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

<b>APPLICANT</b>	DAMM CELLULAR SYSTEMS A/S
	MOLLEGADE 68 6400 SONDERBORG DENMARK
<b>FCC ID</b>	Z5W-104028
<b>IC CERTIFICATION</b>	10159A-104028
<b>MODEL NUMBER</b>	TR412H TRANSCEIVER 805-825/851-869 MHz
<b>PRODUCT DESCRIPTION</b>	800 MHz Transceiver
<b>DATE SAMPLE RECEIVED</b>	12/12/2011
<b>DATE TESTED</b>	1/17/2012
<b>TESTED BY</b>	Joe Scoglio
<b>APPROVED BY</b>	Mario R. de Aranzeta
<b>TIMCO REPORT NO.</b>	2916AT11TestReport.doc
<b>TEST RESULTS</b>	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL  
WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.**



Testing Certificate #0955-01



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**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:** February 27, 2012

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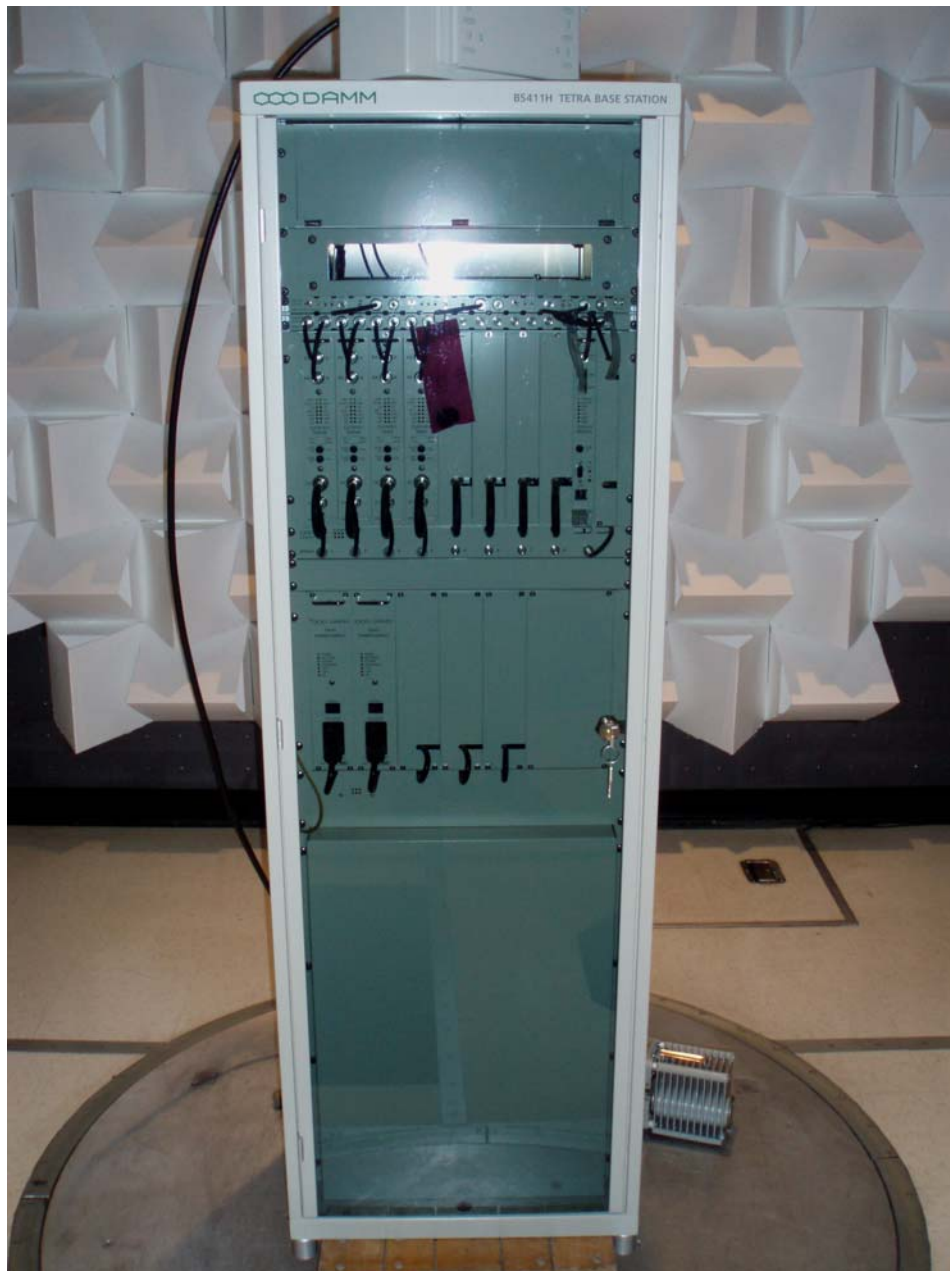
**GENERAL INFORMATION**  
**DUT Specification**

