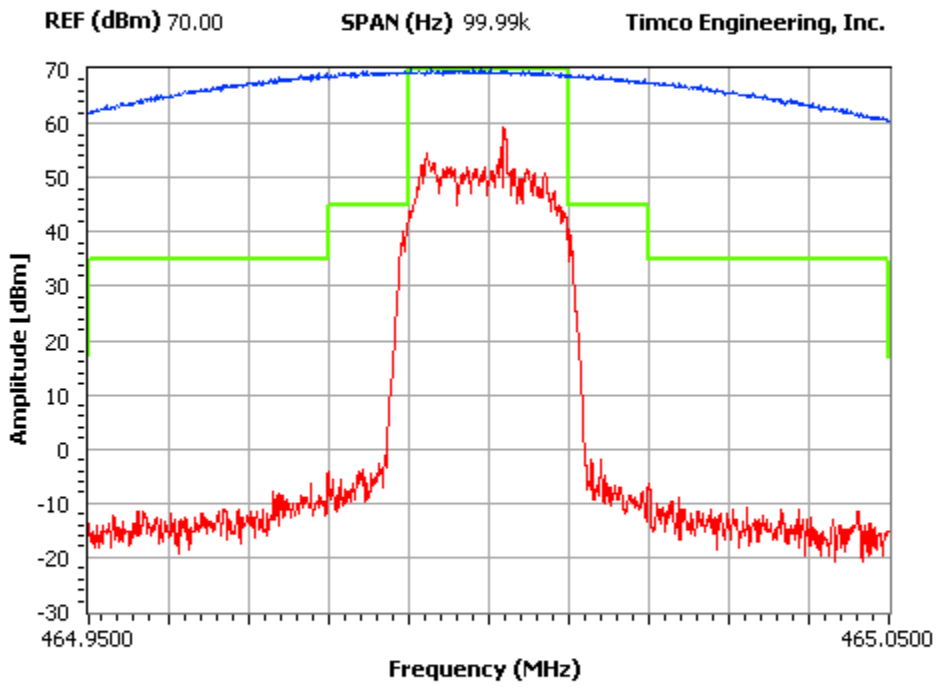
0.35 TETRA
25.0 kHz – DIGITAL



Mask B
0.20 modified TETRA
465 MHz

NOTES: **Mask B 20 kHz 0.20 TETRA**

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

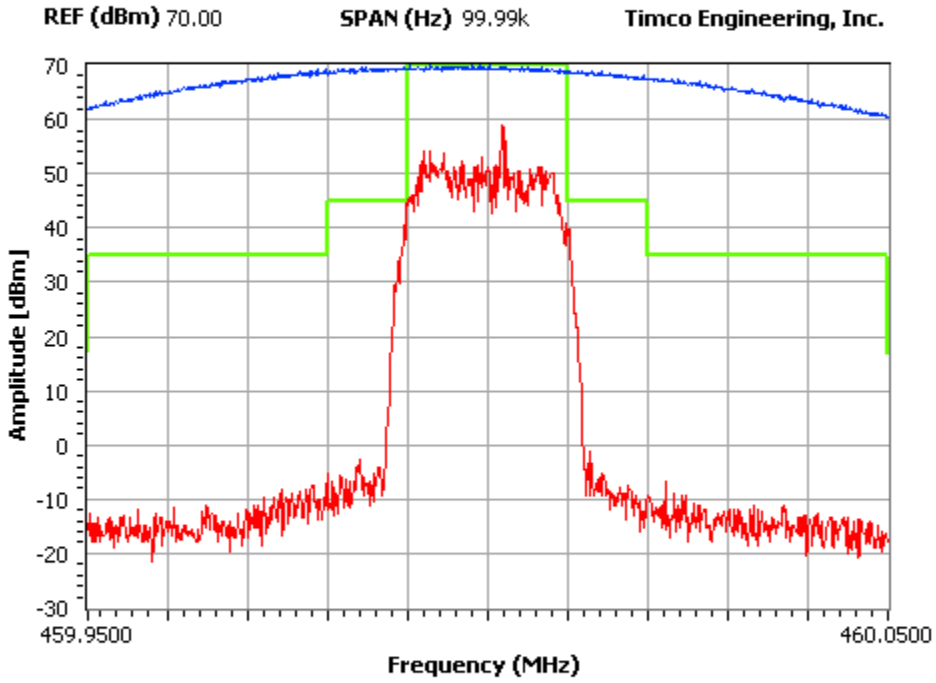
Center Frequency (Hz) 465.000M

