Measurement of RF Interference from a Model TR-3, Digital UHF Transceiver

For : Badger Meter, Inc.
4545 W. Brown Deer Road
Milwaukee, WI 53223

P.O. No. : 549479
Date Tested : May 26 through 29 and June 23, 2009
: October 6, 2009
Test Personnel : Brandon Lugo; Richard King
Specification : FCC Part 90
IC RSS-119

Test Report By : Brandon Lugo

Approved By : Raymond J. Klouda
Raymond J. Klouda
Registered Professional Engineer
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REVISION HISTORY

Revision	Date	Description
—	July 1, 2009	Initial release
A	October 20, 2009	Added an occupied bandwidth measurement

Measurement of RF Emissions from an

Badger Meter, Inc., Model TR-3 Digital UHF Transceiver

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of the series of radio interference measurements performed on a Badger Meter, Inc., Model TR-3 Digital UHF Transceiver (hereinafter referred to as the test item). Serial Nos. 142, 141, and 166 were assigned. The test item is designed to transmit at 460MHz for FCC part 90 and Industry Canada using an external antenna. The test item was submitted for testing by Badger Meter, Inc. located in Milwaukee, WI.

1.2 Purpose - The test series was performed to determine if the test item meets the technical requirements of the Federal Communication Commission (FCC) Part 90 and Industry Canada (IC) RSS-119. Testing was performed in accordance with ANSI C63.4-2003 and TIA-603-C-2004.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 Applicable Documents - The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 90, dated 1 October 2008
- ANSI C63.4-2003, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
- TIA-603-C-2004, “Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards”
- RSS-119 - Land Mobile and Fixed Radio Transmitters and Receivers Operating in The Frequency Range 27.41- 960 MHz Issue 9 June 2007

1.5 EMC Laboratory Identification - This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the

National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.6 Laboratory Conditions The temperature at the time of the test was 23°C and the relative humidity was 35%.

2.0 TEST ITEM SET-UP AND OPERATION:

The test item is a Badger Meter, Inc., Model TR-3 Digital UHF Transceiver. The test item is designed to transmit at 460MHz. The test item operates at a 1 Watt power level. The test item operates in a 12.5kHz channel spacing. Photographs of the test item are shown as Figure 2.

2.1 Power Input - The test item obtained 3.6VDC power through 2 leads from a Tenma DC power supply, Model No. 72-6907, Serial No. 295082.

2.2 Grounding - Since only two wires were used to provide the input power, the test item was ungrounded during the tests.

2.3 Peripheral Equipment - No peripheral equipment was submitted with the test item.

2.4 Interconnect Cables - No interconnect cables were submitted with the test item.

2.5 Operational Mode - For all transmitter tests, the test item was set to transmit at 460MHz.

2.6 Test Item Modifications - No modifications were required for compliance.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

3.2 Calibration Traceability - Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

3.3 Measurement Uncertainty - All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty budgets were based on guidelines in "ISO Guide

to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

The measurement uncertainty for these tests is presented below:

Conducted Emission Measurements		
Combined Standard Uncertainty	1.07 dB	-1.07 dB
Expanded Uncertainty (95% confidence)	2.1 dB	-2.1 dB

Radiated Emission Measurements		
Combined Standard Uncertainty	2.26 dB	-2.18 dB
Expanded Uncertainty (95% confidence)	4.5 dB	-4.4 dB

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.2 Transmitter:

4.2.1 RF Power Output:

4.2.1.1 Requirements - In accordance with paragraph 90.205(r), the output power shall not exceed by more than 20 percent the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

4.2.1.2 Procedures – With the test item transmitting at 460MHz, the antenna port of the test item was connected to a spectrum analyzer through 40 dB of attenuation. The resolution bandwidth of the spectrum analyzer was set wider than the bandwidth of the test item. The output power of the item was then measured.

4.2.1.3 Results - The output power measurements are shown in a tabular form on page 20. As can be seen from the data, the power output at each frequency is within the maximum allowable power of 20% above the manufacturer's rated output power.

4.2.2 Emission Mask

4.2.2.1 Requirements - For equipment operating at 460MHz with a 12.5kHz channel bandwidth, any emissions 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 (fo) to 5.625kHz removed from (fo): Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625kHz but no more than

12.5kHz: At least 7.25(fd – 2.88kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz; At least 50 + 10log (P) dB or 70dB whichever is the lesser attenuation.

4.2.2.2 Procedures - The test item was set to transmit at 460MHz and was run in the Standard Modulation data packet. During Standard Modulation, a message is sent with a header fixed length of 3 bytes, and a message length of 1 byte.

(a) The antenna port of the test item was connected to a spectrum analyzer through 40dB of attenuation.

(b) The following spectrum analyzer settings were employed:
- trace 1 = on
- center frequency = transmit frequency of the test item
- resolution bandwidth = 1MHz
- video bandwidth > resolution bandwidth
- frequency span = 100kHz/200kHz
- sweep = Auto
- detector function = peak
- trace = max hold

(c) Several sweeps were made with the settings listed above.

(d) Trace 1 was changed from max hold to view

(e) The following spectrum analyzer settings were employed:
- trace 2 = on
- resolution bandwidth = 100Hz/300Hz
- video bandwidth = 1kHz
- sweep = Auto
- detector function = peak
- trace = max hold

(f) Several sweeps were made with the settings listed above.

4.2.2.3 Results - The spectrum analyzer plots of the emissions of the test item are shown on pages 21 through 23. The limits, shown on the plots, are referenced to the power measured with a 1MHz resolution bandwidth. As can be seen from the data, the test item did comply with the emission mask requirements. The 99% bandwidth measured 11 kHz for the 12.5 kHz channel.

4.2.3 Field Strength of Spurious Emissions:

4.2.3.1 Requirements - For a 12.5kHz channel - on any frequency

removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz the emissions must be attenuated by at least 50 + 10log (P) dB or 70dB whichever is the lesser attenuation. For a 12.5kHz channel - on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 250% of the emission bandwidth, the emissions must be attenuated by at least 43 + 10log (P) dB.

4.2.3.2 Procedures - All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4 2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

1. Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 5GHz was investigated using a peak detector function. All preliminary tests were performed separately with the test item operating in the transmit mode at 460MHz.

2. All significant broadband and narrowband signals found in the preliminary sweeps were then measured using a peak detector at a test distance of 3 meters. The measurements were made with a tuned dipole or double ridged waveguide antenna over the frequency range of 30MHz to 5GHz.

3. To ensure that maximum emission levels were measured, the following steps were taken:

   a) The test item was rotated so that all of its sides were exposed to the receiving antenna.
   b) Since the measuring antennas are linearly polarized, both horizontal and vertical field components were measured.
   c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

4. The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power a

tuned dipole or double ridged waveguide antenna was set in place of the test item and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was corrected to compensate for cable loss, as required, and when the double ridged waveguide antenna was used, increased by the difference in gain between the dipole and the waveguide antenna.

4.2.3.3 Results - The preliminary radiated emissions plots are presented on pages 24 through 27. Factors for the antennas and cables were added to the data before it was plotted. This data is only presented for a reference, and is not used as official data.

The final radiated levels are presented on page 28. The radiated emissions were measured through the 10th harmonic. As can be seen from the data, all emissions measured from the test item were within the specification limits. Photographs of the test configuration are shown in Figures 3 and 4.

4.2.4 Frequency Stability :

4.2.4.1 Requirements - Fixed and base stations operating at 460MHz with a 12.5kHz channel bandwidth must have a frequency stability of 1.5ppm.

4.2.4.2 Procedures - A stub antenna was connected to a frequency counter and placed next to the test item. The test item and stub antenna were then placed in a humidity temperature chamber.

a) The test item was set to transmit at 460MHz. The transmit frequency was measured and recorded at ambient temperature.
b) The temperature chamber was then set to -30ºC.
c) Once the temperature chamber had reached -30ºC, the test item was allowed to soak for 30 minutes.
d) After soaking at -30ºC for thirty minutes, the test item was turned on and set to transmit at 460MHz and the transmit frequency was measured and recorded.
e) Steps (b) through (d) were repeated at -20ºC.
f) Steps (b) through (d) were repeated at -10ºC.
g) Steps (b) through (d) were repeated at 0ºC.
h) Steps (b) through (d) were repeated at +10ºC.
i) Steps (b) through (d) were repeated at +20ºC.
j) Steps (b) through (d) were repeated at +30ºC.
k) Steps (b) through (d) were repeated at +40ºC.
l) Steps (b) through (d) were repeated at +50ºC.
m) The test item was then removed from the temperature chamber and allowed to adjust to nominal room temperature.
n) The supply voltage was checked and adjusted to the nominal level (3.6VDC).

The test item was turned on and set to transmit at 460MHz. The transmit frequency was measured and recorded at ambient temperature.

o) The supply voltage was then varied to 85% of its nominal level (3.06VDC). The test item was turned on and set to transmit at 460MHz. The transmit frequency was measured and recorded at ambient temperature.

p) The supply voltage was then varied to 115% of its nominal level (4.14VAC). The test item was turned on and set to transmit at 460MHz. The transmit frequency was measured and recorded at ambient temperature.

