

Exhibit B – Test Report
Energy Technology Group, Inc.
RCU-41 Transmitter

Project Number: 04035-10

Prepared for:
ENERGY TECHNOLOGY GROUP, INC.
5601 Bridge Street, Suite 400
Fort Worth, TX

By

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August 2003

CERTIFICATION
Electromagnetic Interference
Test Report

ENERGY TECHNOLOGY GROUP, INC.
RCU-41 TRANSMITTER

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THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF PROFESSIONAL TESTING (EMI), INC.



Certificate of Compliance

Applicant: Energy Technology Group, Inc.
 Applicant's Address: 5601 Bridge Street, Suite 400
 Fort Worth, TX
 Model: RCU-41 Transmitter
 Project Number: 04035-10

The **Energy Technology Group, Inc. RCU-41 Transmitter** was tested to and found to be in compliance with FCC Part 15.203, 15.207, 15.209, and 15.247 for Intentional Radiators.

The highest average emissions generated by the above equipments are listed below:

	<u>Frequency (MHz)</u>	<u>Level (Watts)</u>	<u>Limit (Watts)</u>	<u>Margin (Watts)</u>
Peak Fundamental	902.4	.89	1.0	.11

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

Jeffrey A. Lenk
 President

1.0 EUT Description

The Equipment Under Test (EUT) is the **Energy Technology Group, Inc., RCU-41 Transmitter**. The RCU-41 is a transmitter (part of a transceiver) for use with the **RCU-41 unit**. Energy Technologies Group, Inc. Remote Communications Unit provides for the remote and continuous monitoring of a customer's utility services, like energy and water usage by a centrally located facility. The RCU-41 unit collects signals from each of the utility metering devices via dedicated wired links. The collected information is then transmitted to a collection point or central facility by radio transmission.

The EUT has 256 hopping channels separated by 100 KHz. Each frequency is visited on a pseudorandom basis before the sequence repeats. Power is provided by a wall mounted transformer.

The EUT antenna is an internally mounted, printed circuit half-wave, half folded dipole with a single reflector element. If this antenna was optimized and mounted in free space, its forward gain would be less than 6 dBi.

The EUT transmits at the frequency of 902-928 MHz and is designed for compliance with 47 CFR 15.247 of the FCC rules. Specific test requirements for the device include the following:

- 47 CFR 15.247 Operational requirements for frequency hopping systems
- 47 CFR 15.209 Spurious Radiated Emission Limits
- 47 CFR 15.207 Conducted Emissions
- 47 CFR 15.203 Antenna Requirements

The transmitter operates within the frequency of 902 to 928 MHz. It is a frequency hopping system. As per FCC 47 CFR 15.247, the EUT is limited to operate in bandwidths separated by a minimum of 25 KHz or 20 dB bandwidth of the hopping channel whichever is greater. Each frequency must be used equally on the average by the transmitter.

For the EUT, if the 20 dB bandwidth of the hopping channel is less than 250 KHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 KHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

The system tested consisted of the following:

<u>Manufacturer & Model</u>	<u>Serial #</u>	<u>FCC ID #</u>	<u>Description</u>
Energy Technology Group, Inc. RCU-41 Transmitter	None	QNL-RCU-41	Transmitter used in transceiver used to collect and transmit utility services data

System Peripherals

None.

1.1 EUT Operation

The EUT was placed in various modes by uploading parameters into the EUT from a laptop, using special engineering software.

2.0 Electromagnetic Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of PTI's policy for EMC Measurement Uncertainty is provided in Appendix C.

2.1 Conducted Emissions Measurements

Conducted emissions measurements were made on the mains terminals of the **Energy Technology Group, Inc. RCU-41**, to determine the line-to-ground radio noise emitted from each power-input terminal. Conducted emissions measurements on the mains terminals were performed at Professional Testing, located in Round Rock, Texas.

