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FCC PART 90
TEST REPORT

APPLICANT	DAMM CELLULAR SYSTEMS A/S
	MOLLEGADE 68 6400 SONDERBORG
FCC ID	Z5W-105003
IC CERTIFICATION	10159A-105003
MODEL NUMBER	BS421 BASE STATION 450-460/460-470 MHz
PRODUCT DESCRIPTION	BASE STATION
DATE SAMPLE RECEIVED	2/28/2012
DATE TESTED	3/6/2012
TESTED BY	Joe Scoglio
APPROVED BY	Mario R. de Aranzeta
TIMCO REPORT NO.	486AUT12TestReport.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.

ACCREDITED

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: April 8, 2012

GENERAL INFORMATION
DUT Specification

DUT Description	BASE STATION
FCC ID	Z5W-105003
IC Certification	10159A-105003
Model Number	BS421 BASE STATION 450-460_460-470 MHz
Serial Number	N/A
Operating Frequency	450 - 460.0 - 470.0 MHz
Test Frequencies	460.0 MHz, 465.0 MHz, 470.0 MHz
Type of Emission	21K0D1W 20K0D1W
Modulation	0.35 TETRA, 0.20 modified TETRA
	π/4 DQPSK
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.

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.

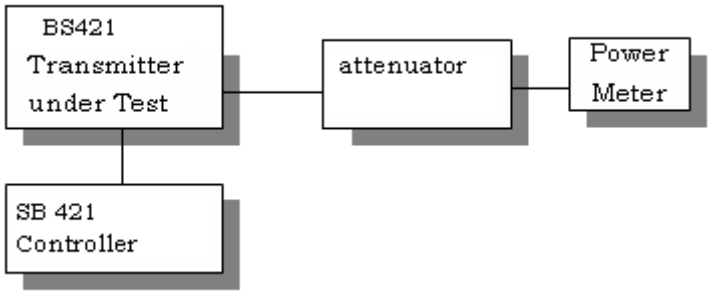
RF POWER OUTPUT

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

Test Requirements:

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: The power output is continuously variable from the lowest power indicated to the highest power indicated.

Frequency	Mode		Mode	
	0.20	0.35	0.20	0.35
MHz	High	High	Low	Low
460	12 W	12 W	0.6 W	0.6 W
465	12.6 W	12.5 W	0.6 W	0.6 W
470	12.1 W	12.1 W	0.6 W	0.5 W

The output power is continuously variable by software selection.

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

For the high power setting in either mode.
Input Power: (26.0 V)*(3. A) = 78 Watts

Volts	Mode		Mode	
	0.20	0.35	0.20	0.35
	High	High	Low	Low
26 V	3 A	3 A	1.6 A	1.6 A

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 *α* 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

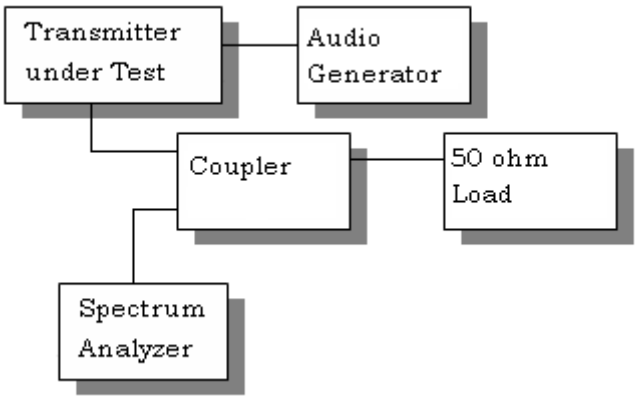
For transmitters that are not equipped with an audio low pass filter pursuant to S90.211 (b), the power of any emission must be attenuated below the un-modulated carrier output power as follows; (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in 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 para 2.2.11.