4.2.4.3 Results - The frequency stability measurements are presented on pages 29 and 30. As can be seen from the data, all frequency deviations were within the 1.5 ppm limit. A photograph of the test configuration is shown on Figure 5.

4.2.5 Transient Frequency Behavior

4.2.5.1 Requirements - Transmitters designed to operate at 460MHz with 12.5kHz channel spacing must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals	Maximum Frequency Difference	Time (ms)
t_1[4]	+/-12.5kHz/6.25kHz	10.0
t_2	+/-12.5kHz/6.25kHz	25.0
t_3[4]	+/-12.5kHz/6.25kHz	10.0

Where:

t_1[4] is the time period immediately following t_{on}
t_2 is the time period immediately following t_1
t_3[4] is the time period from the instant when the transmitter is turned off until t_{off}

[4] If transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

4.2.5.2 Procedures - Two test signals were connected to the test discriminator via a combining network. The transmitter was connected to a 50 ohm power attenuator. The output of the power attenuator was connected to the test discriminator via one input of the combining network. A test signal was connected to the second input of the combining network.

(a) The test signal was adjusted to the nominal frequency of the transmitter.

(b) The test signal was modulated by a 1 kHz signal with a deviation equal to the value of the relevant channel separation (12.5kHz).

(c) The test signal was adjusted to correspond to 0.5% of the power of the transmitter under test measured at the input of the test discriminator. This level was maintained throughout the measurement.

(d) The amplitude difference (ad) and the frequency difference (fd) output of the test discriminator were connected to a storage oscilloscope.

(e) The storage oscilloscope was set to display the channel corresponding to the (fd) input up to ±1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

(f) The storage oscilloscope was set to a rate of 5 ms/div and set so that the triggering occurs at 1 div from the left edge of the display.

(g) The 1 kHz test signal was shown continuously. The storage oscilloscope was set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

(h) The transmitter was then switched on, without modulation, to produce the trigger pulse and a picture on the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

(i) The transmit signal suppresses the 1 kHz test signal and produces the start of the test or t_{on}. During this test time, the frequency difference was measured and recorded verses time.

(j) The transmitter was then switched off to produce the trigger pulse and a picture of the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the frequency difference of the transmitter versus time and the other showing the 1 kHz test signal.

(k) The transmitter signal no longer suppresses the 1 kHz test signal and produces t_3.

4.2.5.3 Results - The plots of the transient frequency behavior are shown on pages 31 and 32. As can be seen from the data, all transient frequencies were within the maximum frequency difference limits.

5.0 CONCLUSIONS:

It was determined that the Badger Meter, Inc., Model TR-3 Digital UHF Transceiver did fully meet the RF power output, emissions mask, field strength of spurious emissions, frequency stability, and transient frequency behavior requirements of the FCC "Code of Federal Regulations" Title 47, Part 90, and RSS-119 - Land Mobile and

Fixed Radio Transmitters and Receivers Operating in The Frequency Range 27.41- 960 MHz Issue 9 June 2007.

6.0 CERTIFICATION:

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

7.0 ENDORSEMENT DISCLAIMER:

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

TABLE I: TEST EQUIPMENT LIST

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ 500L	0028483108	1.8GHZ	N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
ETD0	ENV Chambers For Auto Dept Use Only	Thermotron	S-8	15461	-70 to 150 degrees C	Note 1	
ETDA	HONEYWELL CHART RECORDER	HONEYWELL	DR45AT-1100	0825Y878133300009	PROGRAMMABLE	12	
ETDC	Temperature Controller	Thermotron	2800	753726	Programmable	Note 1	
GBR6	SIGNAL GENERATOR	HEWLETT PACKARD	8648C	3642U02047	9KHZ-3000MHZ	2/13/2009	2/13/2010
GCR0	SIGNAL GENERATOR	HEWLETT PACKARD	8647A	3414U00454	0.25-1000MHZ	8/21/2008	8/21/2009
GDJ0	SYNTHESIZED GENERATOR	HEWLETT PACKARD	8672A	2221A02477	2-18GHZ	2/25/2009	2/25/2010
GRD0	SIGNAL GENERATOR	HEWLETT PACKARD	E4432B	US38080222	250KHZ-3.0GHZ	9/5/2008	9/5/2009
MDBN	MULTIMETER (B. LUGO)	FLUKE CORPORATION	177	84990070		1/20/2009	1/20/2010
MFC0	MICROWAVE FREQ. COUNTER	HEWLETT PACKARD	5343A	2133A00591	10HZ-26GHZ	5/30/2008	5/30/2009
MSP6	8 CH DIGITAL OSCILLOSCOPE	YOKOGAWA	DL708E	7018GD573	---	1/15/2009	1/15/2010
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	3/12/2009	3/12/2010
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	10/25/2008	10/25/2009
NWI1	RIDGED WAVE GUIDE	AEL	H1498	154	2-18GHZ	10/25/2008	10/25/2009
NWP0	DOUBLE RIDGED WAVEGUIDE ANTENNA	EATON	3115	2099	1GHZ-18GHZ	10/25/2008	10/25/2009
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/11/2009	3/11/2010
RBE1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESU26	10096	20Hz-26GHz	4/15/2009	4/15/2010
RYE0	MODULATION ANALYZER	HEWLETT PACKARD	8901B	3104A03410	0.15-1300MHZ	5/23/2009	5/23/2010
T1EE	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BN2321	DC-18GHZ	12/4/2008	12/4/2009
T2DA	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BH5446	DC-18GHZ	9/3/2008	9/3/2009
T2DH	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1039	DC-18GHZ	1/22/2009	1/22/2010