2.1.1 Test Procedure

The EUT was configured and operated in a manner consistent with typical applications. The PC power cord in excess of one meter was folded back and forth forming a bundle 30 to 40 cm long in the approximate center of the cable. Power supply cords for the peripheral equipment were powered from an auxiliary LISN. Excess interface cable lengths were separately bundled in a non-inductive arrangement at the approximate center of the cable with the bundle 30 to 40 centimeters in length. The conducted emissions were maximized, by varying the operating states and configuration of the EUT.

The tests were performed in a 12' x 16' RayProof modular shielded room. The EUT was placed on a non-metallic table 0.4 meters from a vertical metal reference plane and 0.8 meters from a horizontal metal reference plane.

The measurements were taken using a Line Impedance Stabilization Network (LISN). A Spectrum Analyzer with a measurement bandwidth of 10 kHz was used to record the conducted emissions measurements. The configuration of the shielded room showing the location of the EUT and the measurement equipment is given as Figure 1.

2.1.2 Test Criteria

The FCC Part 15.207 conducted emission limits are given below.

Frequency (MHz)	Limits (dBμV) <u>Average</u>	Limits (dBμV) <u>Quasi-peak</u>
0.15 – .50	56 - 46	66 -56
.50 - 5	46	56
5 – 30	50	60

The lower limit shall apply at the transition frequency.

2.1.3 Test Results

The conducted emissions data is included in Appendix A. The conducted emissions generated by the **Energy Technology Group, Inc. RCU-41 Transmitter** as measured on its mains terminals were found to be below FCC 15.207 maximum emissions criteria.

2.2 Radiated Emissions Measurements

Radiated emission measurements were made on transmitter Fundamental emissions generated by the **Energy Technology Group, Inc. RCU-41 Transmitter**. The fundamental was measured to prove that the internal antenna gain was less than 6 dBi.

Measurements of the maximum emission levels for the fundamental emissions of the transmitter were made at the Professional Testing "Open Field" Site 3, located in Round Rock, Texas. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

Tests of the fundamental for the device were performed to determine the worst case orientation and polarization of the device.

2.2.1 Test Procedure

The following testing procedure was applied to the EUT mentioned above.

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable, which allows 360-degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. The radiated emissions were maximized by placing the EUT in all three orthogonal positions and by rotating the table and by scanning the receive antenna height.

A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. A drawing showing the test setup is given as Figure 2.

2.2.2 Test Criteria

For frequency hopping systems, the following limits are used as per 15.247.

For systems operating in the 902-928 MHz bandwidth

- 1 watt for systems using 50 or more hopping channels, which is applicable in the case of the EUT.

In addition to these requirements, the EUT must meet the restricted emission band requirements of §15.205 and §15.209.

2.2.3 Test Results

The radiated test data for the fundamental is included in Appendix A. The emissions were maximized at each frequency and the highest emissions identified were measured using peak detection. The antenna gain was determined to be less than 6dBi.

Test Result plots are included in Appendix A. Transmitter output power was determined to be less than 1 watt. A table of the power is included in Appendix A for low, medium and high frequency channels.

A plot of all the channels is given in Appendix B showing that all channels are within the 902-928 MHz band and that all of the channels transmit approximately the same power. This plot also shows the maximum relative power obtained in a 100 KHz bandwidth. A 30 dB attenuator was used in the test set up. Additional plots both below 902 MHz and above 928 MHz made using 100 KHz bandwidth show that all spurious signals are more than -20 dB below the relative maximum power measured in band with 100 KHz bandwidth.

The spurious radiated emissions generated by the Energy Technology Group, Inc. RCU-41 Transmitter are below the FCC Part 15 maximum emission criteria.

2.3 RF conducted Emissions

Measurements of the RF conducted emissions for the **Energy Technology Group, Inc. RCU-41 Transmitter** were made at the Professional Testing's Round Rock, Texas site.

2.3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. The EUT output was attenuated by a 30 dB attenuator which was connected to a spectrum analyzer. The peak signal between 902 and 928 MHz was measured using 100 KHz measurement bandwidth. The EUT was then measured outside of the 902 – 928 MHz band to demonstrate no emission was within 20 dB of the peak measurement within the band.

