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FCC PART 90 800 MHz TETRA RADIO TEST REPORT

APPLICANT	FUNK-ELECTRONIC P I C I O R G R O S G M B H
	Claudiastr. 5 * 51149 Cologne 51145 GERMANY
FCC ID	TO9TMO-100
MODEL NUMBER	TMO-100
PRODUCT DESCRIPTION	800 MHZ TETRA RADIO
DATE SAMPLE RECEIVED	1/6/2017
DATE TESTED	2/3/2017
TESTED BY	Cory Leverett
APPROVED BY	Tim Royer

Report Number	Version Number	Description	Issue Date
36AUT17TestReport	Rev.1	Initial Issue	2/8/2017
36AUT17TestReport	Rev.2	Added Emission information to page 6	2/21/2017

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

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GENERAL REMARKS

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Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.
- ☐ 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 requirements.

I attest that the necessary measurements were made at:

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

A handwritten signature in blue ink, appearing to read "Cory Leverett", is written over a circular red stamp. The stamp contains the text "TIMCO ENGINEERING, INC." and "NEWBERRY, FL 32669".

Tested by:

Name and Title: Cory Leverett, Project Manager/Testing Technician

Date: 02/ 07/ 2017

A handwritten signature in blue ink, appearing to read "Tim Royer", is written over a circular blue stamp. The stamp contains the text "TIMCO ENGINEERING, INC." and "NEWBERRY, FL 32669".

Reviewed and approved by:

Name and Title: Tim Royer, Project Manager

Date: 02/ 07/ 2017

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GENERAL INFORMATION

EUT Specification

EUT Description	800 MHZ TETRA RADIO
FCC ID	TO9TMO-100
Model Number	TMO-100
Operating Frequency	809-824, and 854-869 MHz
Test Frequencies	809.025, 823.975, 854.025, 868.975 MHz
Type of Emission	20K5D7W
Modulation	TETRA Digital
EUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power 12 – 24 V
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☐ Pre-Production
	☒ Production
Type of Equipment	☒ Fixed
	☐ Mobile
	☐ Portable
Test Conditions	The temperature was 24-26°C with a relative humidity of 50 - 65%. Atmospheric Pressure 1014.9mb
Modification to the EUT	None
Test Exercise	The EUT was operated in a normal mode.
Applicable Standards	ANSI/TIA 603-D:2010, FCC CFR 47 Part 2, & 90
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA.

RF EXPOSURE INFORMATION: 47CFR 2.1093

The requirements for this equipment are covered in the included a RF Exposure exhibit.

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Test Results Summary

Test Description	FCC RULE PART NO.	RESULT
RF Power Output	2.1046(a),	Pass
Occupied Bandwidth	2.1049(c)(h),	Pass
Adjacent Channel Power	90.221(a)(c)	Pass
Spurious Emissions at Antenna Terminal	2.1051(a), 90.221(d)	Pass
Field Strength of Spurious Radiation	2.1053, 90.221(d)	Pass
Frequency Stability	2.1055, 90.213	Pass

EMISSION TYPE

Rule Part No.: Part 90.207, 90.209, RSS-119

Requirements: Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized. The designator will be prefixed by a specified necessary bandwidth. This number does not necessarily indicate the bandwidth occupied by the emission at any instant.

In those cases where §2.202 of this chapter does not provide a formula for the computation of necessary bandwidth, the occupied bandwidth, as defined in part 2 of this chapter, may be used in lieu of the necessary bandwidth.

Procedure: Part 2.201, 2.202

The 99% energy rule as defined in part 2 was used and is more accurate than Carson's rule. It basically states that 99% of the modulation energy falls within X kHz

Test Data: Necessary Bandwidth

Tuned Frequency (MHz)	99% Bandwidth (KHz)	Authorized Bandwidth (KHz)
809.025	20.14	22
823.975	20.14	22
854.025	20.14	22
868.975	20.29	22

Test Data: Emission Characteristics

D = the main carrier is amplitude and angle-modulated
7 = Two or more channels containing quantized or digital information
W = Multiple formats of Data transmitted

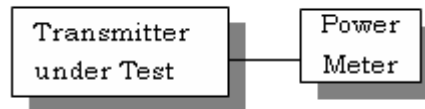
RF POWER OUTPUT

Rule Part No.: Part 2.1046(a), Part 90, RSS-119.

Requirements: The maximum output power of the transmitter for mobile stations is 100 watts

Procedure: TIA 603-D, using a 50-ohm, resistive wattmeter coupled directly to the antenna terminals. Tested with a nominal battery voltage (if battery operated), or a properly adjusted power supply (if not battery operated).

Setup Diagram:



Test Data: Power Output Measurement Table

Tuned Freq. MHz	Power Output	
	High	
	dBm	Watts
809.025	32.84	1.92
823.975	32.80	1.91
854.025	33.11	2.05
868.975	33.17	2.07

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

INPUT POWER: (24V) (0.4A) = 9.6 Watts

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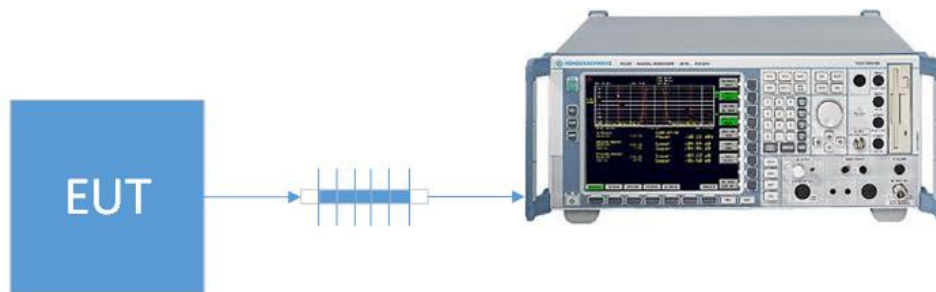
OCCUPIED BANDWIDTH