<b>DUT Description</b>	Transceiver 0.2(modified) and 0.35 TETRA
<b>FCC ID</b>	Z5W-104028
<b>IC Certification</b>	10159A-104028
<b>Model Number</b>	TR412H transceiver 800 MHz
<b>Serial Number</b>	N/A
<b>Operating Frequency</b>	RX = 805 – 825 TX = 851 – 869
<b>Test Frequencies</b>	856 MHz, 863 MHz, 869 MHz
<b>Type of Emission</b>	21K0D1W, 21K0D1D, 21K0D1E & 20K0D1W, 20K0D1D, 20K0D1E
<b>Modulation</b>	0.35 TETRA, 0.20 modified TETRA
<b>DUT Power Source</b>	<input checked="" type="checkbox"/> 110-120Vac/50- 60Hz
	<input type="checkbox"/> DC Power 12V
	<input type="checkbox"/> Battery Operated Exclusively
<b>Test Item</b>	<input type="checkbox"/> Prototype
	<input checked="" type="checkbox"/> Pre-Production
	<input type="checkbox"/> Production
<b>Type of Equipment</b>	<input checked="" type="checkbox"/> Fixed
	<input type="checkbox"/> Mobile
	<input type="checkbox"/> Portable
<b>Test Conditions</b>	Temperature was 26°C Relative humidity of 50%.
<b>Modification to the DUT</b>	None
<b>Test Exercise</b>	The DUT was placed in continuous transmit mode.
<b>Applicable Standards</b>	ANSI/TIA 603-C:2004, FCC CFR 47 Part 90, IC RSS-119, RSS-GEN
<b>Test Facility</b>	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA.

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**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.



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**GENERAL INFORMATION (cont'd)**  
**DUT Specification**

TR-412H Transceiver



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## 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 10.0 MHz and the spectrum was scanned from 30 MHz to the 10<sup>th</sup> 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.

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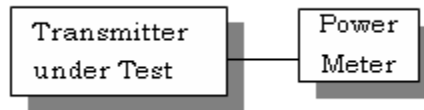
## RF POWER OUTPUT

**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 to the RF output connector. With a nominal battery voltage and the transmitter properly adjusted the RF output measures:

### Test Setup Diagram:



### Test Data:

At output of TR-412H module:

OUTPUT POWER: HIGH – 62.5  
LOW – 2.5

As configured at RF output connector:

OUTPUT POWER: HIGH – 32  
LOW – 1.4

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

INPUT POWER:  $(26.0V)(7A) = 182.0$  Watts

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**MODULATION CHARACTERISTICS**

**Part 2.1033(c)**

**Part 2.1033(c) (4)**

**FCC Part 90.209, IC RSS-119 5.5**

**FCC Part 90.207**

Type of Emission:  $\pi/4$ DQPSK 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:

$$\begin{array}{ll}
 G(f) = 1 & \text{for } |f| \leq (1 - \alpha)/2T \\
 G(f) = \sqrt{0.5(1 - \sin(\pi(2|f|T - 1)/2\alpha))} & \text{for } (1 - \alpha)/2T \leq |f| \leq (1 + \alpha)/2T \\
 G(f) = 0 & \text{for } |f| \geq (1 + \alpha)/2T
 \end{array}$$

Where  $\alpha$  is the roll-off factor, which determines the width of the transmission band at a given symbol rate. For TETRA the value of  $\alpha$  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  $\alpha$  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.