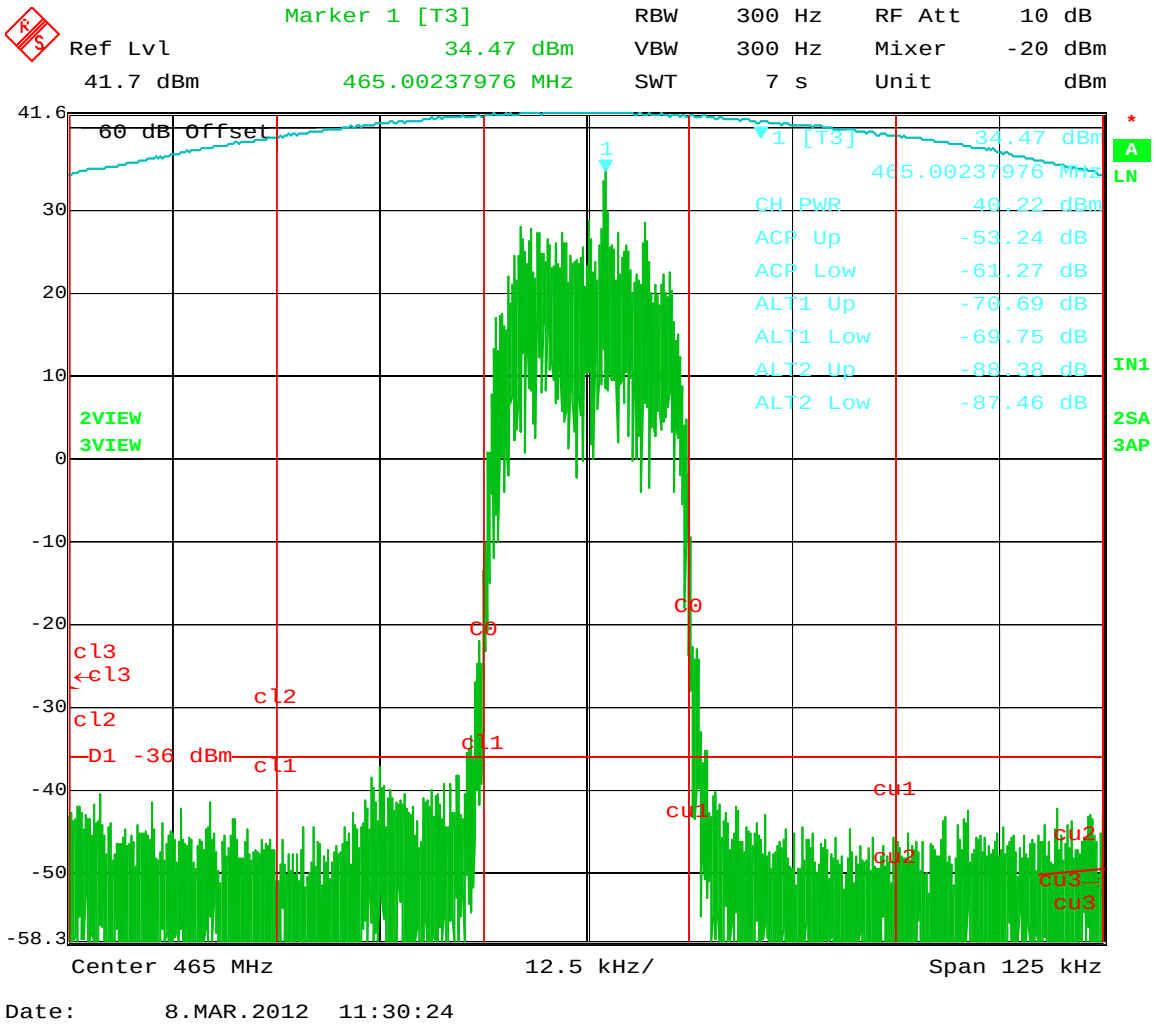
Test Setup Diagram:

OCCUPIED BANDWIDTH MEASUREMENT



Test Data: See the plots below

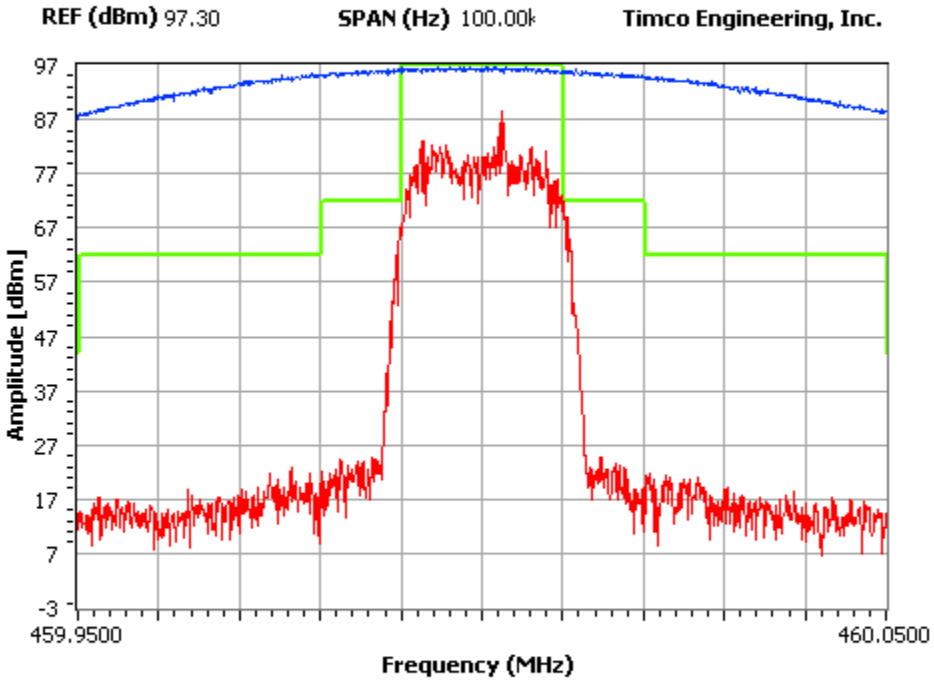
Occupied Bandwidth
0.35 TETRA



OBW
0.20 modified TETRA
Mask B
460 MHz

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

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

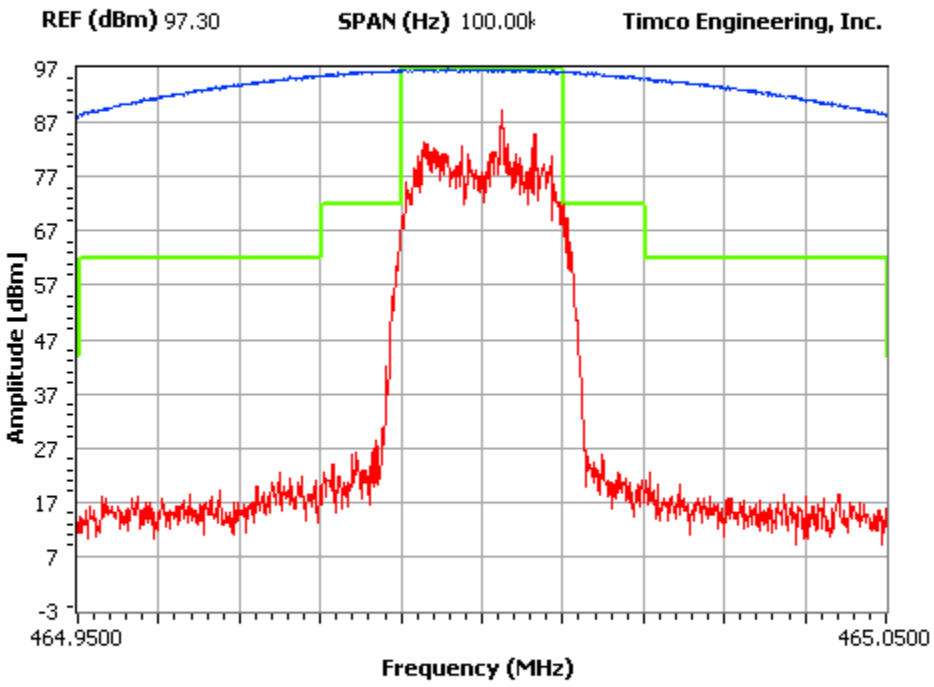
Center Frequency (Hz) 460.000M

Marker Delta (Hz) 0.00

OBW
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

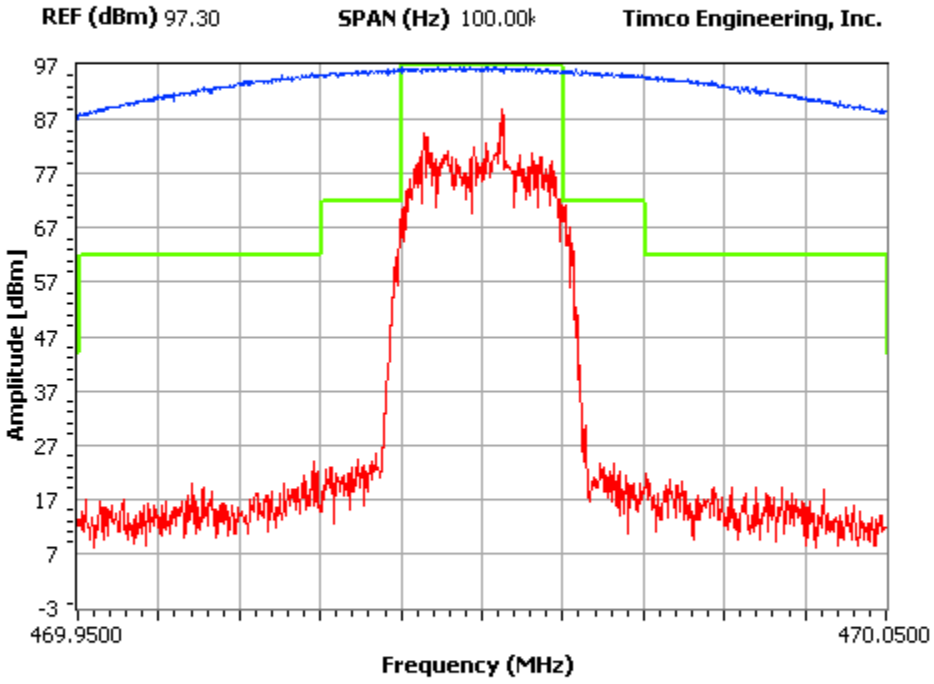
Center Frequency (Hz) 465.000M

Marker Delta (Hz) 0.00

OBW
0.20 modified TETRA
470 MHz

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

FCC 90.210 Mask B