FCC Rule Part No. 2.1049(c), 90.210 (note 5)

Requirements: The measured bandwidth must be less than authorized bandwidth; there is no emissions mask requirement if ACP limits of 90.221 are met

Procedure: TIA 603-D, directly coupled measurement at the antenna terminal through 50 ohm termination into EMI receiver with 99% bandwidth power measurement function

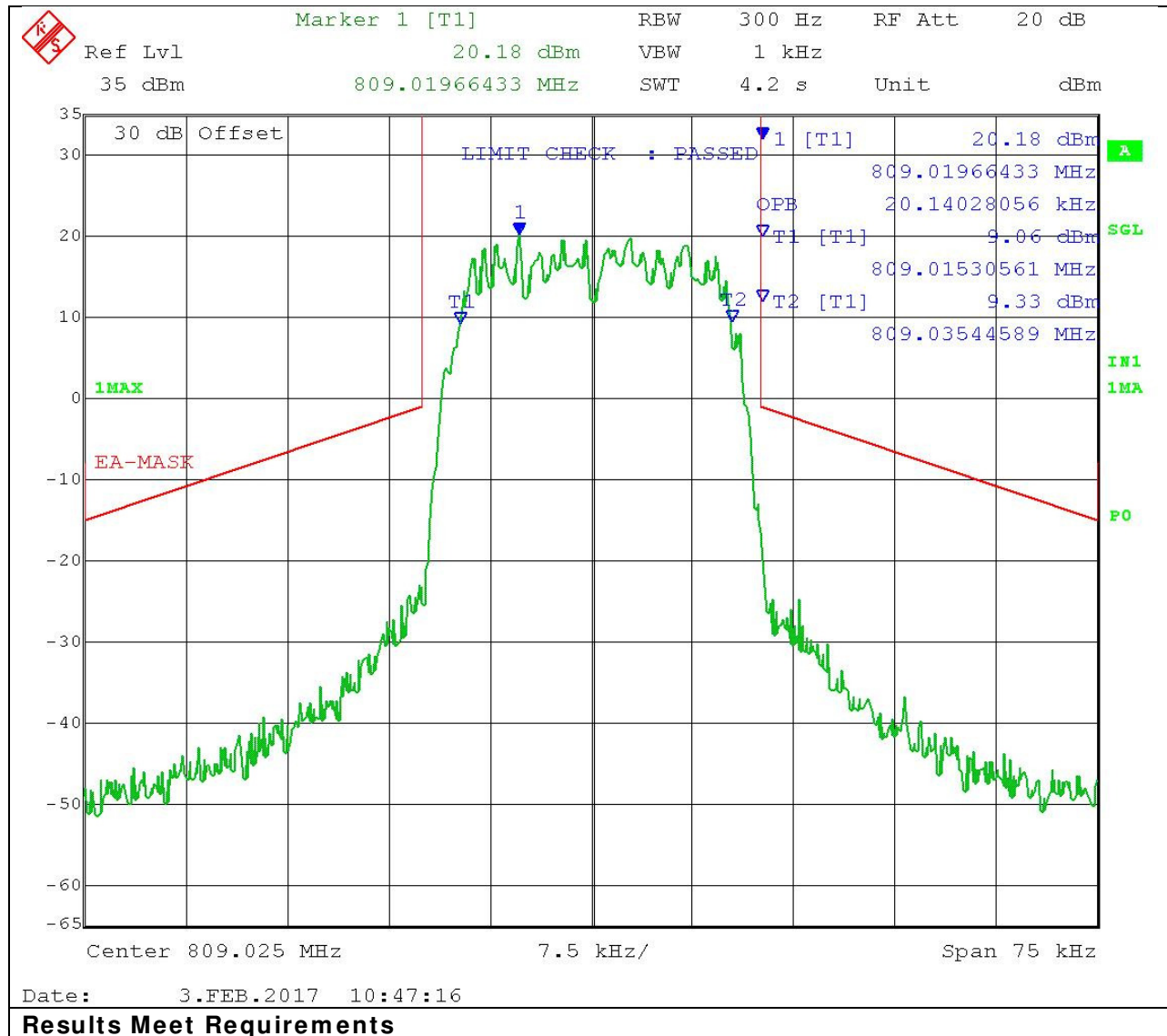
Setup Diagram:



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OCCUPIED BANDWIDTH

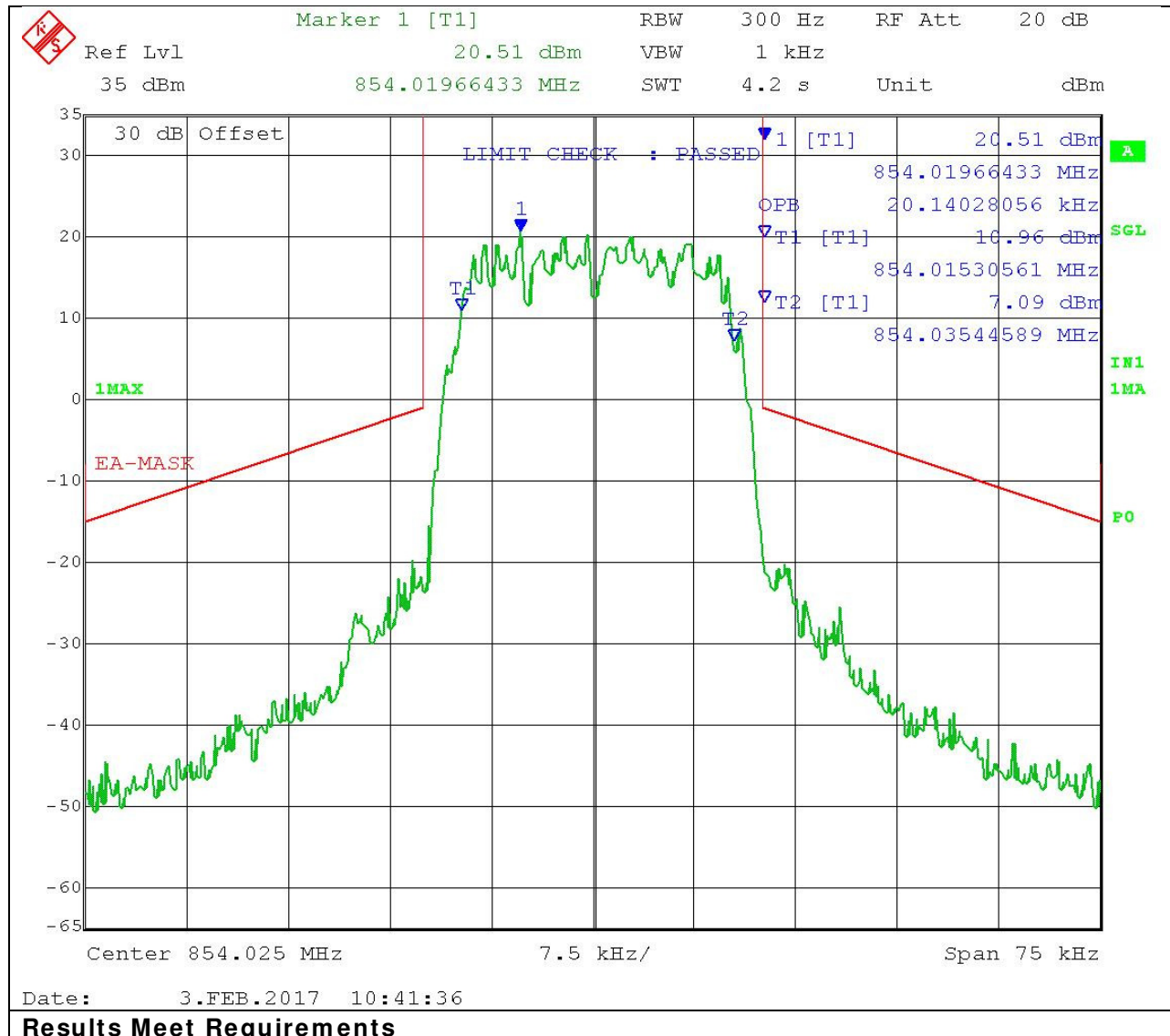
Test Data: 809.025 MHz Plot



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OCCUPIED BANDWIDTH

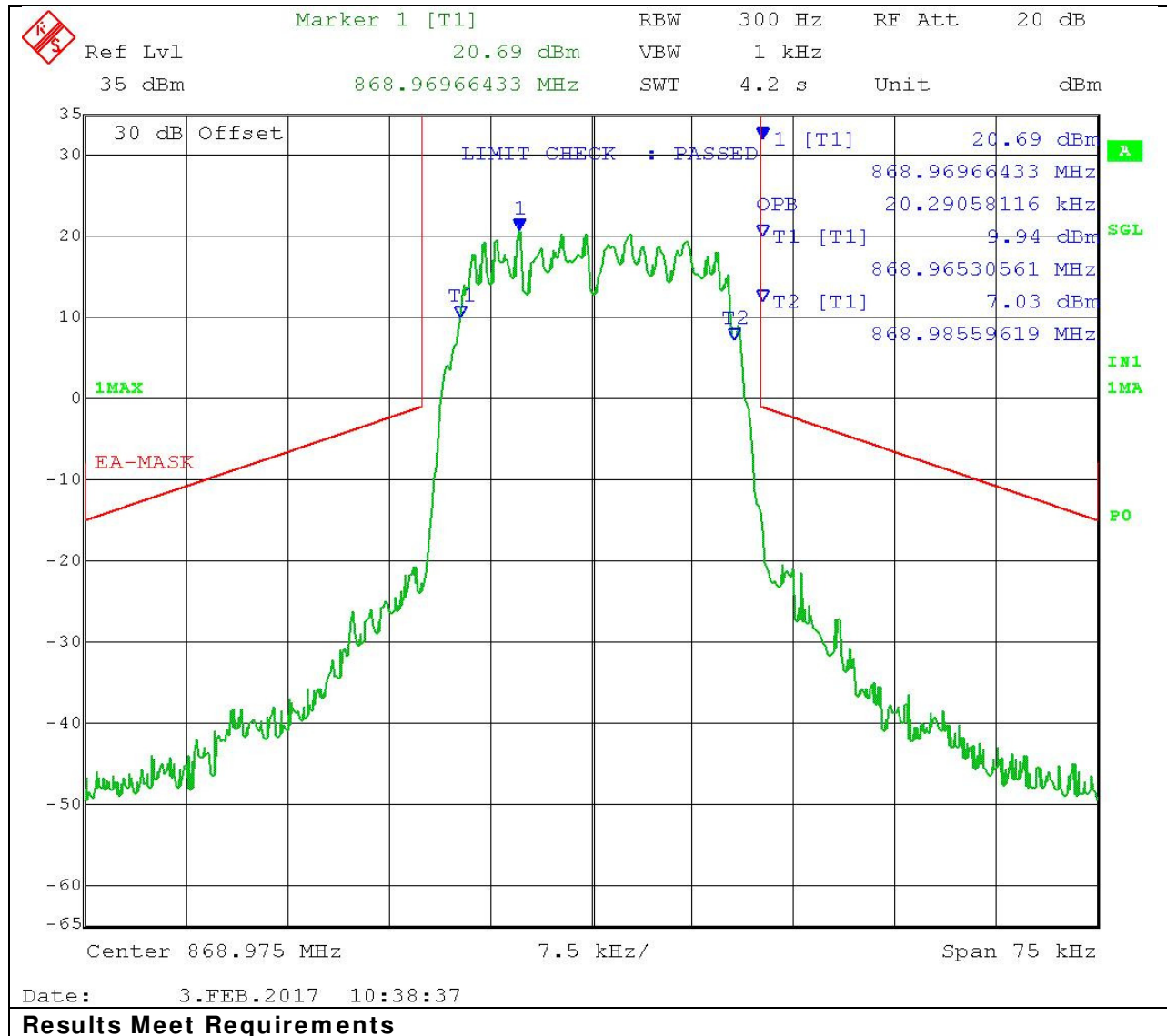
Test Data: 854.025 MHz Plot



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OCCUPIED BANDWIDTH

Test Data: 868.975 MHz Plot



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ADJACENT CHANNEL POWER (ACP)

FCC Rule Part No. 90.221 (a) (c)

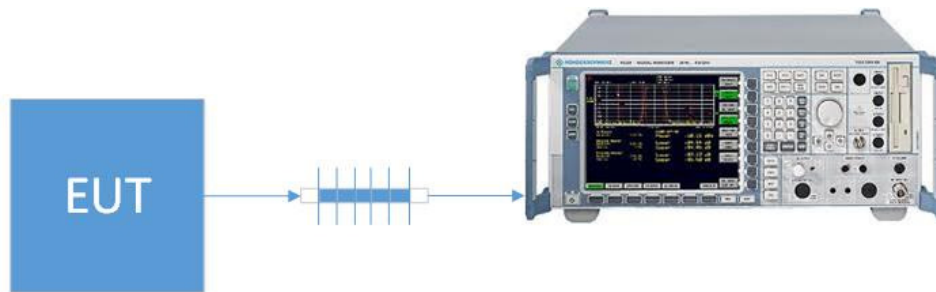