### **MODULATION LIMITING PLOT**

Employs digitally encoded voice

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**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**

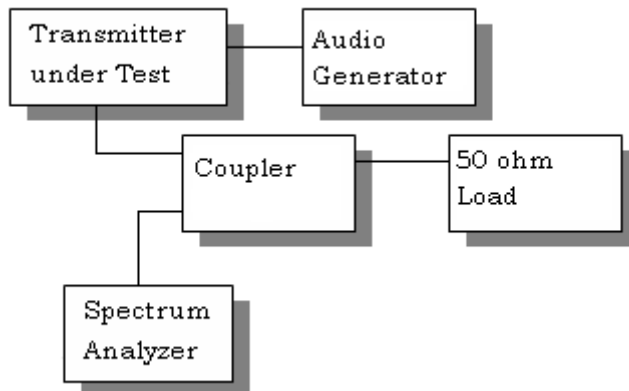
For transmitters that are not equipped with an audio low pass filter pursuant to S90.211 (b), the power of any emission must be attenuated below the un-modulated carrier output power as follows; (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$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

**OCCUPIED BANDWIDTH MEASUREMENT**

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

**Test Setup Diagram:**

OCCUPIED BANDWIDTH MEASUREMENT



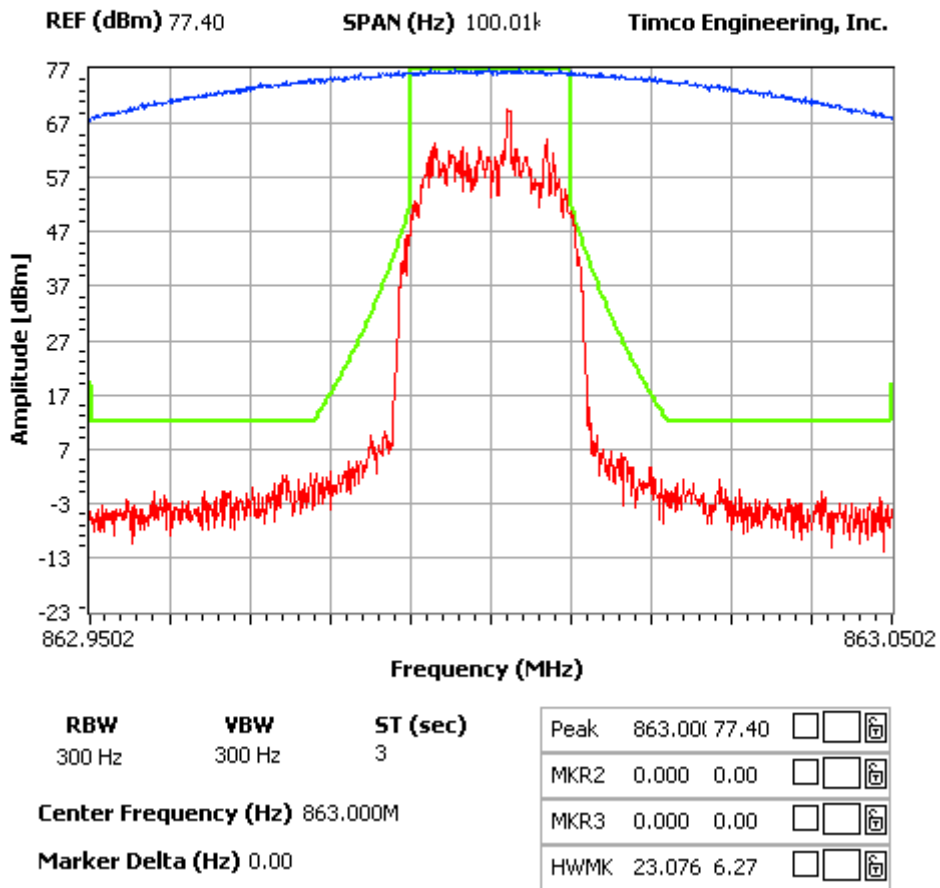
**Test Data:** See the plots below

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**25.0 kHz – DIGITAL  
0.2 modified**