2.3.2 Test Criteria

As per FCC 47 CFR Part 15.247 Section 5(C) – in any 100 KHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 KHz bandwidth within the band that contains the highest level of desired power, based on either an RF conducted or radiated measurement. For the purpose of testing the **Energy Technology Group, Inc. RCU-41 Transmitter**, conducted emission measurements were used.

2.3.3 Test Results

The RF conducted measurement test data is included in Appendix B. The measurement shows compliance with the FCC Part 15.247 Section 5.C.

The number of channels, channel width, and channel occupancy were also measured using RF conducted measurements. The data plots are in Appendix B and C.

The EUT has 256 channels. The channel on time is – 252 msce. The channel on plus channel off time is 283.5 msec. Total time to complete all channels is (.2835 times * 256) equal to 65.5 seconds. According to FCC requirement, the average time of occupancy on any frequency shall not be grerater than 0.4 seconds within a 20 second period, which amounts to 20 ms per channel. The test data shows that each channel tested was occupied for a period of 252 ms. once every 65.5 seconds, which is 3.847 ms/channel. This exhibits compliance with FCC 47 CFR Part 15.247 Section 1(i).

The number of channels in 1 MHz was determined to be approximately 10. The EUT has 256 channels. The channel spacing is then approximately 100 KHz. This exhibits compliance with FCC 47 CFR Part 15.247 Section 1.

A plot showing 10 channels in one MHZ of bandwidth is presented to prove that the channel bandwidth in 100 KHz. Several plots of channel timing made in zero span are presented to show equal usage and to determine the total channel occupancy time.

3.0 Antenna Requirement

An analysis of the **Energy Technology Group, Inc. RCU-41 Transmitter** was performed to determine compliance with Section 15.203 of the Rules. This section requires specific handling and control of antennas used for devices subject to regulations under the Intentional Radiator portions of Part 15.

3.1 Evaluation Procedure

The structure and application of the **Energy Technology Group, Inc., RCU-41 Transmitter** were analyzed with respect to the rules. The antenna for this unit is an internal antenna permanently attached to the EUT. An auxiliary antenna port is not present.

3.2 Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

- (a) Antenna be permanently attached to the unit.
- (b) Antenna must use a unique type of connector to attach to the EUT.
- (c) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

3.3 Evaluation Results

The **Energy Technology Group, Inc. RCU-41 Transmitter** meets the criteria of this rule by virtue of having an internal antenna located inside the enclosure. The enclosure and antenna will be professionally installed.

4.0 Receiver Portion

The **Energy Technology Group, Inc., RCU-41 Transmitter – Receiver Portion** was tested and found to be in compliance with FCC Part 15 for Receivers and for Class B Digital Devices.

The Receiver portion was verified for compliance with 47 CFR 15.109 of the FCC rules. Radiated emission measurements were made on the emission levels generated by the Receiver portion of the **Energy Technology Group, Inc. RCU-41 Transmitter** and were found to be below the FCC Part 15.109 maximum emission criteria. A DoC has been prepared for the receiver portion.

5.0 Modifications to Equipment

The following modification was made to the **Energy Technology Group, Inc. RCU-41 Transmitter** during the testing process.

1. A 1.5 pF capacitor was put on the input of the power amplifier.

6.0 List of Test Equipment

A list of the test equipment utilized to perform the testing is given below. The date of calibration is given for each.