Requirements: Operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the adjacent channel power (ACP) limits below. The table specifies a value for the ACP as a function of the displacement from the channel center frequency and a measurement bandwidth of 18 kHz.

Maximum adjacent power levels for frequencies in the 809-824/854-869 MHz band:

Frequency offset	Maximum ACP (dBc) for devices less than 15 watts	Maximum ACP (dBc) for devices 15 watts and above
25 kHz	-55 dBc	-55 dBc
50 kHz	-65 dBc	-65 dBc
75 kHz	-65 dBc	-70 dBc

Procedure: TIA 603-D, directly coupled measurement at the antenna terminal through 50 ohm termination into EMI receiver with ACP measurement function

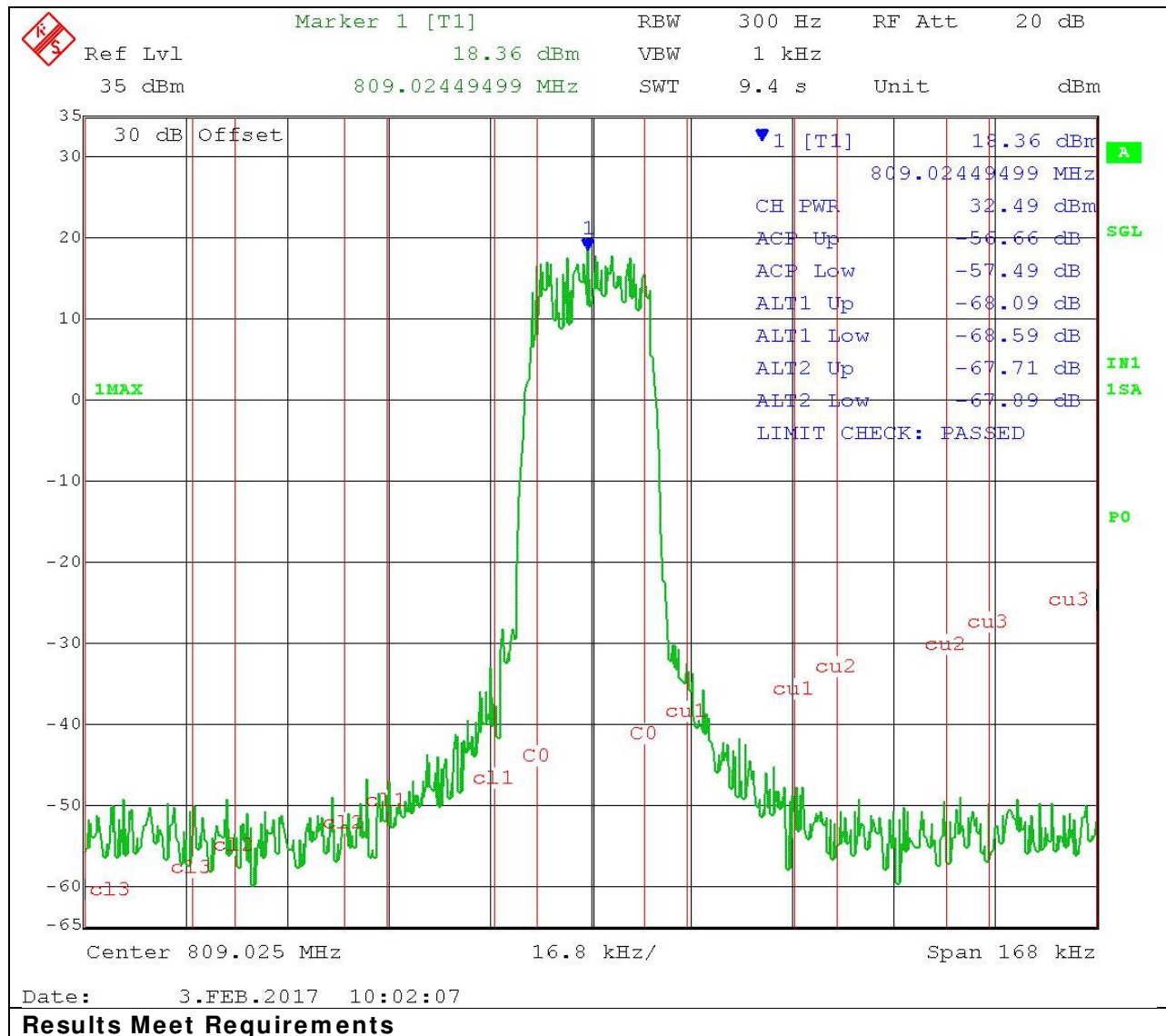
Setup Diagram:



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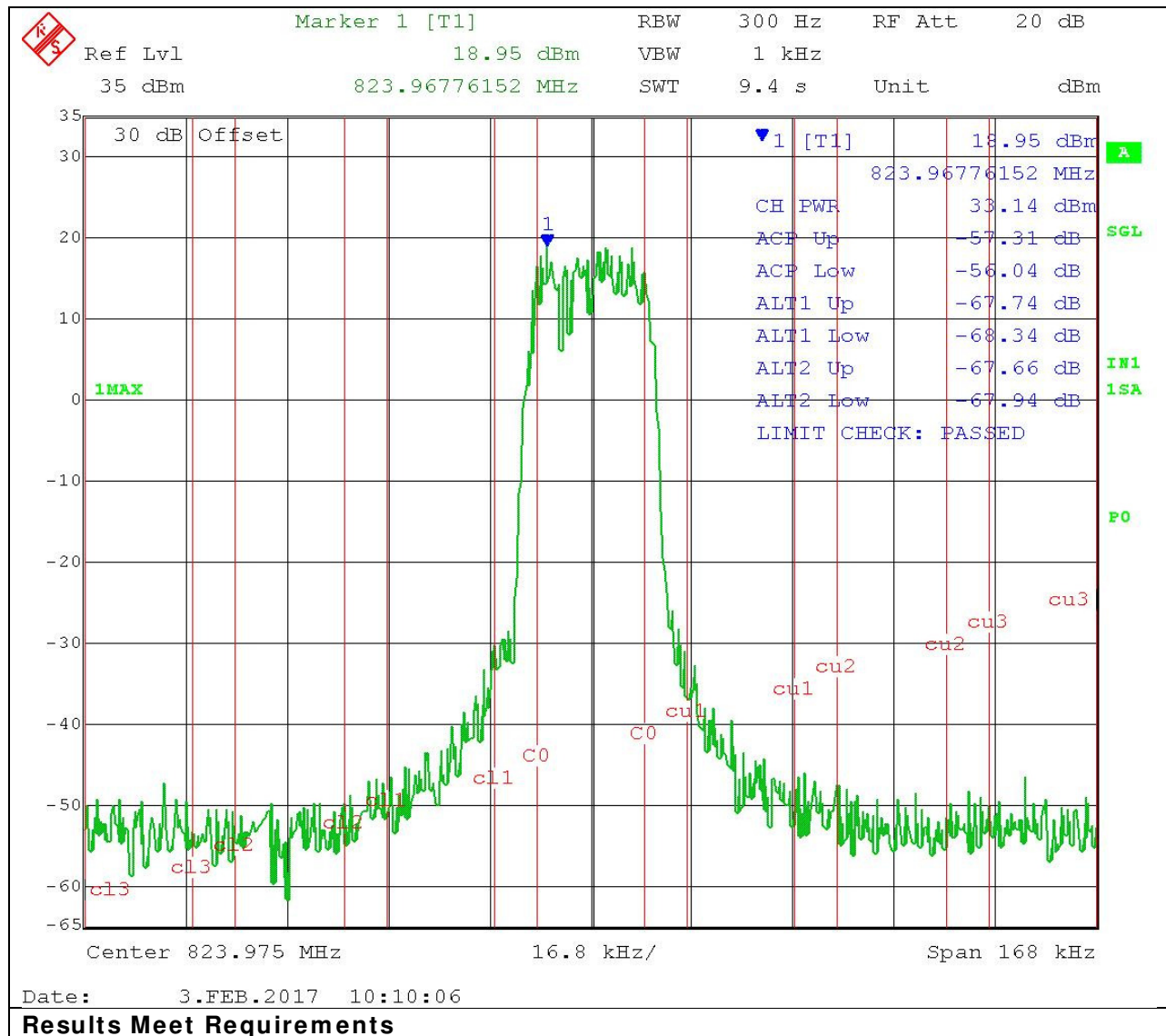
ADJACENT CHANNEL POWER (ACP)