NOTES:

FCC 90.210 Mask G

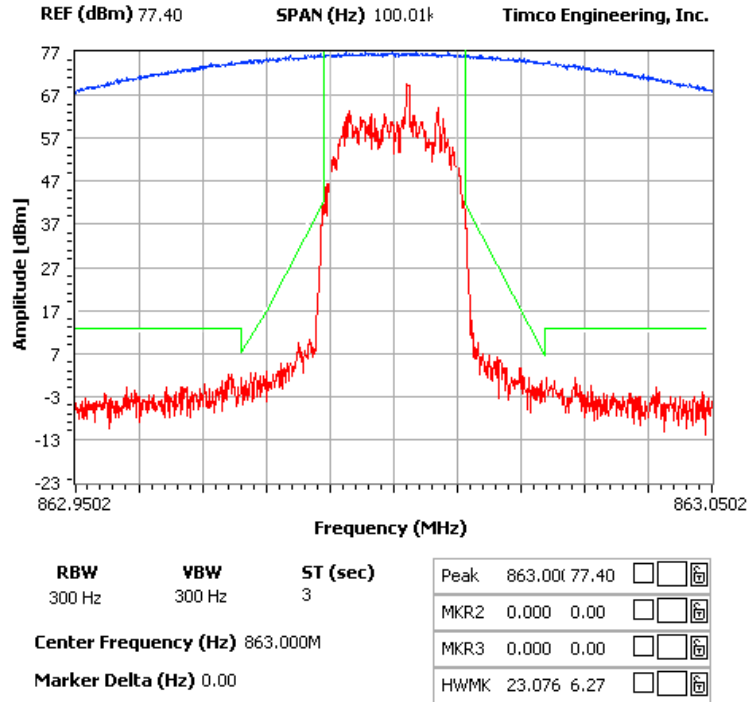


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## Mask EA 0.2 modified