RBW	VBW	ST (sec)
300 Hz	300 Hz	3

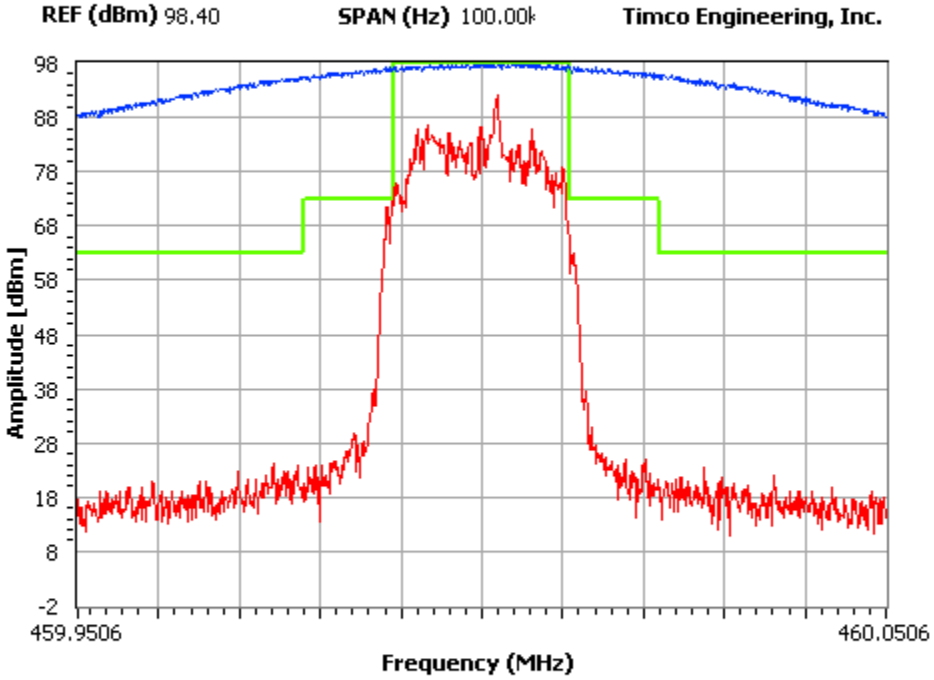
Center Frequency (Hz) 470.000M

Marker Delta (Hz) 0.00

OBW
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

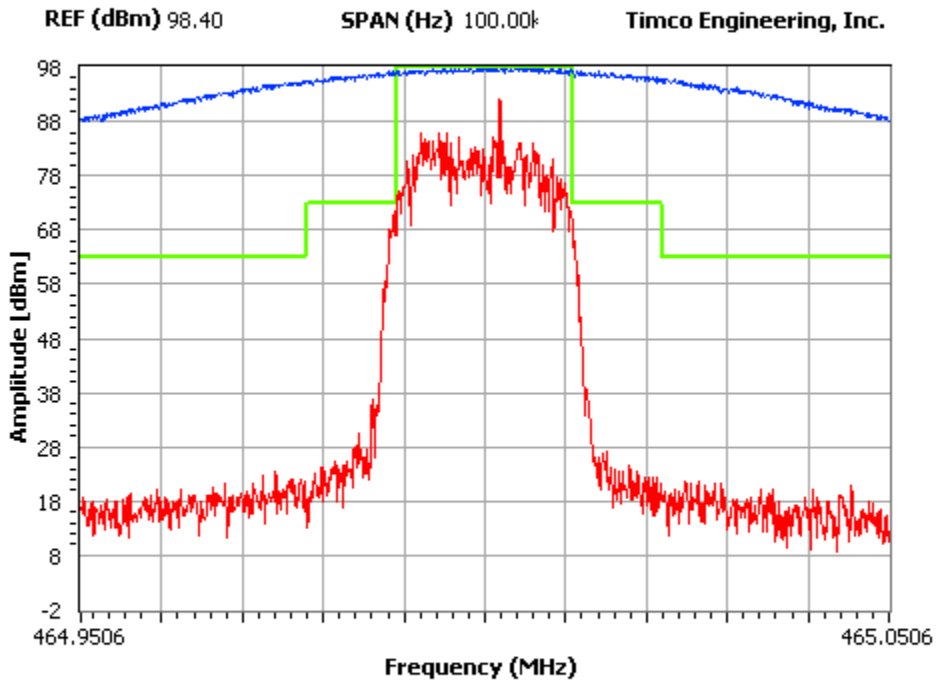
Center Frequency (Hz) 460.001M

Marker Delta (Hz) 0.00

OBW
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

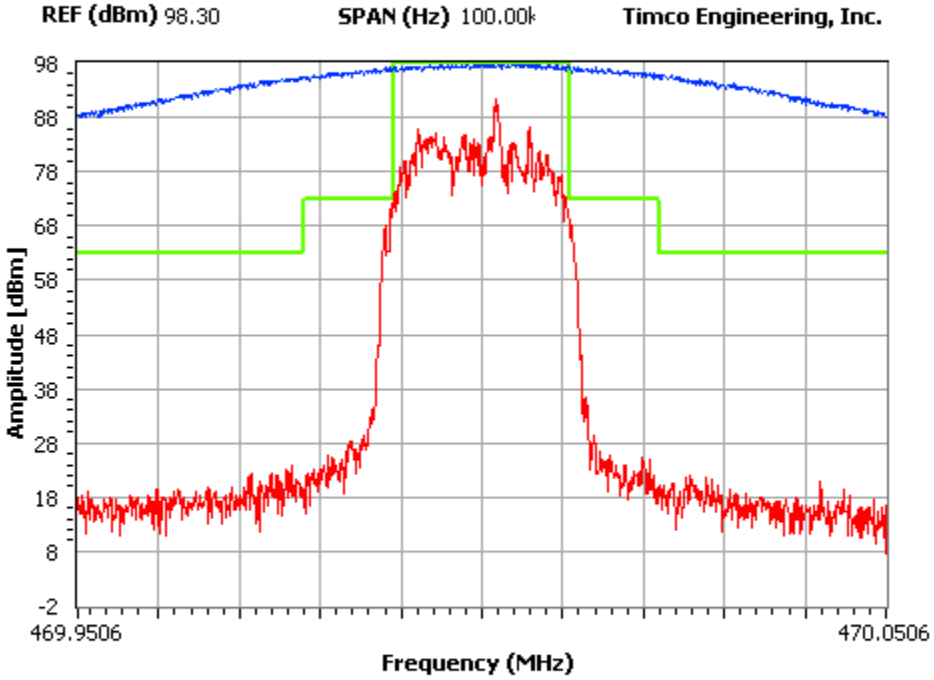
Center Frequency (Hz) 465.001M

Marker Delta (Hz) 0.00

OBW
0.35 TETRA
470 MHz

NOTES:

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 13 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.

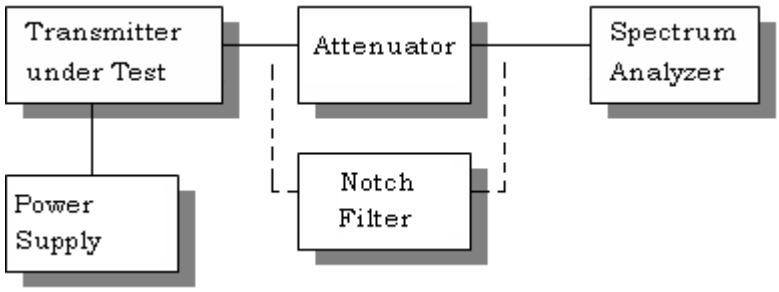