Electromagnetic Emissions Test Equipment

<u>Model</u>	<u>Description</u>	<u>Calibration Due</u>
HP 85662A	Display Unit	November 2003
HP 85650A	Quasi-Peak Adapter	November 2003
EMC 3115	Ridge Guide Antenna	June 2004
Cond. EMI Cable	RG-223	November 2003
MITEQ	20 GHz Preamplifier	November 2003
MITEQ	18 GHz 20 dB Preamplifier	December 2003
SOLAR 8012-50-R-24-BNC	LISN	October 2003
HP8566B	Spectrum Analyzer	November 2003
Tektronix 2706	RF Preselector	December 2003
HP 8447D	Preamplifier	November 2003
Compliance Design B-100	Biconical Antenna	October 2003
EMCO 3146	Log Periodic Antenna	December 2003
HP 436A	Power Meter	May 2004
HP 8482A	Power Sensor	April 2004

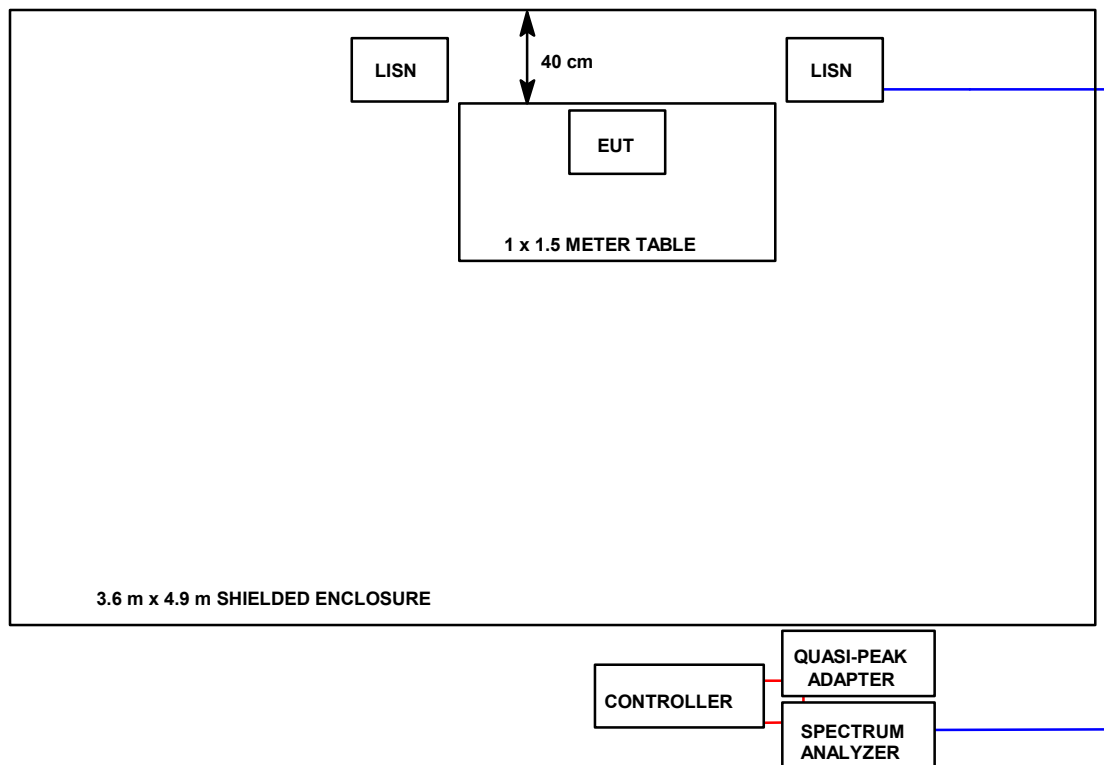
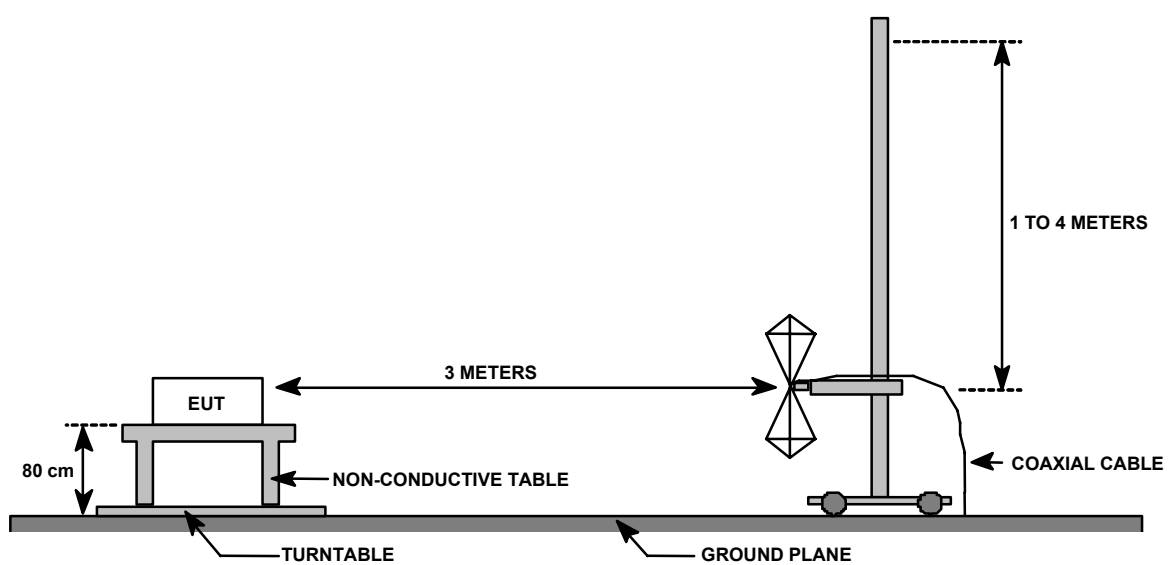
FIGURE 1: Conducted Emissions Mains Terminal Measurements