Marker Delta (Hz) 0.00

Mask B
0.20 modified TETRA
460 MHz

NOTES: **Mask B 20 kHz 0.20 TETRA**

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

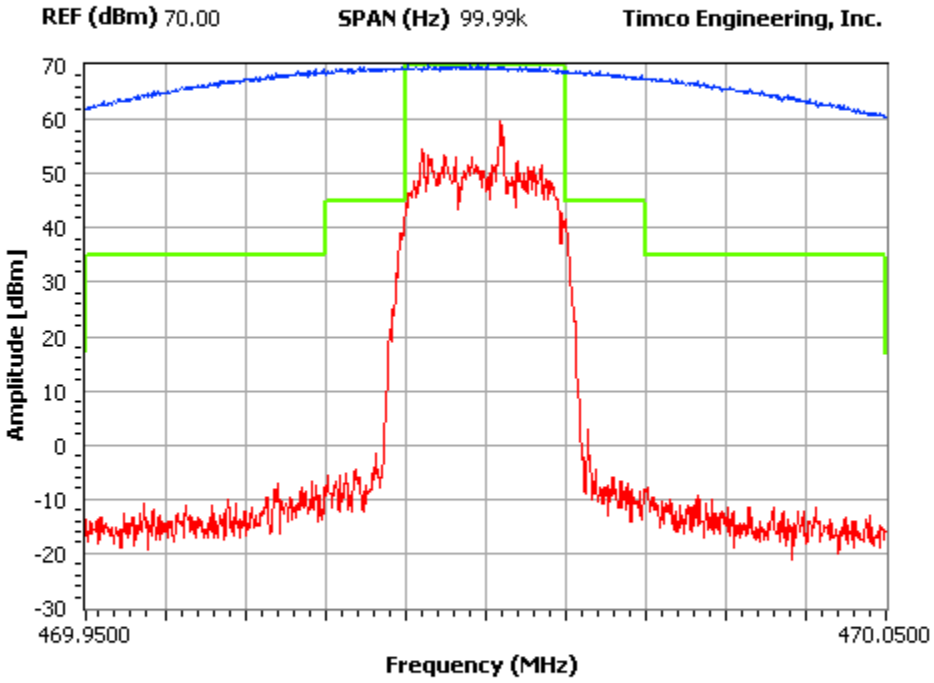
Center Frequency (Hz) 460.000M

Marker Delta (Hz) 0.00

Mask B
0.20 modified TETRA
470 MHz

NOTES:

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

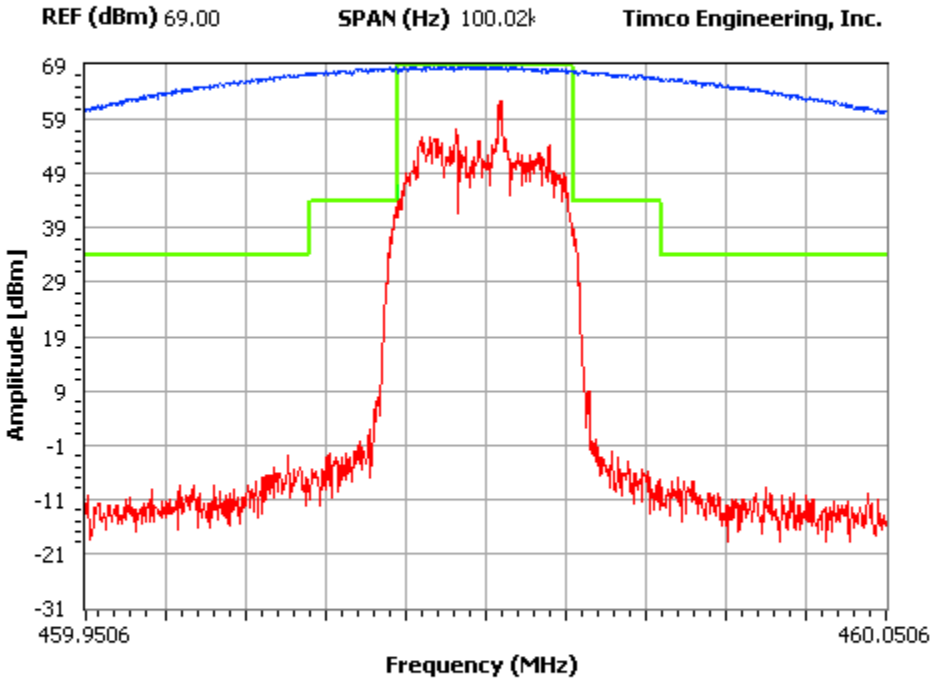
Center Frequency (Hz) 470.000M

Marker Delta (Hz) 0.00

Mask B (22 kHz)
0.35 TETRA
460 MHz

NOTES: Mask B 22 kHz 0.35 TETRA

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

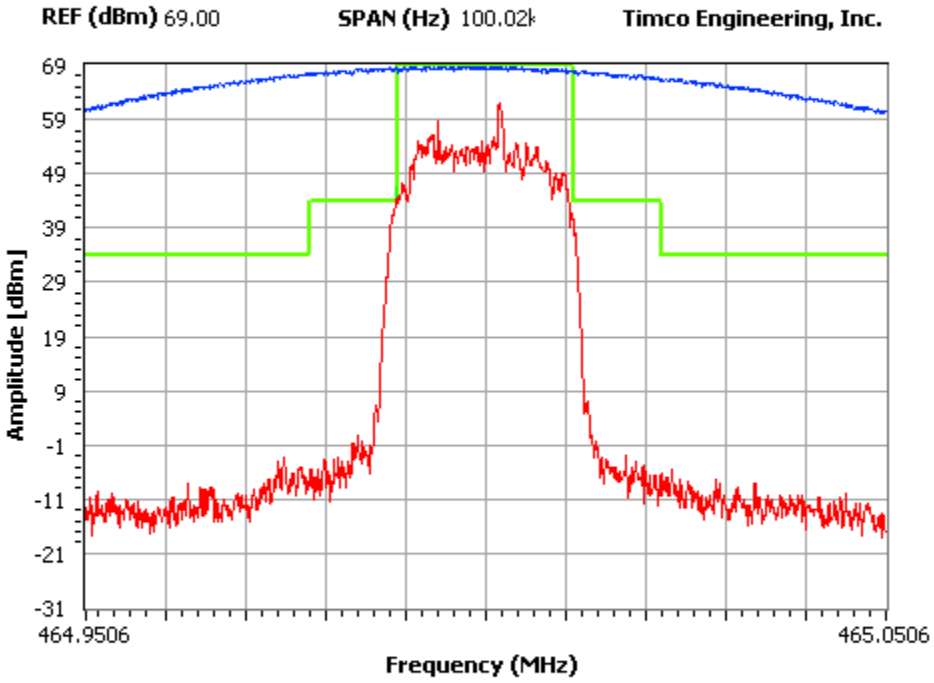
Center Frequency (Hz) 460.001M

Marker Delta (Hz) 0.00

Mask B (22 kHz)
0.35 TETRA
465 MHz

NOTES: Mask B 22 kHz 0.35 TETRA

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

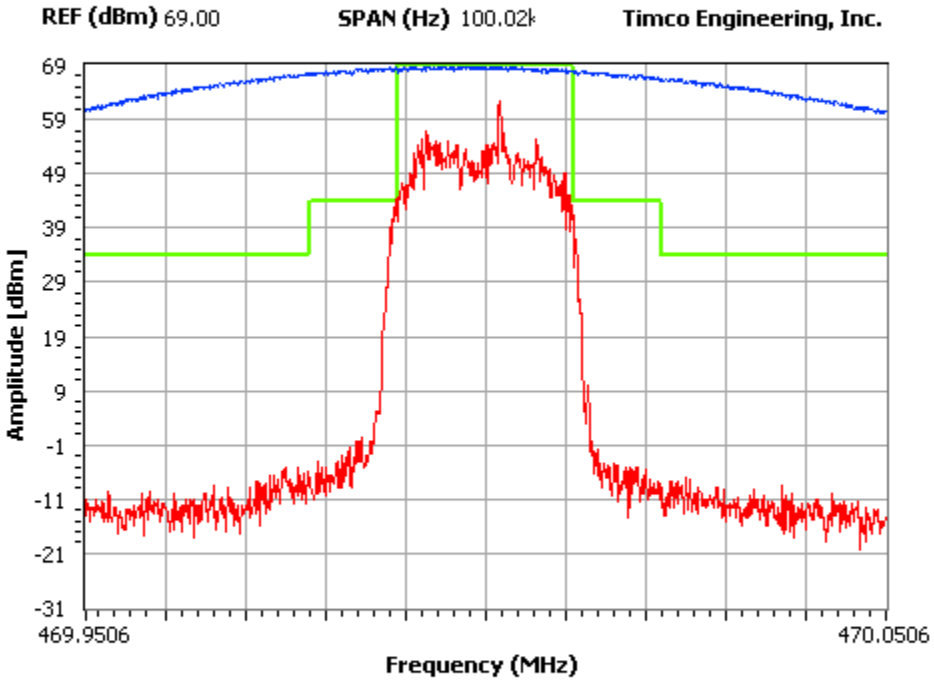
Center Frequency (Hz) 465.001M

Marker Delta (Hz) 0.00

Mask B (22 kHz)
0.35 TETRA
470 MHz

NOTES: Mask B 22 kHz 0.35 TETRA

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

Center Frequency (Hz) 470.001M

Marker Delta (Hz) 0.00

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: FCC Part 2.1051(a), RSS-GEN 7.1.4

Requirements: 25 kHz Channel Spacing = 56 dBc (for 20 Watts)

Method of Measurement: The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard ANSI/TIA 603-C: 2004.

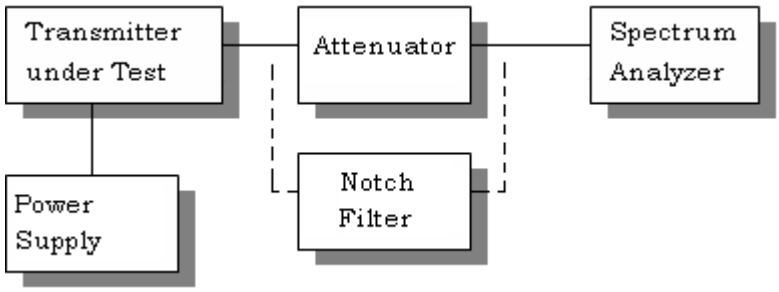
Test Data:

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
460	460	0		460	460	0
	920	114.4			920	100.2
	1380	95.7			1380	98.9
	1840	113.6			1840	99.1
	2300	115.6			2300	105.6
	2760	117.6			2760	105.8
	3220	119			3220	107
	3680	119.6			3680	104.4
	4140	117.3			4140	107.1
	4600	117.2			4600	105

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
465	465	0		465	465	0
	930	111			930	97.8
	1395	88.1			1395	97.2
	1860	110.8			1860	101.7
	2325	115.6			2325	101.6
	2700	117.8			2700	104.7
	3255	117.7			3255	103
	3720	118.1			3720	102.2
	4185	117.6			4185	103.5
	4650	117.7			4650	102.7

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
470	470	0		470	470	0
	940	99.2			940	99.3
	1410	92.3			1410	98.1
	1880	114.3			1880	100.4
	2350	124.3			2350	111.2
	2820	124.9			2820	111
	3290	126.3			3290	112.6
	3760	124.7			3760	112.1
	4230	128			4230	112.5
	4700	124.1			4700	111.2

Method of Measuring Conducted Spurious Emissions



METHOD OF MEASUREMENT: The procedure used was ANSI/TIA 603-C: 2004. The measurements were made at TIMCO ENGINEERING INC. 849 N.W. State Road 45, Newberry, Florida 32669.