Test Data: 809.025 MHz High Power Plot



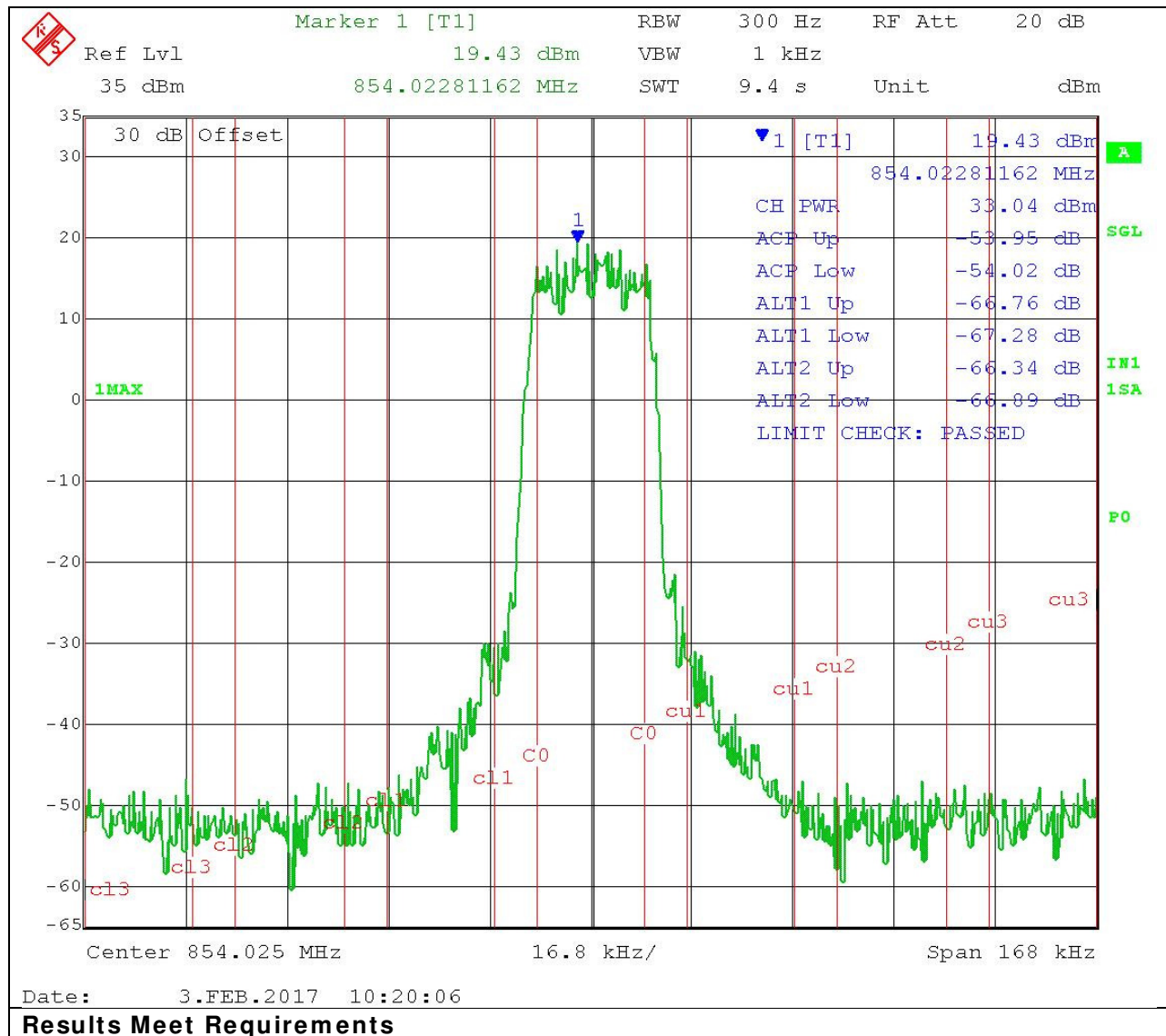
ADJACENT CHANNEL POWER (ACP)

Test Data: 823.975 MHz High Power Plot



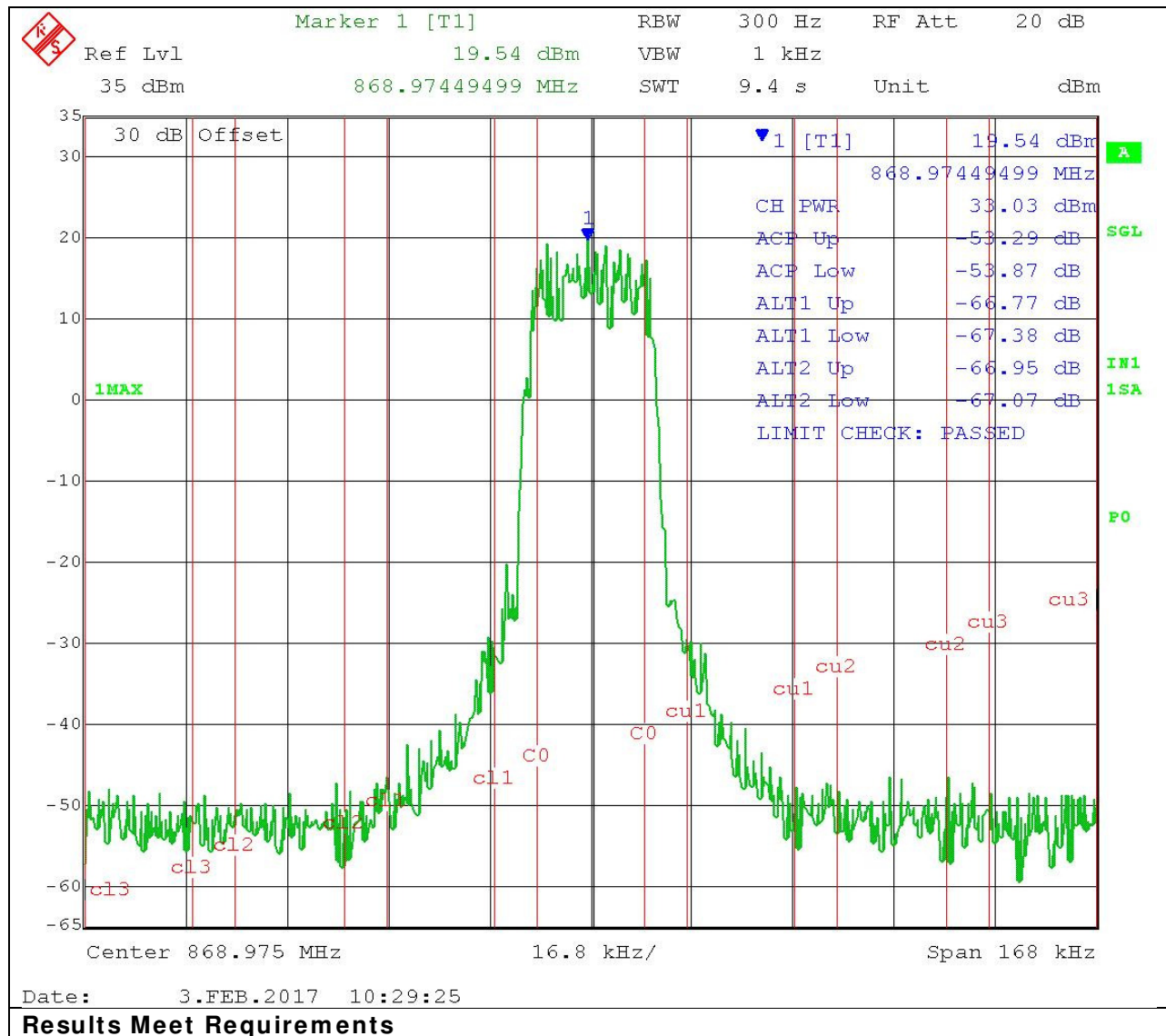
ADJACENT CHANNEL POWER (ACP)