Several places in the band were investigated and the worst case data presented.
Test Data: The spurious emissions were identical in both 0.2 and 0.35 modes.

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
460	460	0		460	460	0
	920	112.2			920	101.6
	1380	97.4			1380	100.3
	1840	112.4			1840	98.7
	2300	118.1			2300	105.5
	2760	120			2760	106.1
	3220	120.6			3220	106
	3680	120			3680	105
	4140	121.3			4140	108.3
	4600	118.8			4600	106.3

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
465	465	0			465	0
	930	112.4			930	101.9
	1395	80.9			1395	94
	1860	111.6			1860	99.8
	2325	114.6			2325	105.6
	2790	116.3			2790	105.2
	3255	118.9			3255	106.4
	3720	117.8			3720	105
	4185	120.1			4185	107.4
	4650	118.3			4650	105.3

TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
470	470	0		470	470	0
	940	113.8			940	100.6
	1410	93.8			1410	98.7
	1880	110.6			1880	100
	2350	117.5			2350	105.5
	2820	119.7			2820	107.8
	3290	117.9			3290	105.9
	3760	118.9			3760	104.9
	4230	119			4230	107.5
	4700	119.7			4700	107.7

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.

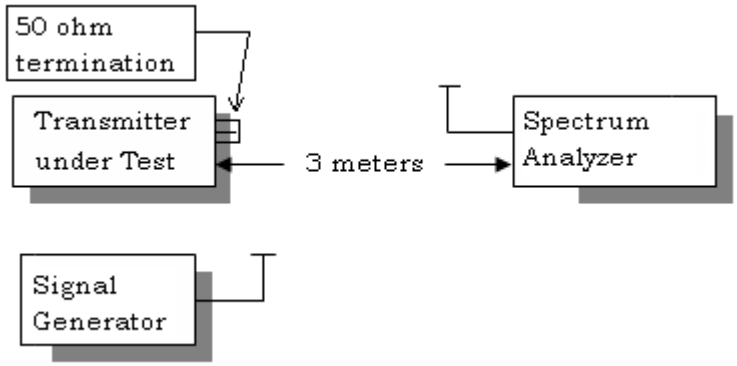
FIELD STRENGTH OF SPURIOUS EMISSIONS

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:



Test Data: The spurious emissions were identical in both 0.2 and 0.35 modes.