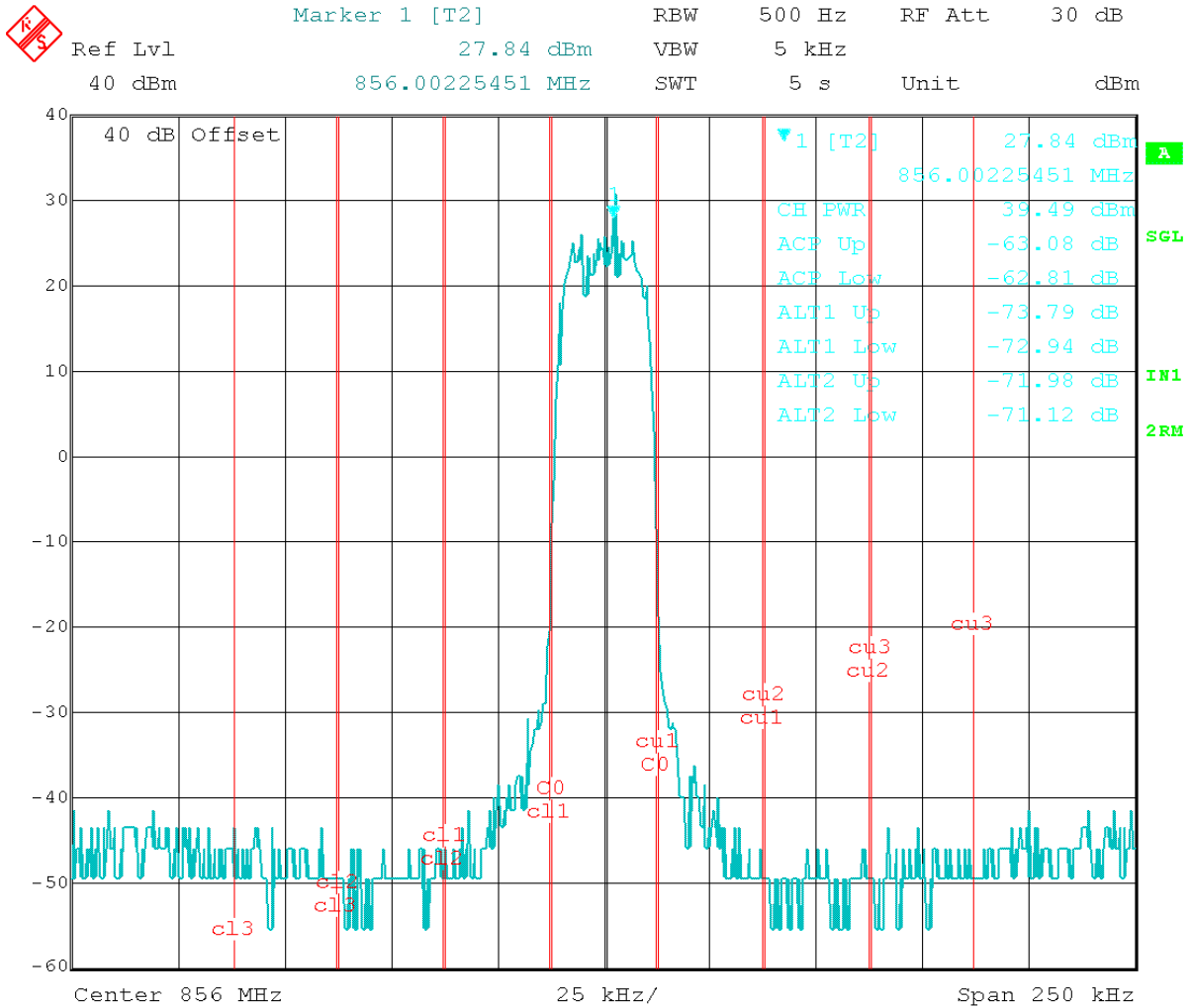
NOTES:

FCC 90. Mask EA



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### ADJACENT CHANNEL POWER PLOTS 0.35 TETRA (conventional)