Test Data: 854.025 MHz High Power Plot



ADJACENT CHANNEL POWER (ACP)

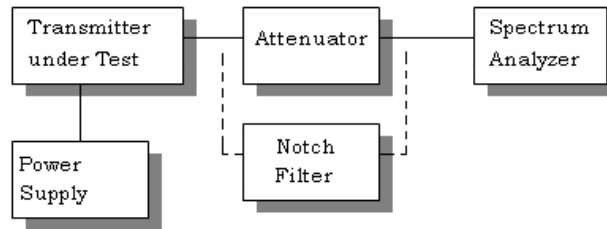
Test Data: 868.975 MHz High Power Plot



SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: Part 2.1051(a), 90.221 (d)

Method of Measuring Conducted Spurious Emissions



Requirements: On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least $43 + 10 \log (P_{\text{watts}})$ dB

Procedure: TIA 603-D, The carrier was modulated internally with random a random bit pattern provided by the applicant. The spectrum was scanned from 9 KHz to at least the 10th harmonic of the highest fundamental frequency.

Test Data: 809.025 MHz High Power

	dBm	Watts	Limit dBc
Power Output	32.84	1.92	45.84
	Frequency MHz	Level dBc	Margin dB
	806.0125	33	0.0
	1612.0250	65.0	12.2
	2418.0375	88.0	35.2
*	3224.0500	86.8	34.0
*	4030.0625	86.1	33.3
*	4836.0750	85.8	32.9
*	5642.0875	82.3	29.4
*	6448.1000	83.6	30.8
*	7254.1125	86.6	33.7
*	8060.1250	85.2	32.3

Note: "*" Indicates noise floor.

Results Meet Requirements

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SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: 823.975 MHz High Power

	dBm	Watts	Limit dBc
Power Output	32.8	1.91	45.8
	Frequency MHz	Level dBc	Margin dB
	823.9875	0	
	1647.9750	74.4	21.6
	2471.9625	91.4	38.6
*	3295.9500	86.8	34.0
*	4119.9375	87.4	34.6
*	4943.9250	86.1	33.3
*	5767.9125	82.8	30.0
*	6591.9000	82.5	29.7
*	7415.8875	86.7	33.9
*	8239.8750	85.9	33.1

Note: “*” Indicates noise floor.

Results Meet Requirements

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SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: 854.025 MHz High Power

	dBm	Watts	Limit dBc
Power Output	33.11	2.05	46.11
	Frequency MHz	Level dBc	Margin dB
	854.0125	33	0.0
	1708.0250	72.7	19.6
	2562.0375	93.3	40.2
*	3416.0500	86.7	33.6
*	4270.0625	88.1	35.0
*	5124.0750	81.6	28.5
	5978.0875	73.8	20.7
*	6832.1000	80.5	27.3
*	7686.1125	86.9	33.8
*	8540.1250	87.8	34.7

Note: “*” Indicates noise floor.

Results Meet Requirements

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SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: 868.975 MHz High Power

	dBm	Watts	Limit dBc
Power Output	33.17	2.07	46.17
	Frequency MHz	Level dBc	Margin dB
	868.9875	33	0.0
	1737.9750	79.4	26.2
	2606.9625	84.4	31.2
*	3475.9500	86.9	33.8
*	4344.9375	87.2	34.1
*	5213.9250	83.6	30.4
	6082.9125	75.9	22.7
*	6951.9000	79.3	26.1
*	7820.8875	86.8	33.6
*	8689.8750	87.9	34.7

Note: "*" Indicates noise floor.