N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

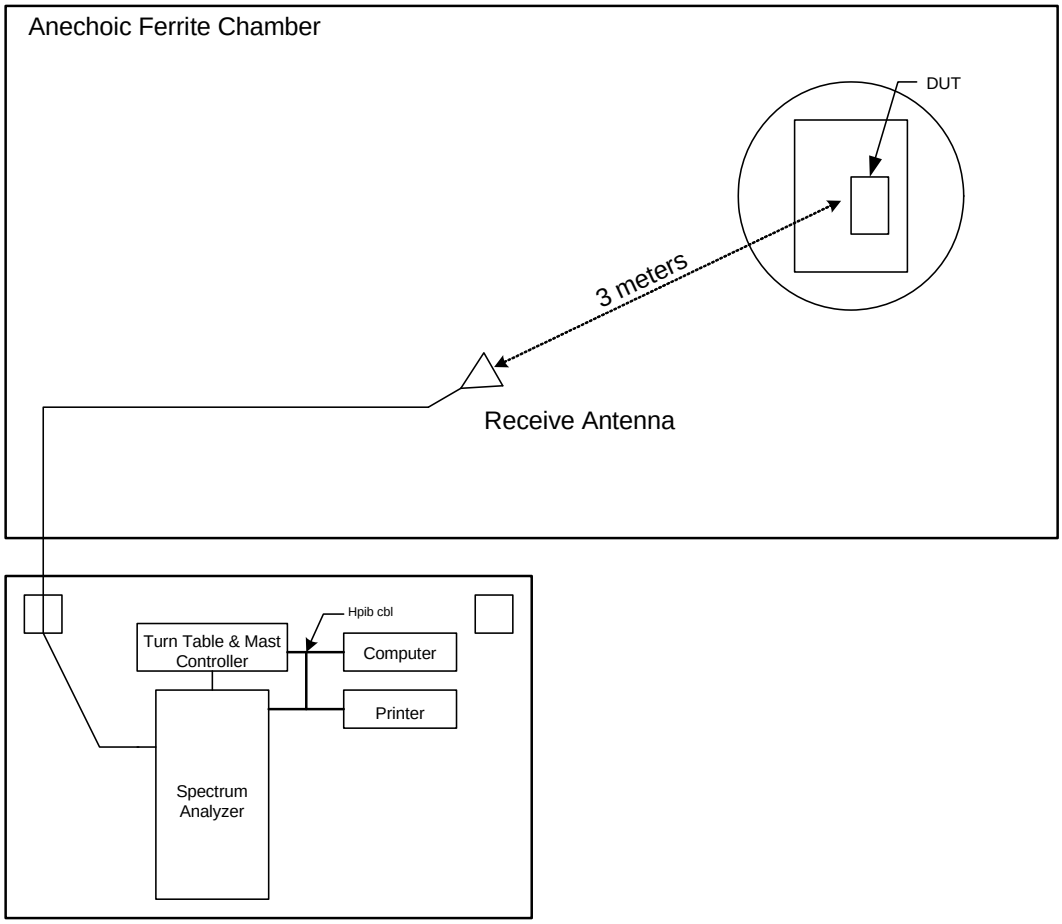


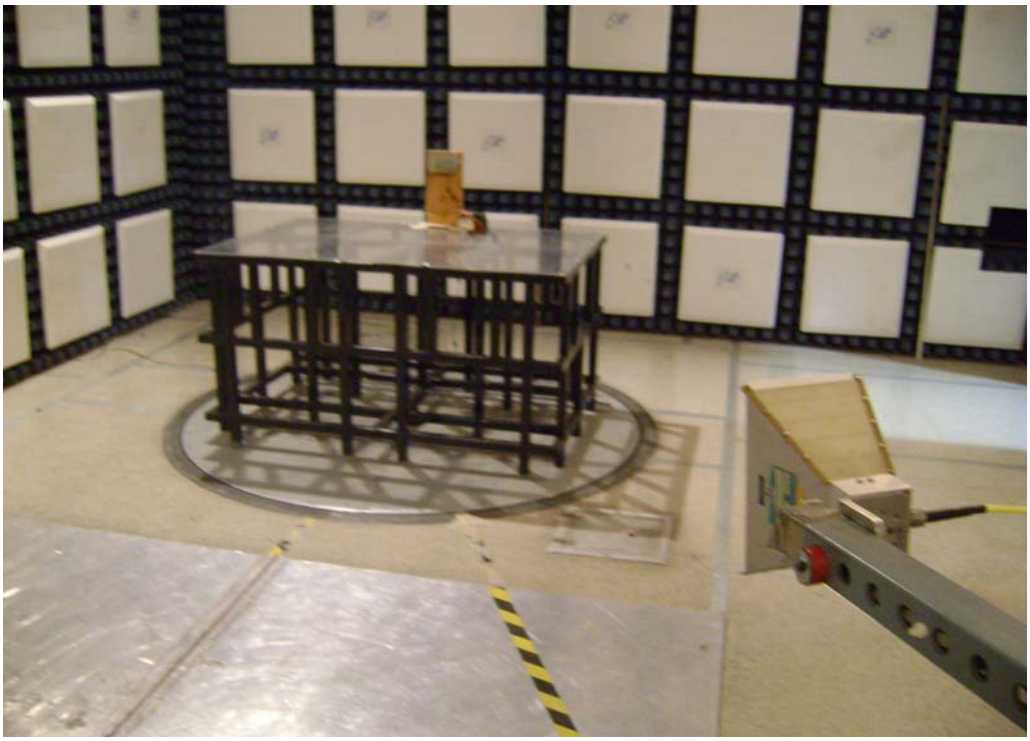
FIGURE 1 BLOCK DIAGRAM OF RADIATED EMISSIONS TEST SETUP

Figure 3

Test Set-up for Radiated Emissions, 30-1000MHz - Horizontal Polarization

Test Set-up for Radiated Emissions, 30-1000MHz - Vertical Polarization

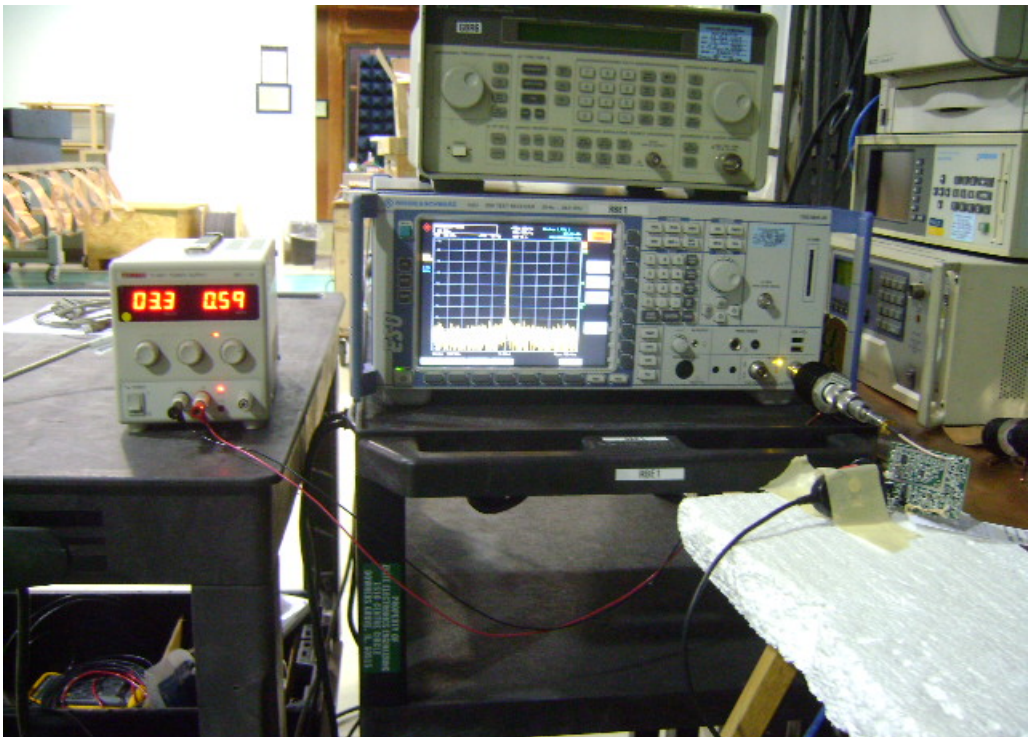
Figure 4



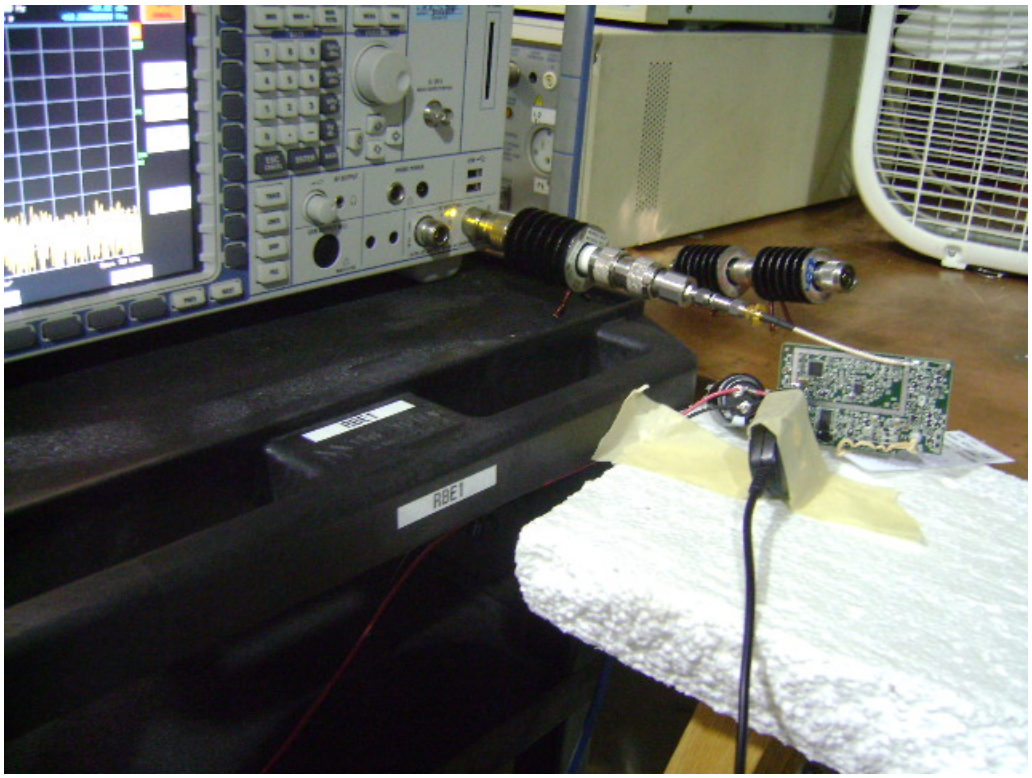
Test Set-up for Radiated Emissions, 1000-5000MHz - Horizontal Polarization

Test Set-up for Radiated Emissions, 1000-5000MHz - Vertical Polarization

Figure 5



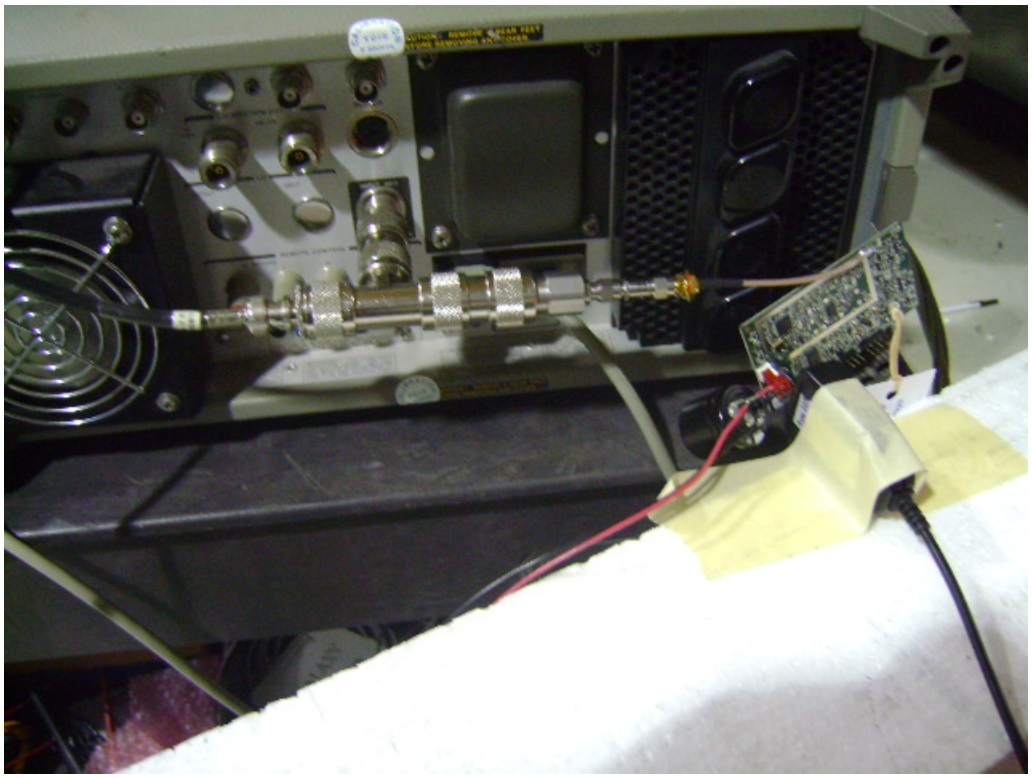
Test Set-up for RF Power Output and Occupied Bandwidth