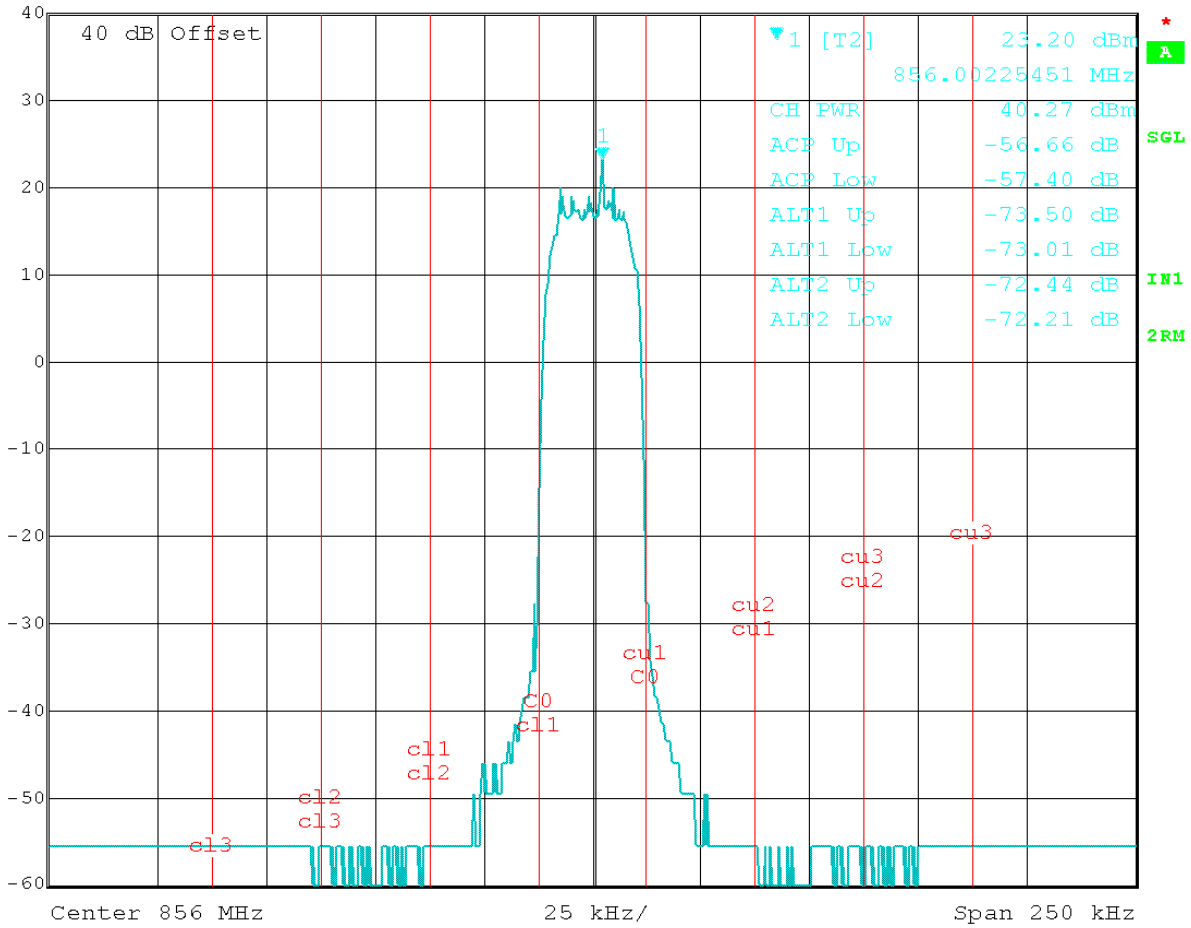


Date: 16.JAN.2012 14:16:00

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Marker 1 [T2] RBW 100 Hz RF Att 30 dB  
 Ref Lvl 23.20 dBm VBW 1 kHz  
 40 dBm 856.00225451 MHz SWT 200 s Unit dBm



Date: 16.JAN.2012 14:07:25

Applicant: DAMM CELLULAR SYSTEMS A/S  
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**SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)**

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

**Requirements:** 25 kHz Channel Spacing = 58.0 dBc (for 32 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
856	856	0		856	856	0
	1712	118			1712	106.8
	2568	103.2			2568	112.9
	3424	122			3424	119.4
	4280	111.2			4280	116.4
	5136	133.2			5136	120.5
	5992	128.6			5992	119.6
	6848	128.1			6848	114.4
	7704	125.5			7704	115.3
	8560	129			8560	117

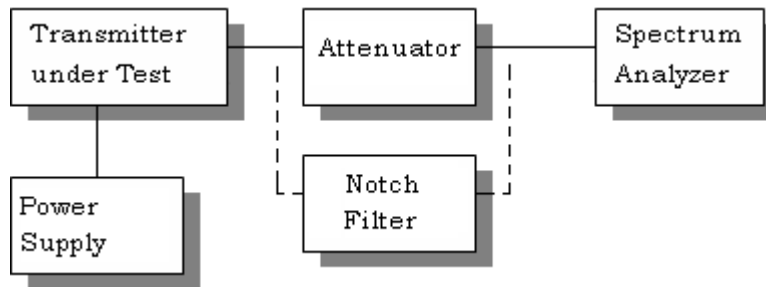
TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
863	863	0		863	863	0
	1726	111.9			1726	105.2
	2589	110.8			2589	111.1
	3452	120.9			3452	119.9
	4315	118.6			4315	118.7
	5178	131.8			5178	117.5
	6041	124.8			6041	115.5
	6904	126.5			6904	114.2
	7767	127.8			7767	116.3
	8630	128.9			8630	115.9