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
460.00	H	0
920.00	H	110.9
1380.00	V	99.1

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
460.00	H	0
920.00	H	97.5
1380.00	V	85.7

High Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
465.00	V	0
930.00	V	109.6
1395.00	V	97.3

Low Power

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
465.00	V	0
930.00	V	96.9
1395.00	V	84.9

HIGH POWER

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
470.00	V	0
940.00	H	110.9
1410.00	V	97.7

LOW POWER

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
470.00	V	0
940.00	H	97.8
1410.00	V	84.8

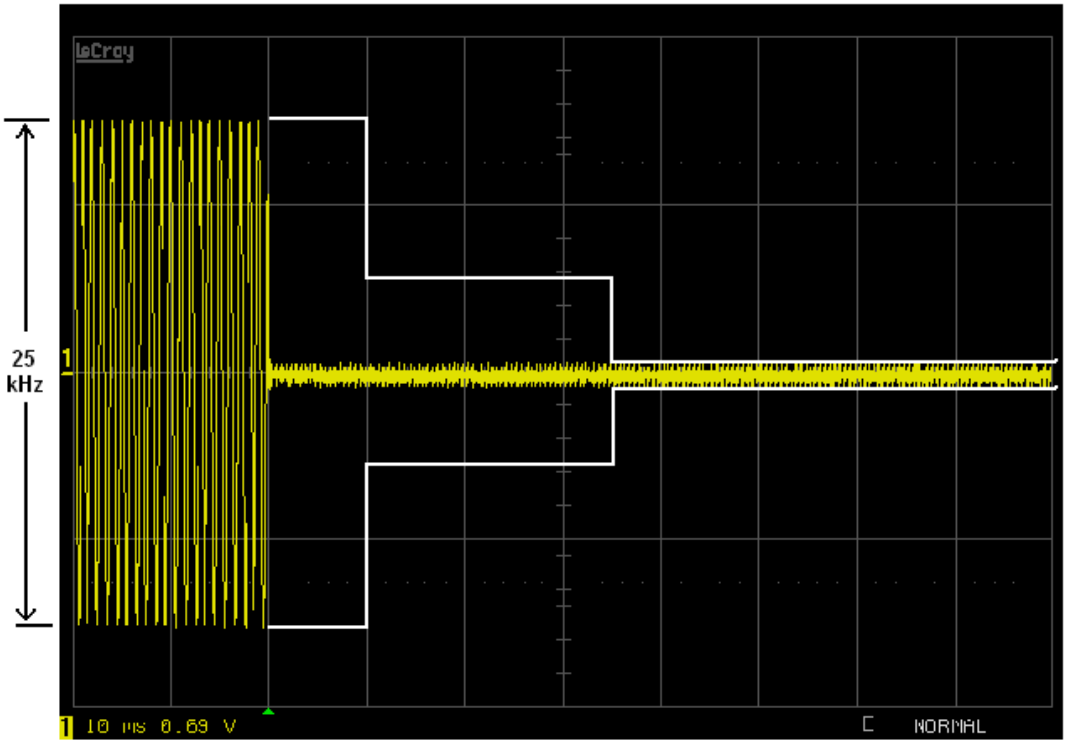
TRANSIENT FREQUENCY BEHAVIOR

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

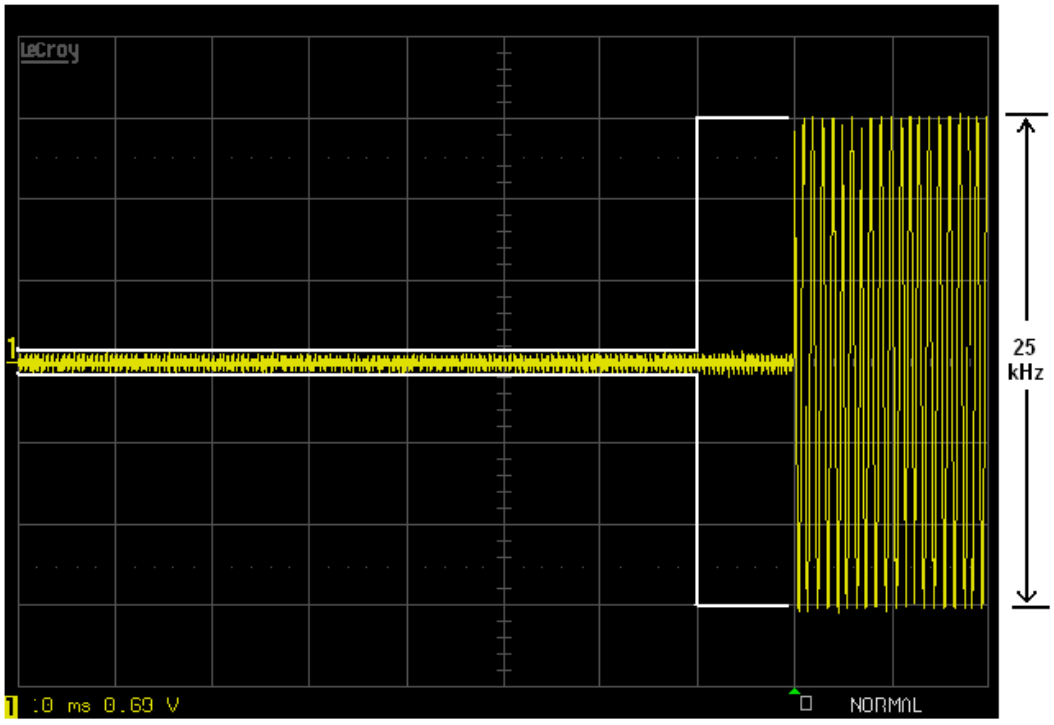
REQUIREMENTS: Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum transient frequencies within the maximum frequency difference limits during the time intervals indicated:

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



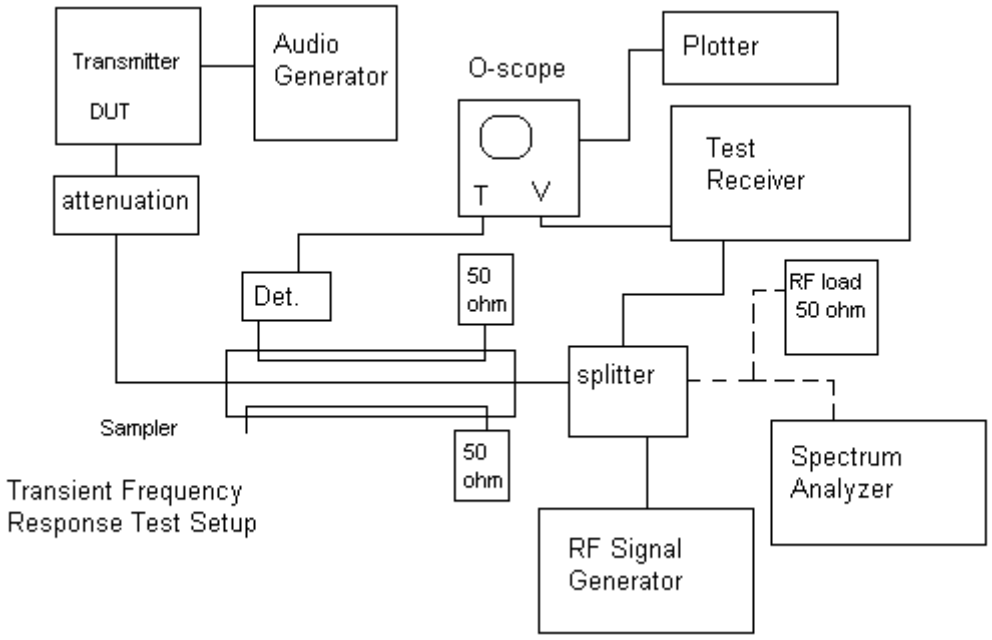
Turn off

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 Silver Tower Spectrum Analyzer	HP	8566B Opt 462	3552A22064 3638A08608	11/10/10	11/10/12
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
Signal Generator	HP	8640B	2308A21464	02/23/12	02/23/14
Hygro-Thermometer	Extech	445703	0602	06/15/11	06/15/13
Digital Multimeter	Fluke	77	35053830	09/09/11	09/09/13
Analyzer Silver Tower RF Preselector	HP	85685A	2926A00983	11/10/10	11/10/12
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 Silver Tower Quasi-Peak Adapter	HP	85650A	3303A01844	11/23/10	11/23/12
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-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	12/31/11	12/31/13
EMI receiver	R & S	ESIB 40	100274	3/16/2012	3/16/2014

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