Test Set-up for RF Power Output and Occupied Bandwidth

Figure 6

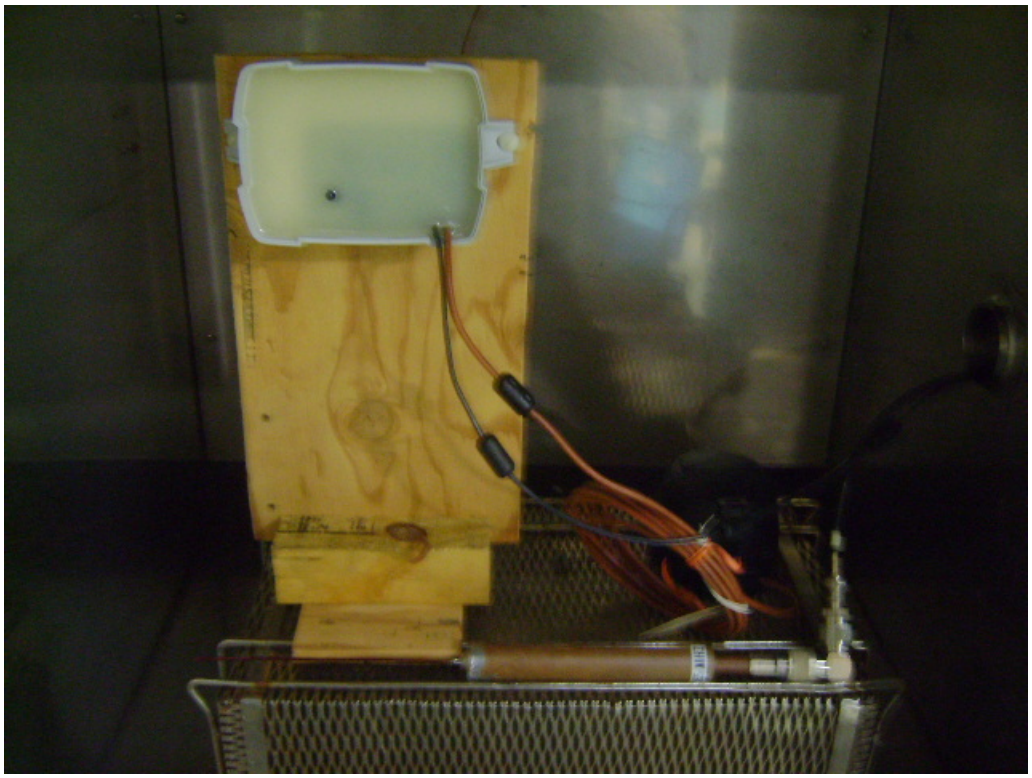
Test Set-up for Transient Frequency Response Behavior



Test Set-up for Transient Frequency Response Behavior

Figure 7

Test Set-up for Frequency Stability – Frequency vs. Temperature



Test Set-up for Frequency Stability – Frequency vs. Temperature

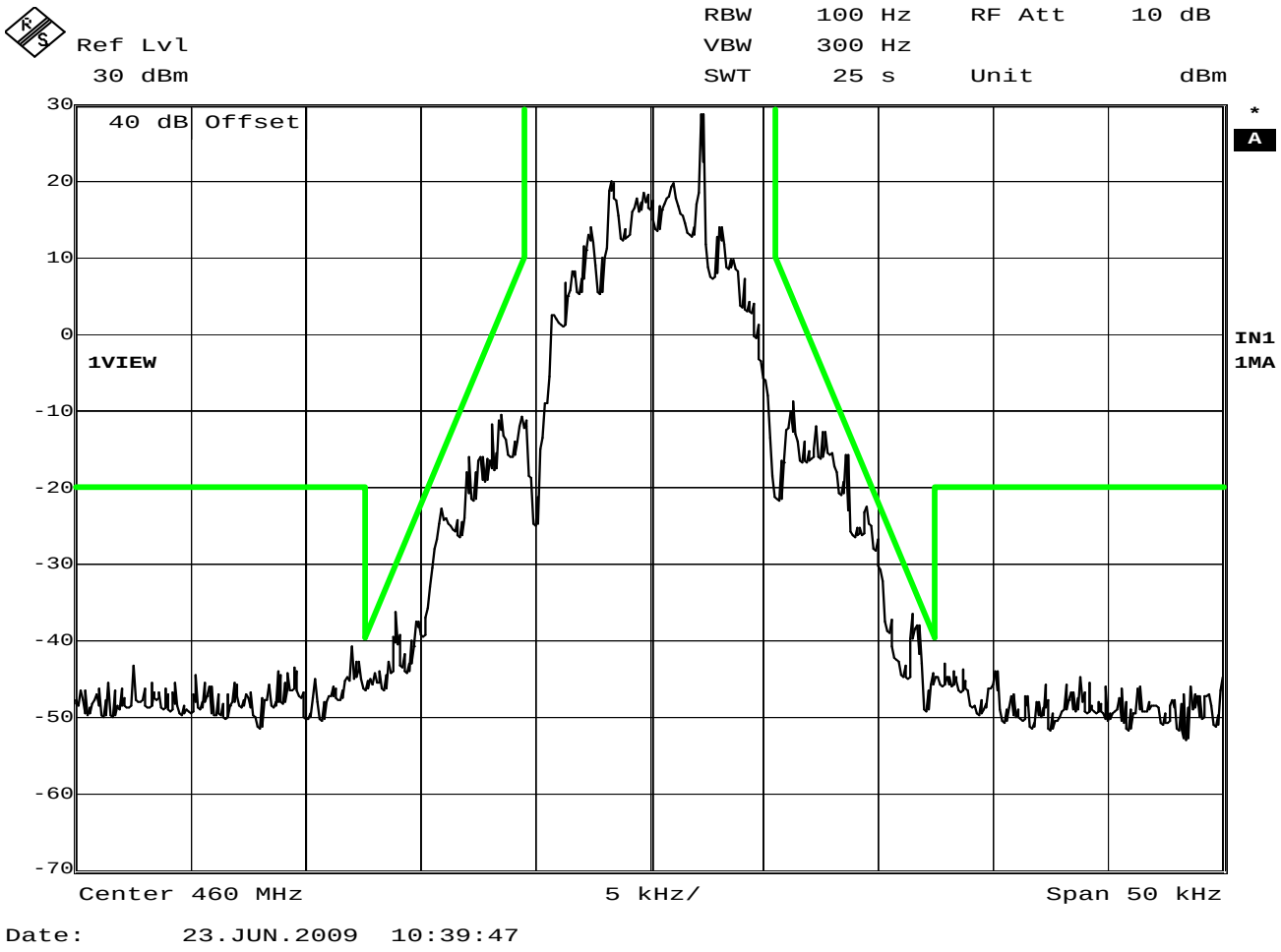
DATA PAGE

MANUFACTURER : Badger Meter, Inc.
MODEL NO. : TR-3
SERIAL NO. : See below
TEST ITEM POWER : 1W
TEST ITEM FREQUENCY : 460MHz
SPECIFICATION : RSS-119
TEST PERFORMED : RF Output Power
DATE : May 27, 2008
NOTES :

UNIT	Firmware Version	Rated Power (Watts)	Frequency (MHz)	Meter Reading (dBm)	Attenuation (dB)	Total (dBm)	Total (Watts)	Rated Power + 20% (Watts)
141	V 1.25	1	460	-10.98	40.0	29.02	.809	1.2
166	V 2.25	1	460	-10.78	40.0	29.22	.836	1.2