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TF HIGH POWER	EF	dB below carrier		TF LOW POWER	EF	dB below carrier
869	869	0		869	869	0
	1738	112.1			1738	105.7
	2607	109.2			2607	112.3
	3476	129			3476	119.3
	4345	125.8			4345	120.2
	5214	132.1			5214	121.2
	6083	122.2			6083	115.3
	6952	128.4			6952	115.7
	7821	127.1			7821	114.6
	8690	128.1			8690	116.5

**Method of Measuring Conducted Spurious Emissions**



**METHOD OF MEASUREMENT:** The procedure used was ANSI/TIA 603-C: 2004.

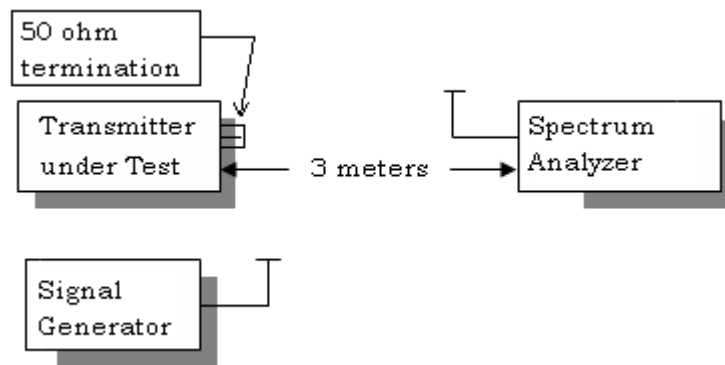
## FIELD STRENGTH OF SPURIOUS EMISSIONS

**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:**

**High Power**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
856.00	H	0
1712.00	H	77.2
2568.00	H	91.8
3424.00	H	89.6
4280.00	H	91.9

**Low Power**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
856.00	H	0
1712.00	H	81.7
4280.00	H	81.3

**High Power**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
863.00	H	0
1726.00	H	77.1
2589.00	H	91.4
3452.00	V	88.0
4315.00	H	91.8

**Low Power**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
863.00	H	0
1726.00	H	82.8
4315.00	H	81.3

**HIGH POWER**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
869	H	0
1738	H	86.5
2607	H	89.9
3476	H	89.6
4345	V	87.6

**LOW POWER**

Emission Frequency MHz	Ant. Polarity	dB Below Carrier (dBc)
869.00	H	0
1738.00	H	82.5
4345.00	H	81.2

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**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 <sub>1</sub> <sup>4</sup>	±25.0 kHz	5.0 ms	10.0 ms
t <sub>2</sub>	±12.5 kHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup>	±25.0 kHz	5.0 ms	10.0 ms

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

t <sub>1</sub> <sup>4</sup>	±12.5 kHz	5.0 ms	10.0 ms
t <sub>2</sub>	±6.25 kHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup>	±12.5 kHz	5.0 ms	10.0 ms