FIELD STRENGTH OF SPURIOUS EMISSIONS

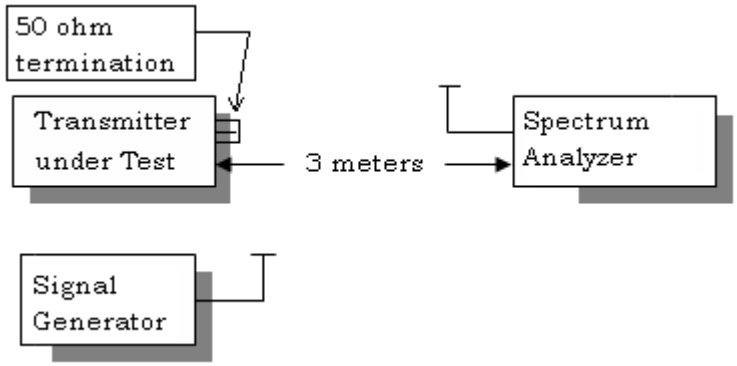
Rule Parts. No.: FCC Part 2.1053, RSS-GEN 4.9

Requirements: The FCC limits for radiated emissions are the same as previously stated for the conducted emissions.

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted per ANSI/TIA 603-C: 2004 using the substitution method.

Measurements were made at the test site of Timco Engineering, Inc. located at 849 NW State Road 45, Newberry, FL 32669.

Test Setup Diagram:



Three places in the band were tested and the worst case data submitted.

Test Data:

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
460.00	V	0
920.00	V	80.1
1840.00	H	89.2
2760.00	H	93.9

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
460.00	V	0
920.00	V	91.8

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
465.00	V	0
930.00	V	78.7

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
465.00	V	0
930.00	V	86.0

HIGH POWER

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
470.00	V	0
940.00	V	77.4
1880.00	V	89.4

LOW POWER

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
470.00	V	0
940.00	V	86.6

TRANSIENT FREQUENCY BEHAVIOR

FCC Part 2.1055(a)(1)
FCC Part 90.214, IC RSS-119 5.8

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

Time Intervals	Maximum frequency difference	All Equipment	
		150-174 MHz	421-512 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

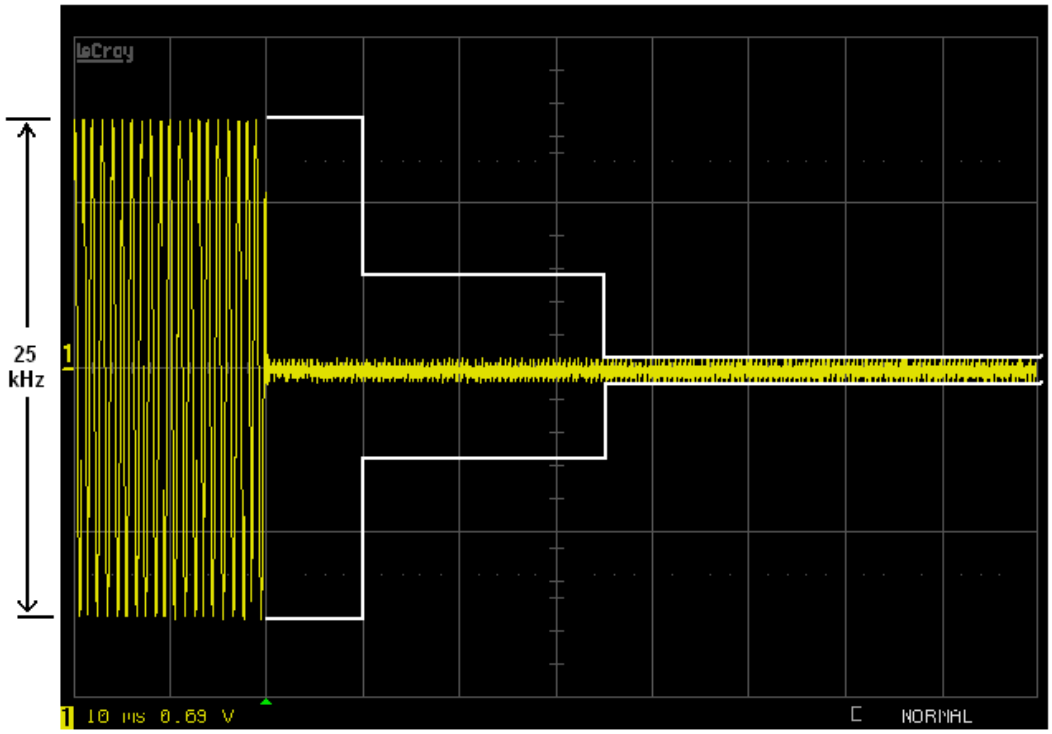
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels

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

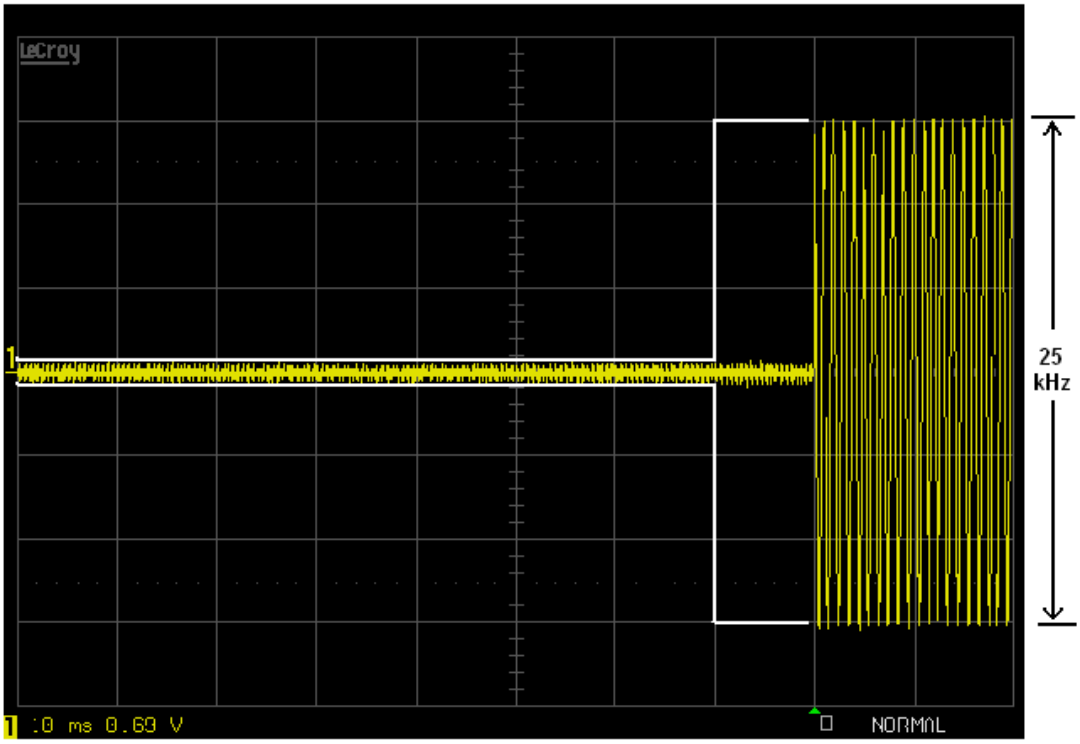
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels

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

The transient response for both conventional 0.35 TETRA and 0.20 modified TETRA were the same and the worst case presented.