Checked By: Brandon Lugo

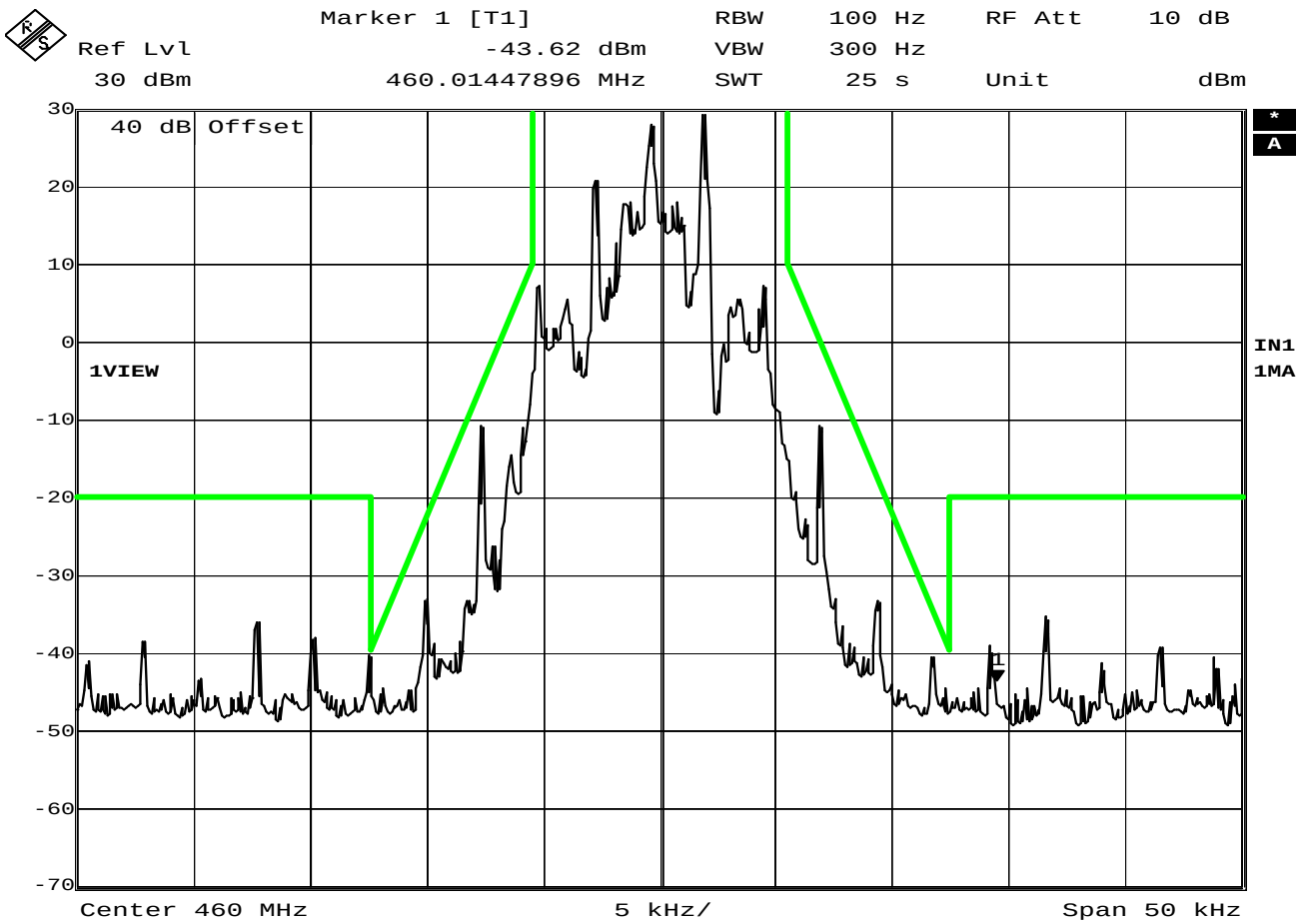
Brandon Lugo



FCC 90/RSS-119 – Occupied Bandwidth

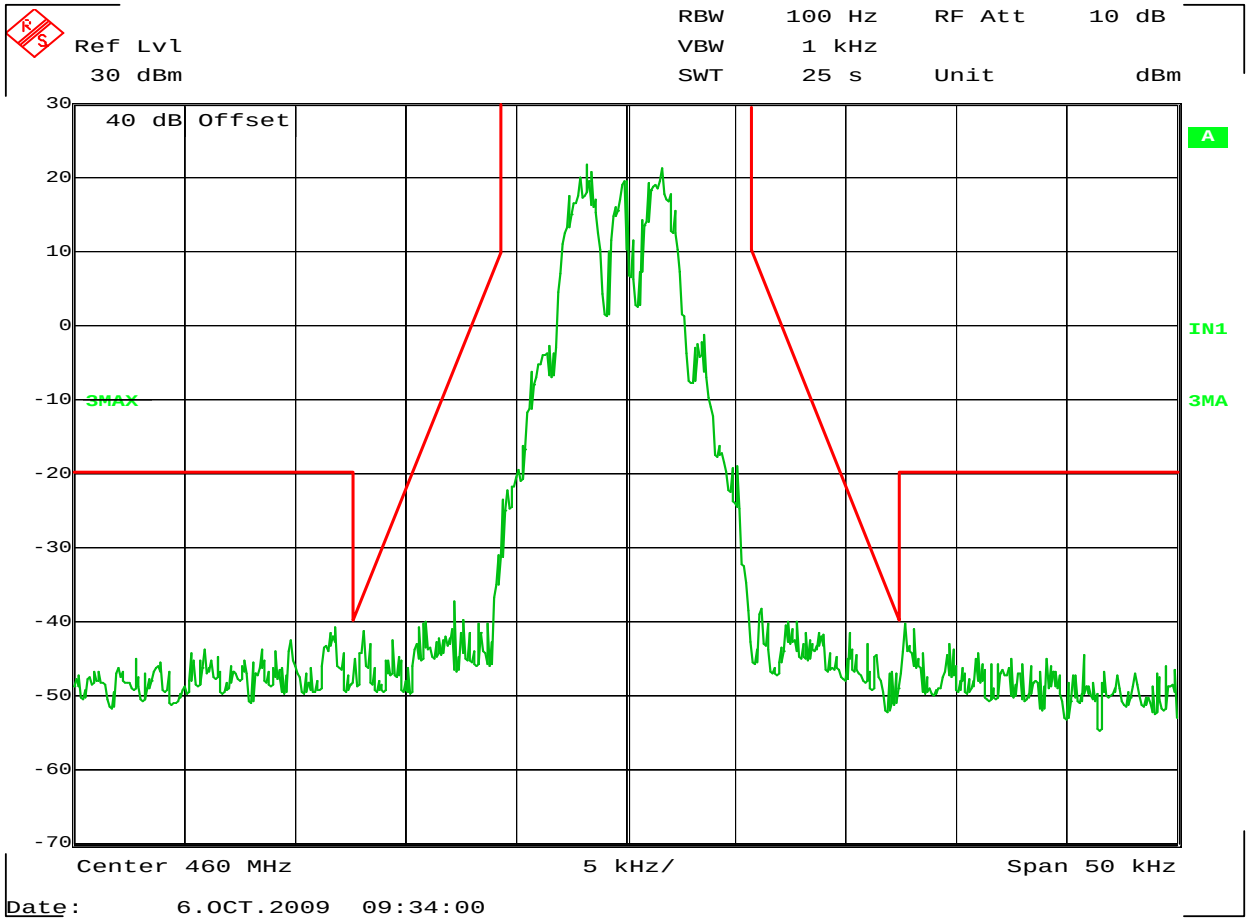
MANUFACTURER : Badger Meter, Inc.
MODEL NUMBER : TR-3
SERIAL NUMBER : 141
TEST MODE : Two level FSK
FREQUENCY : 460MHz
POWER LEVEL : 1W
CHANNEL SPACING : 12.5kHz
MODULATION : “Standard Modulation” Data packet selection
NOTES : Firmware – V 1.28
DATE TESTED : June 23, 2009
EQUIPMENT USED : RBE1, T1EE

:



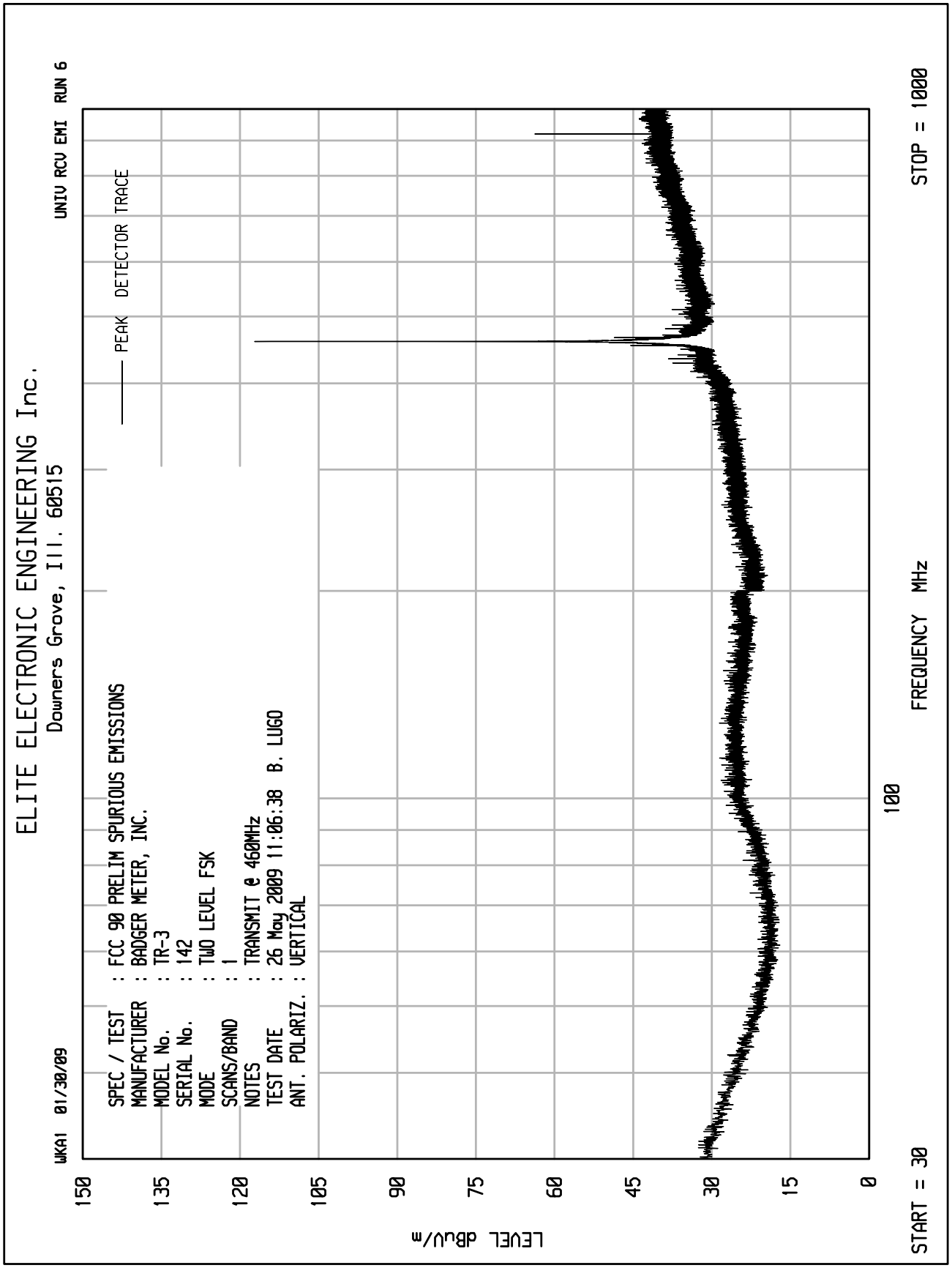
FCC 90/RSS-119 – Occupied Bandwidth

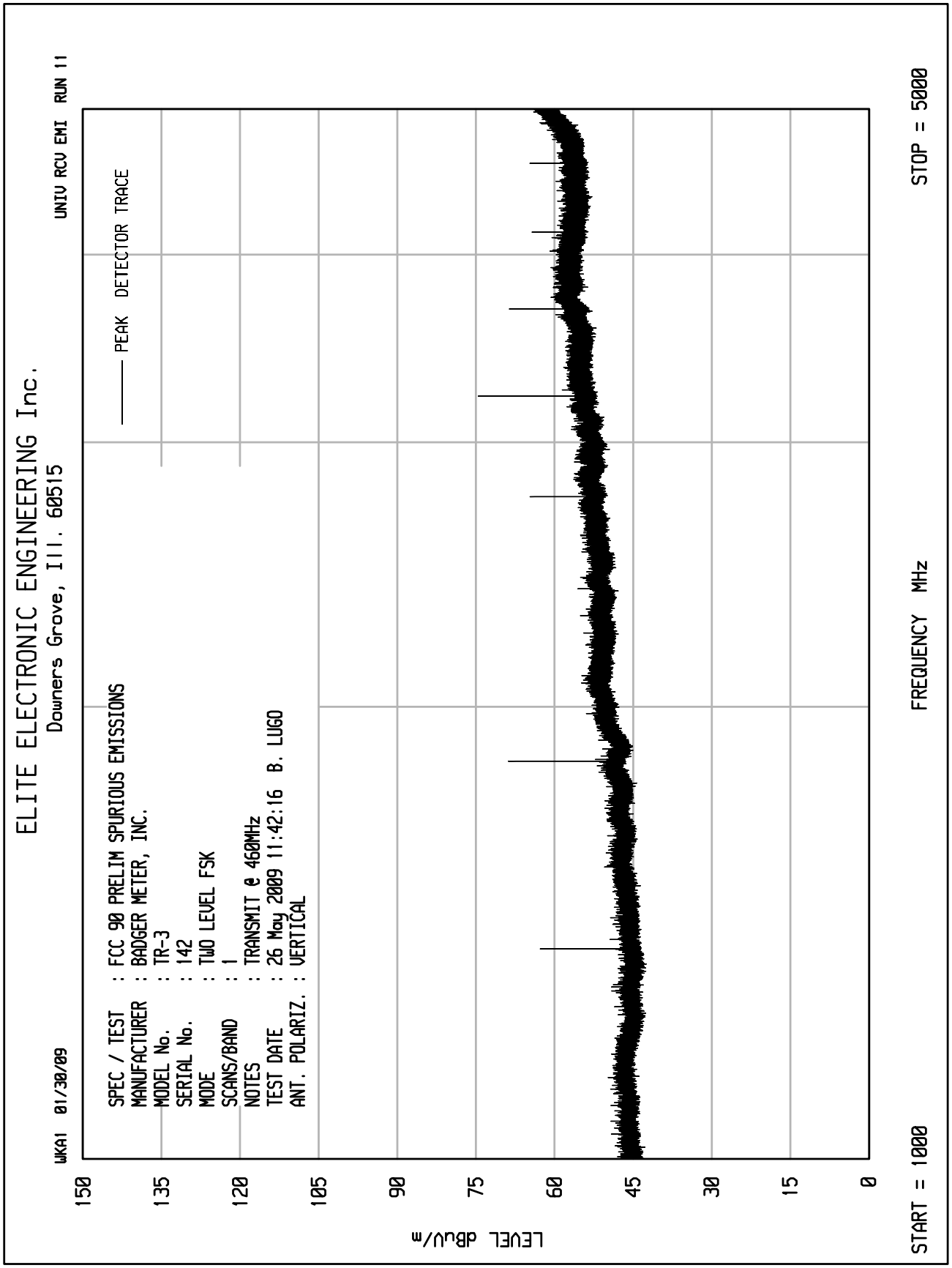
MANUFACTURER : Badger Meter, Inc.
MODEL NUMBER : TR-3
SERIAL NUMBER : 166
TEST MODE : Two level FSK
FREQUENCY : 460MHz
POWER LEVEL : 1W
CHANNEL SPACING : 12.5kHz
MODULATION : “Standard Modulation” Data packet selection
NOTES : Firmware – V 2.28
DATE TESTED : June 23, 2009
EQUIPMENT USED : RBE1, T1EE



FCC 90/RSS-119 – Occupied Bandwidth

MANUFACTURER : Badger Meter, Inc.
MODEL NUMBER : TR-3
SERIAL NUMBER : 166
TEST MODE : Two level FSK
FREQUENCY : 460MHz
POWER LEVEL : 1W
CHANNEL SPACING : 12.5kHz
MODULATION : PN9
NOTES : Firmware – V 2.28
DATE TESTED : June 23, 2009
EQUIPMENT USED : RBE1, T1EE