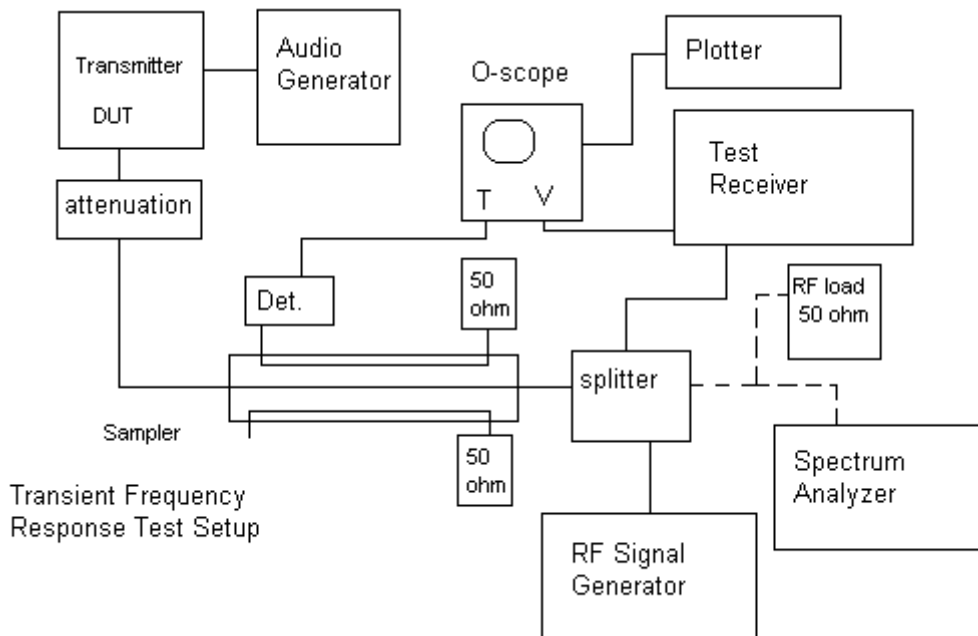
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels

t <sub>1</sub> <sup>4</sup>	±6.25 kHz	5.0 ms	10.0 ms
t <sub>2</sub>	±3.125 kHz	20.0 ms	25.0 ms
t <sub>3</sub> <sup>4</sup>	±6.25 kHz	5.0 ms	10.0 ms

**Not required for this band.**

**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.



## EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
3-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	Listed 5/10/10	5/10/12
AC Voltmeter	HP	400FL	2213A14499	CAL 6/12/11	6/12/13
Antenna: Active Loop	ETS-Lindgren	6502	00062529	CAL 9/23/10	9/23/12
Frequency Counter	HP	5385A	2730A03025	CAL 8/17/11	8/17/13
Hygro-Thermometer	Extech	445703	0602	CAL 6/15/11	6/15/13
Modulation Analyzer	HP	8901A	3435A06868	CAL 7/18/11	7/18/13
Digital Multimeter	Fluke	FLUKE-77	35053830	CAL 9/9/11	9/9/13
Analyzer Tan Tower Preamplifier	HP	8449B-H02	3008A00372	CAL 10/28/11	10/28/13
Analyzer Tan Tower Quasi-Peak Adapter	HP	85650A	3303A01690	CAL 10/28/11	10/28/13
Analyzer Tan Tower RF Preselector	HP	85685A	3221A01400	CAL 10/28/11	10/28/13
Analyzer Tan Tower Spectrum Analyzer	HP	8566B Opt 462	3138A07786 3144A20661	CAL 10/28/11	10/28/13
Temperature Chamber	Tenney Engineering	TTRC	11717-7	CHAR 4/25/10	4/25/12
Antenna	ETS	3117	41534	9/22/2010	9/22/2012
Antenna	Electro metrics	LPA-25	1122	5/04/2011	5/04/2013
Antenna	Electro metrics	94455-1	1096	5/4/2011	5/4/2013

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Damm Cellular Systems A/S, Denmark

Doc. No.

Rev.

Date

0

2012-01-19

BS41x FREQUENCY STABILITY

## FREQUENCY STABILITY

**Date:** 2012-01-19

**Operator:** Morten Christensen, Dev. Engineer

**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: 09000260

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

### Test Data:

**Ref Frequency:** 865.0000Mhz

Assigned Frequency (Ref. Frequency) (MHz)		
Temperature (°C)	Frequency (MHz)	Frequency Stability (PPM)
-30	865.000012	+0.014
-20	865.000010	+0.012
-10	865.000010	+0.012
0	865.000006	+0.007
+10	865.000004	+0.005
+20	865.000002	+0.002
+30	865.000002	+0.002
+40	865.000000	+0.000
+50	865.000000	+0.000