Results Meet Requirements

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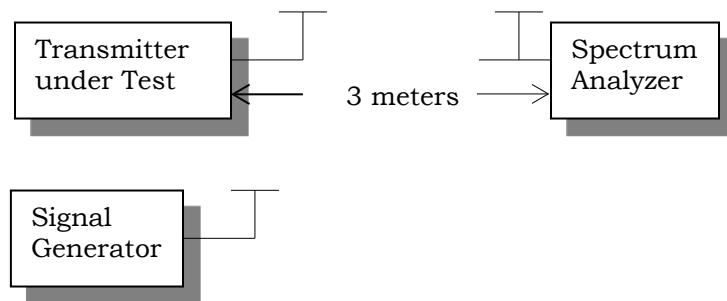
FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

Rule Parts. No.: Part 2.1053, 90.221 (d)

Requirements: On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least $43 + 10 \log$ (Pwatts) dB

Procedure: TIA 603-D, the carrier was unmodulated and the antenna terminals were terminated into a non-radiating 50 ohm end load. The spectrum was scanned from 9 KHz to at least the tenth harmonic of the highest fundamental frequency. Measurements were made at the test site of **TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.**

Setup Diagram:



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FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

Test Data: 868.975 MHz

This test data represents the worst case

Emission Frequency (MHz)	Power Mode	ERP Power Output (dBm)	ERP Power Output (Watts)	FCC Requirement dB	Bandwidth - BW - kHz
868.97	Hi	33.17	2.07	46.17	25.00
Emission Frequency (MHz)	Ant. Polarity	Below Carrier (dBc)		Margin	
1,737.95	V	90.97		44.80	
2,606.93	V	79.41		33.24	
3,475.90	V	84.69		38.52	
4,344.88	V	89.78		43.61	
5,213.85	V	87.51		41.34	
6,082.83	H	84.80		38.63	
6,951.80	V	85.14		38.97	
7,820.78	V	83.52		37.35	
8,689.75	H	79.23		33.06	

Results Meet Requirements

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FREQUENCY STABILITY

Rule Parts No.: Part 2.1055, Part 90.213

Requirements: Temperature range requirements: -30 to +50° C.
Voltage Variation +, -15%
±2.5 PPM

Procedure: TIA 603-D

Test Data: Measurement Table

Temperature	Frequency MHz	Cycles	PPM
25°C (reference)	869.066365		
-30°C	869.066717	352	0.406
-20°C	869.066791	426	0.490
-10°C	869.066812	447	0.514
0°C	869.066756	391	0.450
10°C	869.066745	380	0.437
20°C	869.066741	376	0.433
30°C	869.066771	406	0.467
40°C	869.066775	410	0.472
50°C	869.066782	417	0.480
Input Voltage	Frequency	Cycles	PPM
-15%	869.066337	-28	-0.032
15%	869.066196	-169	-0.194

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EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
24 Volt Power Supply	Astron	VLS-25M	9510040		
Antenna: Biconical 1096 Chamber	Eaton	94455-1	1096	07/14/15	07/14/17
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/14/15	07/14/17
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	09/01/16	09/01/18
Digital Multimeter	Fluke	77	35053830	10/21/15	10/21/17
CHAMBER	Panashield	3M	N/A	04/25/16	12/31/17
Sweep/Signal Generator	Anritsu	68369B	985112	10/28/15	10/28/17
Antenna: Double-Ridged Horn/ETS Horn 2	ETS-Lindgren Chamber	3117	00041534	02/25/15	02/25/17
EMI Test Receiver R & S ESIB 40 Screen Room	Rohde & Schwarz	ESIB 40	100274	08/16/16	08/16/18
Software: Field Strength Program	Timco	N/A	Version 4.0	NA	NA
Antenna: Active Loop	ETS-Lindgren	6502	00062529	11/18/15	11/18/17
Coaxial Cable #103 - KMKM-0180-01 Aqua	Micro-Coax	UFB142A-0-0720-200200	225363-002 (#103)	08/05/15	08/05/17
Type K J Thermometer	Martel	303	080504494	10/26/15	10/26/17
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	04/01/16	04/01/18
Attenuator N 30dB 500W DC-2.5G	Bird	8325	1761	05/18/15	05/18/17
Coaxial Cable - Chamber 3 cable set (Primary)	Micro-Coax	Chamber 3 cable set (Primary)	KMKM-0244-01; KMKM-0670-00; KFKF-0198-01	08/09/16	08/09/18
High Pass Filter 18GHz	Micro-Tronics	HPS18771	-002	05/13/16	05/13/18
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	NA	NA
Attenuator N 30dB 10W DC-18G	Pasternack	PE7015-30	#24	06/22/15	06/22/17
Tunable Notch Filter 250-850 MHz	Eagle	TNF-200	250-850 MHz (#19)	06/26/15	06/26/17
Pre-amp	RF-LAMBDA	RLNA00M45GA	NA	01/04/16	01/04/18

* EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

MEASUREMENT UNCERTAINTY

State of the measurement uncertainty – TIA 603-D June 2010

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16-4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: “Uncertainty in EMC Measurements” and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	EN 300 Limits	Notes
RF Frequency	$\pm 69.5 \text{ Hz}$	$\pm 1 \times 10^{-7}$	(1)
RF Conducted Power	$\pm 0.93 \text{ dB}$	$\pm 0.750 \text{ dB}$	(1)
Conducted spurious emission of transmitter valid up to 40GHz	$\pm 2.36 \text{ dB}$	$\pm 4.0 \text{ dB}$	
Radiated RF Power	$\pm 1.4 \text{ dB}$	$\pm 6.0 \text{ dB}$	
Maximum frequency deviation: Within 300 Hz and 6kHz of audio freq. Within 6kHz and 25kHz of audio Freq.	$\pm 1.88\%$ $\pm 2.04\%$	$\pm 5.0\%$ $\pm 3.0 \text{ dB}$	
Deviation Limitation	$\pm 1.29\%$	$\pm 5.0\%$	
Adjacent channel power	$\pm 1.47 \text{ dB}$	$\pm 5.0 \text{ dB}$	(1)
Radiated emission of transmitter valid up to 18GHz	$\pm 3.96 \text{ dB}$	$\pm 6.0 \text{ dB}$	
Temperature	$\pm 1.0^\circ \text{C}$	$\pm 1.0^\circ \text{C}$	(1)
Humidity	$\pm 5.0\%$	$\pm 10.0\%$	
Valid up to 1 GHz for the RF parameters unless otherwise stated			

- (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=1.96$.

End of REPORT

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