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKAI 01/30/09
SPEC / TEST : FCC 90 PRELIM SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER, INC.
MODEL No. : TR-3
SERIAL No. : 142
MODE : TWO LEVEL FSK
SCANS/BAND : 1
NOTES : TRANSMIT @ 460MHz
TEST DATE : 26 May 2009 11:06:38 B. LUGO
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000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Downers Grove, Ill. 60515
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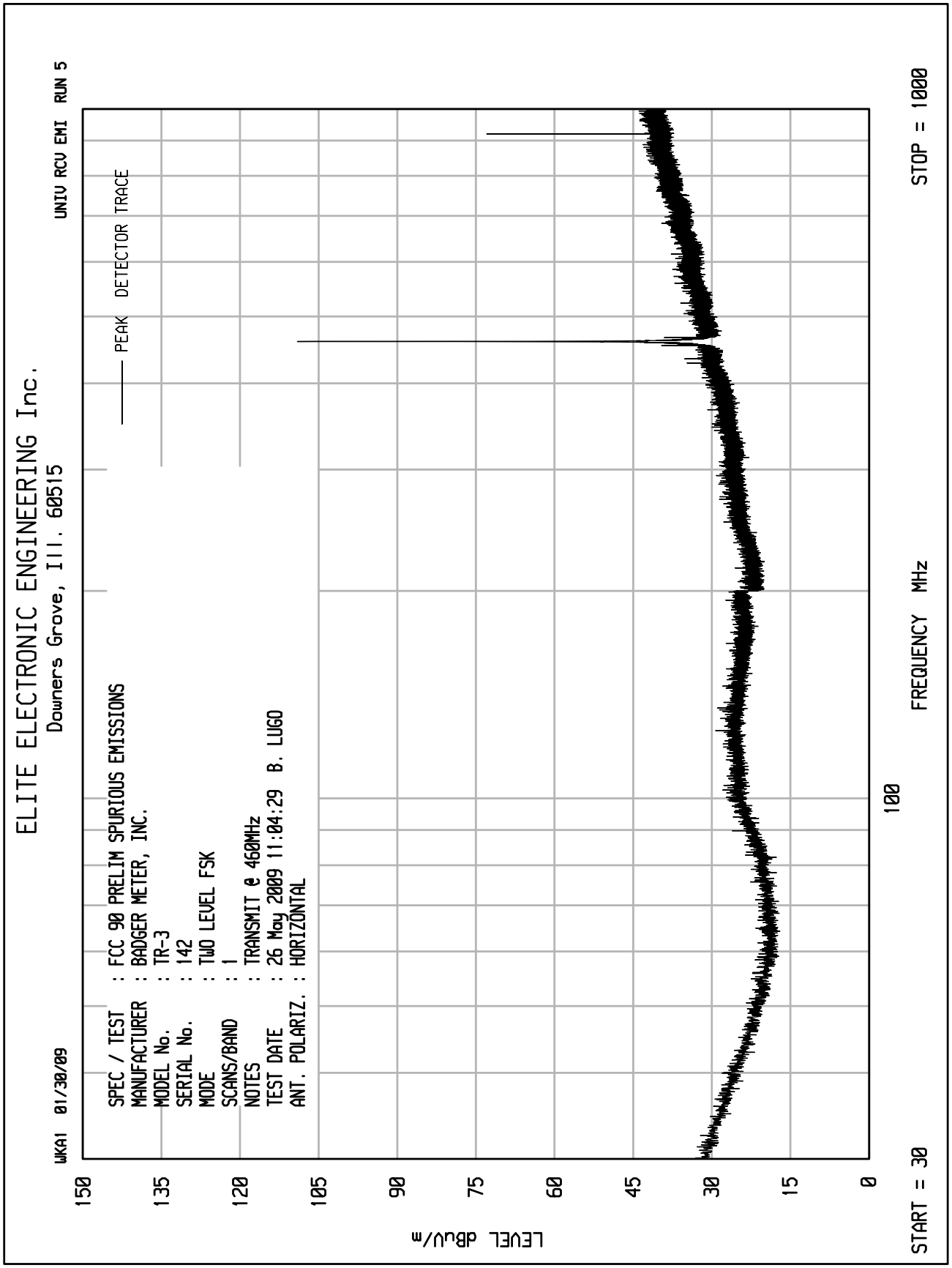
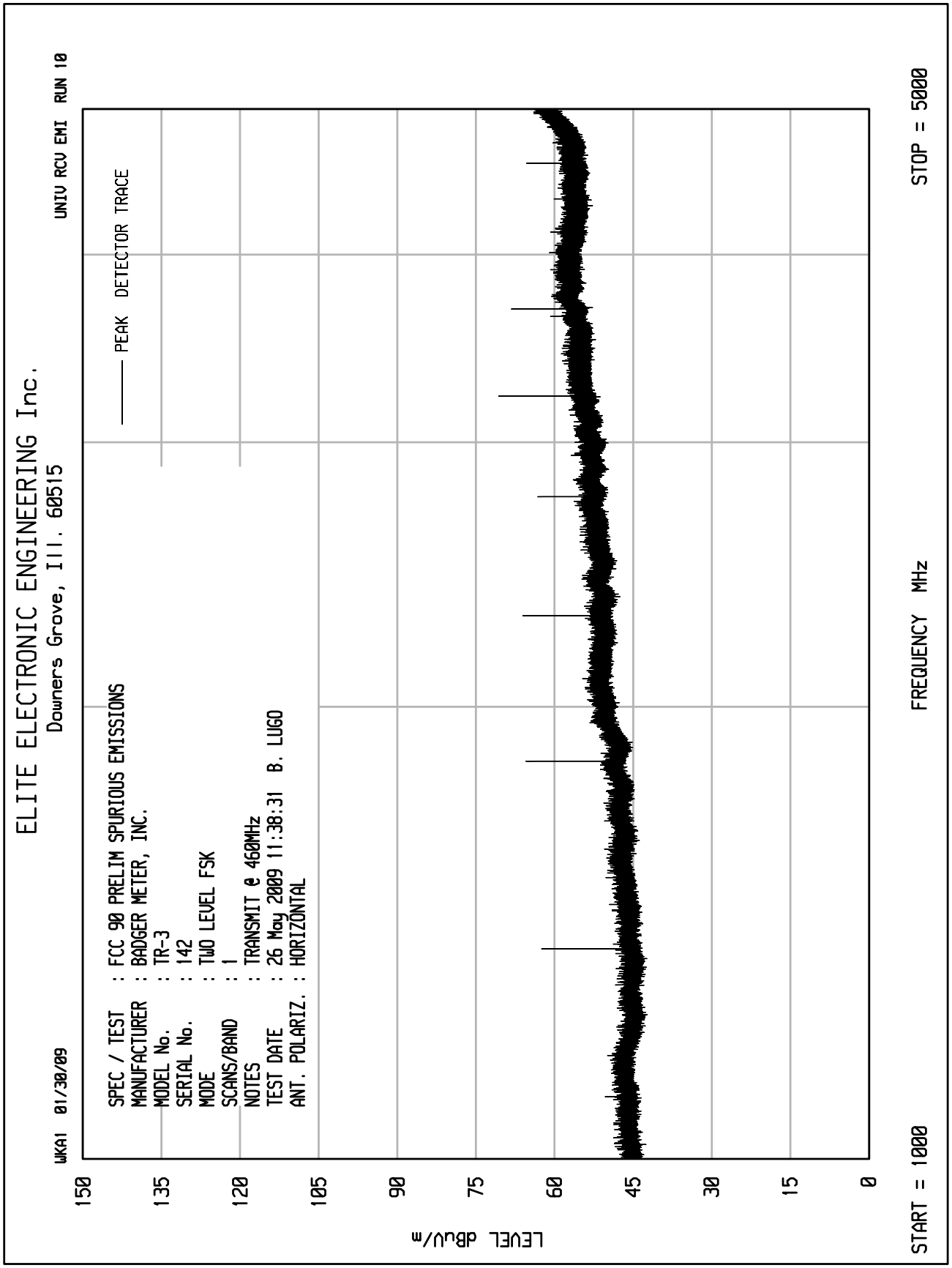
SPEC / TEST : FCC 90 PRELIM SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER, INC.
MODEL No. : TR-3
SERIAL No. : 142
MODE : TWO LEVEL FSK
SCANS/BAND : 1
NOTES : TRANSMIT @ 460MHz
TEST DATE : 26 May 2009 11:42:16 B. LUGO
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 5000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKAI 01/30/09
SPEC / TEST : FCC 90 PRELIM SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER, INC.
MODEL No. : TR-3
SERIAL No. : 142
MODE : TWO LEVEL FSK
SCANS/BAND : 1
NOTES : TRANSMIT @ 460MHz
TEST DATE : 26 May 2009 11:04:29 B. LUGO
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 10
WKAI 01/30/09
SPEC / TEST : FCC 90 PRELIM SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER, INC.
MODEL No. : TR-3
SERIAL No. : 142
MODE : TWO LEVEL FSK
SCANS/BAND : 1
NOTES : TRANSMIT @ 460MHz
TEST DATE : 26 May 2009 11:38:31 B. LUGO
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 5000

DATA PAGE

MANUFACTURER : Badger Meter, Inc.
MODEL : TR-3
SERIAL NO. : 142
SPECIFICATION : FCC Part 90 and RSS 119- Spurious Radiated Emissions
DATE : May 26 and 27, 2009
NOTES : Transmit at 460MHz
: 1 Watt, 12.5kHz channel spacing

Freq. MHz	Ant Pol	Mtr Rdg (dBuV)	Matched Sig Gen (dBm)	equil ant gain	CBL Loss (dB)	Total (dBm)	Limit
920.0	H	52.8	-22.7	1.5	1.9	-23.1	-20
920.0	V	47.0	-27.4	1.5	1.9	-27.8	-20
1380.0	H	43.7	-32.4	7.2	2.4	-27.6	-20
1380.0	V	38.9	-37.9	7.2	2.4	-33.1	-20
1840.0	H	46.0	-26.2	7.9	2.8	-21.1	-20
1840.0	V	43.3	-28.6	7.9	2.8	-23.5	-20
2300.0	H	43.7	-27.9	8.4	3.0	-22.5	-20
2300.0	V	40.4	-30.1	8.4	3.0	-24.7	-20
2760.0	H	42.8	-27.2	8.7	3.2	-21.7	-20
2760.0	V	38.5	-30.8	8.7	3.2	-25.3	-20
3220.0	H	38.3	-29.4	8.1	3.4	-24.7	-20
3220.0	V	40.7	-26.2	8.1	3.4	-21.5	-20
3680.0	H	32.5	-35.2	7.5	3.8	-31.5	-20
3680.0	V	30.6	-37.6	7.5	3.8	-33.9	-20
4140.0	H	30.5	-35.3	8.2	4.1	-31.2	-20
4140.0	V	28.4	-38.8	8.2	4.1	-34.7	-20

Checked By: Brandon Lugo

Brandon Lugo

DATA PAGE

MANUFACTURER : Badger Meter, Inc.
MODEL : TR-3
SERIAL NO. : 142
TEST ITEM POWER : 1W
TEST ITEM FREQUENCY : 460MHz
SPECIFICATION : RSS-119
TEST PERFORMED : Frequency Stability vs. Temperature
DATE : May 27 and 28, 2009
NOTES :

Temperature	Measured Frequency (MHz)	Nominal Frequency (MHz)	Deviation (Hz)	Limit (Hz)
+50ºC	459.999975	460.000359	384	+/-690
+40ºC	459.999954	460.000359	405	+/-690
+30ºC	459.999947	460.000359	412	+/-690
+20ºC	460.000064	460.000359	265	+/-690
+10ºC	459.999907	460.000359	452	+/-690
0ºC	459.999887	460.000359	472	+/-690
-10ºC	459.999853	460.000359	506	+/-690
-20ºC	459.999837	460.000359	522	+/-690
-30ºC	459.999776	460.000359	583	+/-690