Turn on



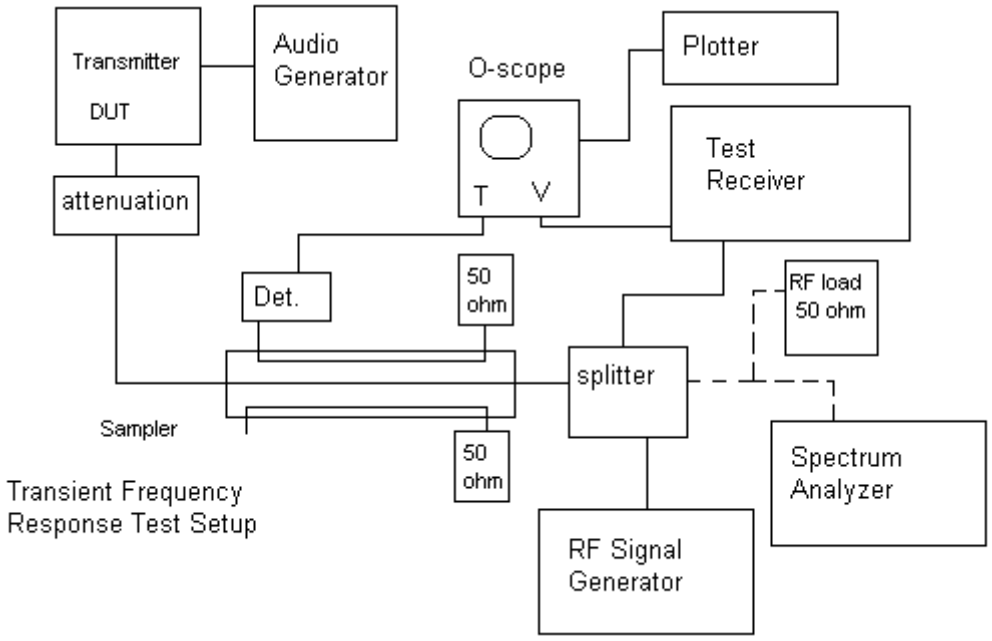
Turn off

TEST PROCEDURE: ANSI/TIA 603-C:2004 PARA 2.2.19

1. Using the variable attenuator the transmitter level was set to 40 dB below the test receivers maximum input level, then the transmitter was turned off.

2. With the transmitter off the signal generator was set 20dB below the level of the transmitter in the above step, this level will be maintained with the signal generator through-out the test.

3. Reduce the attenuation between the transmitter and the RF detector by 30 dB. With the levels set as above the transient frequency behavior was observed & recorded.



Transient Frequency Response Test Setup

EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Analyzer Tan Tower Spectrum Analyzer	HP	8566B Opt 462	3138A07786 3144A20661	11/24/09	10/28/13
Analyzer Tan Tower Preamplifier	HP	8449B-H02	3008A00372	11/21/09	10/28/13
Antenna: Biconnical	Electro-Metrics	BIA-25	1171	01/15/10	01/15/12
Antenna: Biconnical	Eaton	94455-1	1096	05/04/11	05/04/13
Antenna: Log-Periodic	Electro-Metrics	LPA-25	1122	05/04/11	05/04/13
Frequency Counter	HP	5352B	2632A00165	06/22/11	06/22/13
Frequency Counter	HP	5385A	2730A03025	08/17/11	08/17/13
Power meter	Boonton	4531	11793	11/12/2010	11/12/2012
Hygro-Thermometer	Extech	445703	0602	06/15/11	06/15/13
Digital Multimeter	Fluke	77	35053830	09/09/11	09/09/13
Analyzer Tan Tower RF Preselector	HP	85685A	3221A01400	11/21/09	10/28/13
Antenna: Passive Loop	EMC Test Systems	EMCO 6512	9706-1211	06/02/09	06/02/12
Modulation Analyzer	HP	8901A	3435A06868	07/18/11	07/18/13
Analyzer Tan Tower Quasi-Peak Adapter	HP	85650A	3303A01690	11/22/09	10/28/13
Temperature Chamber	Tenney Engineering	TTRC	11717-7	06/18/10	06/18/12
Frequency Counter	HP	5385A	3242A07460	06/22/11	06/22/13
3/10-Meter OATS	TEI	N/A	N/A	12/31/11	12/31/13
3-Meter OATS	TEI	N/A	N/A	12/31/11	12/31/13
3-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	12/31/2011	012/31/13

FREQUENCY STABILITY

Date: 2012-01-19

Rule Parts. No.: FCC Part 2.1055, Part 90.213, RSS-119 5.3, RSS-GEN 7.2.4

Requirements: Temperature range requirements: -30 to +50° C.
Voltage Variation +, -15%
±1.5 PPM

Method of Measurements: ANSI/TIA 603-C: 2004

Equipment:

DAMM	
BS41x	
BSC412	SN: 10001798
TR412	SN: 11000749

Meas. Equipment:

Freq. Meas.	Stabilock 4040	SN: 1625043
Climate Chamber	CoolTec II	SN: P1083

Test Data:

Ref Frequency: 462.5000 MHz

Assigned Frequency (Ref. Frequency) (MHz)		
Temperature (°C)	**Frequency (MHz)**	**Frequency Stability (PPM)**
-30	462.500006	+0.014
-20	462.500006	+0.014
-10	462.500005	+0.012
0	462.500003	+0.007
+10	462.500002	+0.005
+20	462.500002	+0.005
+30	462.500001	+0.002
+40	462.500000	+0.000
+50	462.500000	+0.000

Performed by: Morten Christensen, Engineer