Limit = 1.5ppm = 460Hz * 1.5ppm = 690Hz

Checked By: Brandon Lugo

Brandon Lugo

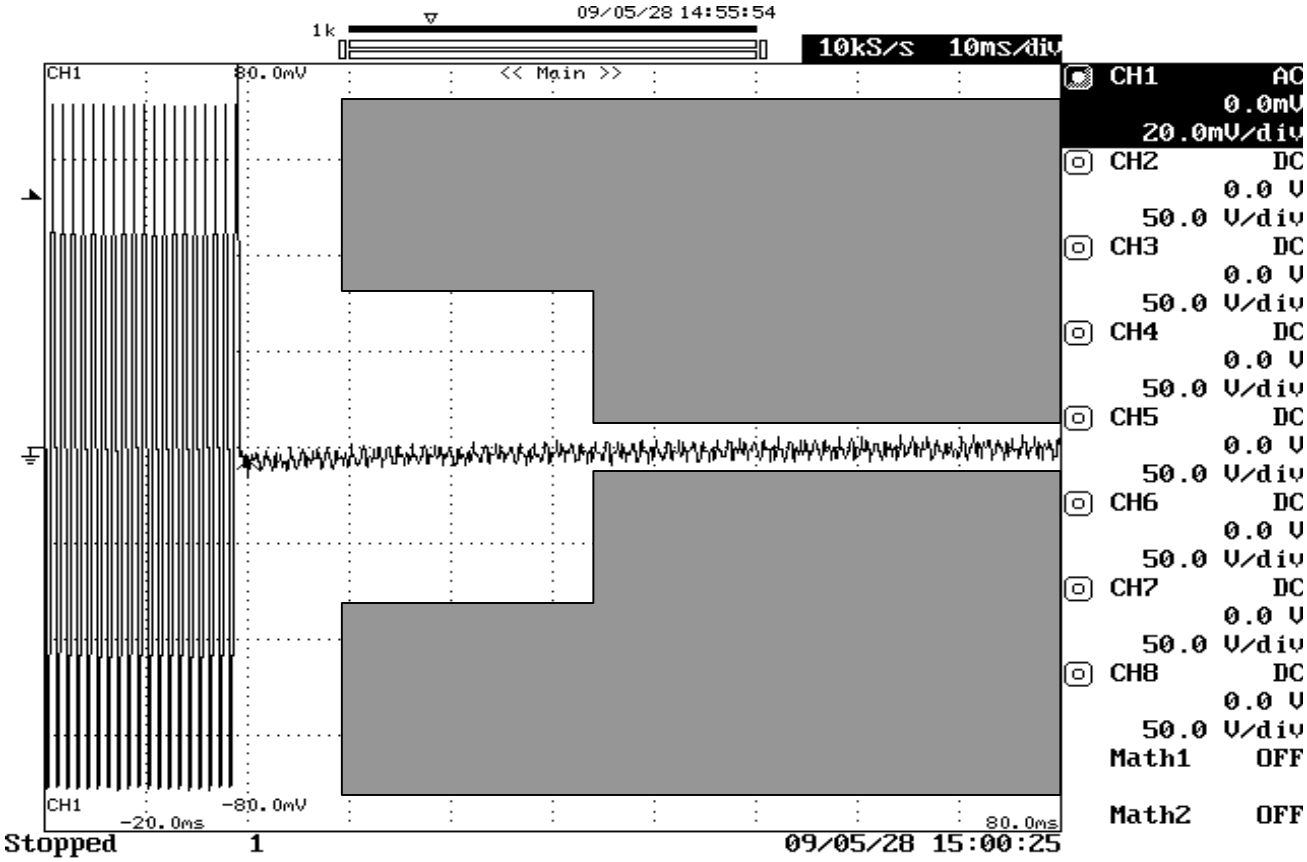
DATA PAGE

MANUFACTURER : Badger Meter, Inc.
MODEL : TR-3
SERIAL NO. : 142
TEST ITEM POWER : 1W
TEST ITEM FREQUENCY : 460MHz
SPECIFICATION : RSS-119
TEST PERFORMED : Frequency Stability vs. Voltage
DATE : May 29, 2009
NOTES :

Nominal Frequency	4.14VDC Measured Frequency	3.06VDC Measured Frequency	4.14VDC Deviation	3.06VDC Deviation	Limit
(Hz)	(Hz)	(Hz)	(Hz)	(Hz)	(Hz)
460.000027	460.000049	460.000011	-22	16	+/-690

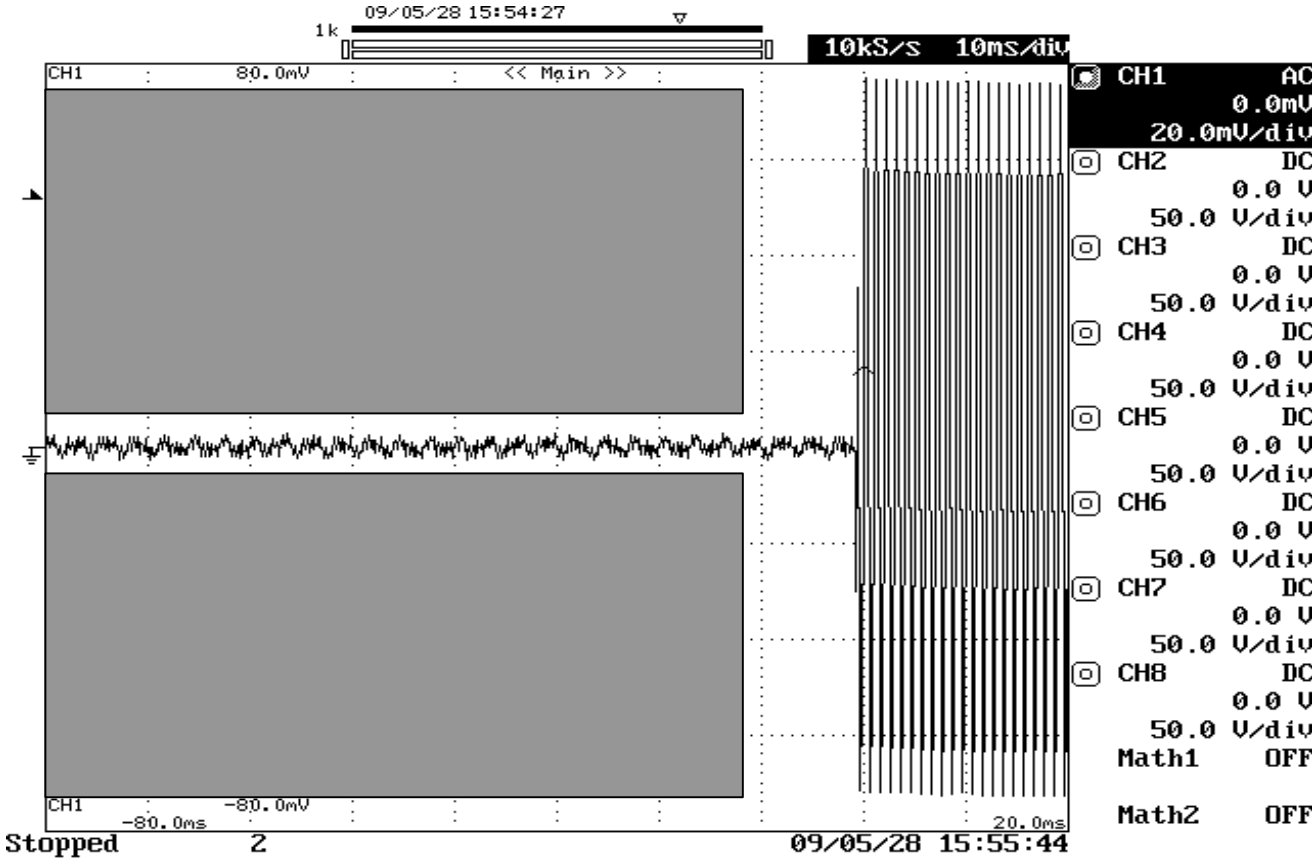
Checked By: Brandon Lugo

Brandon Lugo



FCC 90/RSS-119 – Transient Frequency Response Behavior

MANUFACTURER : Badger Meter, Inc.
MODEL NUMBER : TR-3
SERIAL NUMBER : 166
TEST MODE : Two level FSK
FREQUENCY : 460MHz
POWER LEVEL : 1W
CHANNEL SPACING : 12.5kHz
MODULATION : CW
NOTES : ON Condition – t1=10ms, t2=25ms
DATE TESTED : May 28, 2009
EQUIPMENT USED : RYE0, GCR0, MSP6



FCC 90/RSS-119 – Transient Frequency Response Behavior

MANUFACTURER : Badger Meter, Inc.
MODEL NUMBER : TR-3
SERIAL NUMBER : 166
TEST MODE : Two level FSK
FREQUENCY : 460MHz
POWER LEVEL : 1W
CHANNEL SPACING : 12.5kHz
MODULATION : CW
NOTES : OFF Condition – t3=10ms
DATE TESTED : May 28, 2009
EQUIPMENT USED : RYE0, GCR0, MSP6