FIGURE 2: Radiated Emissions Test Setup

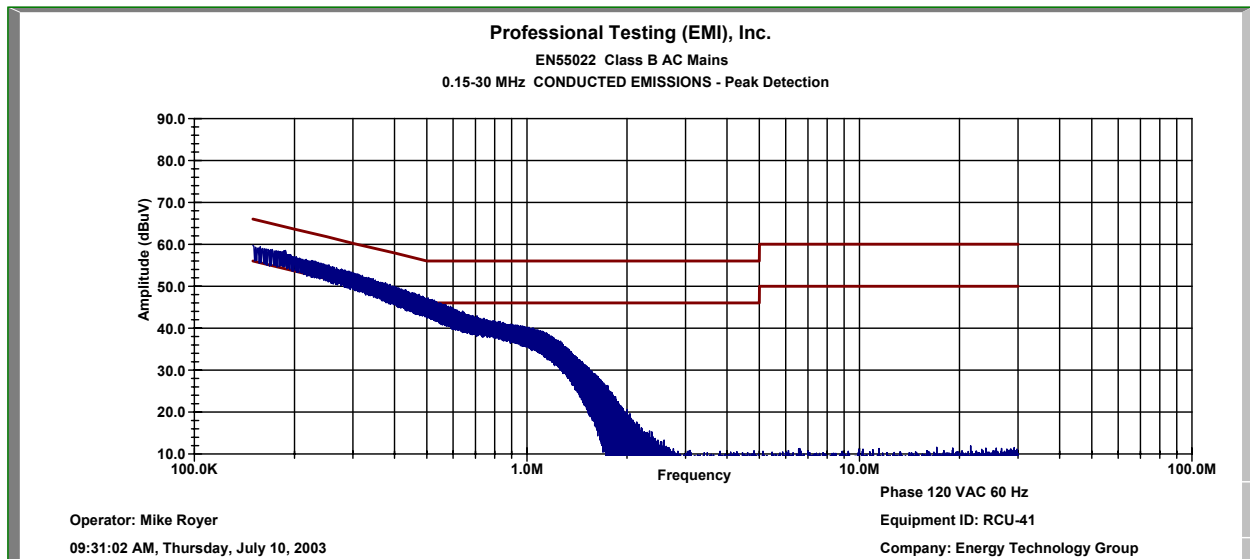
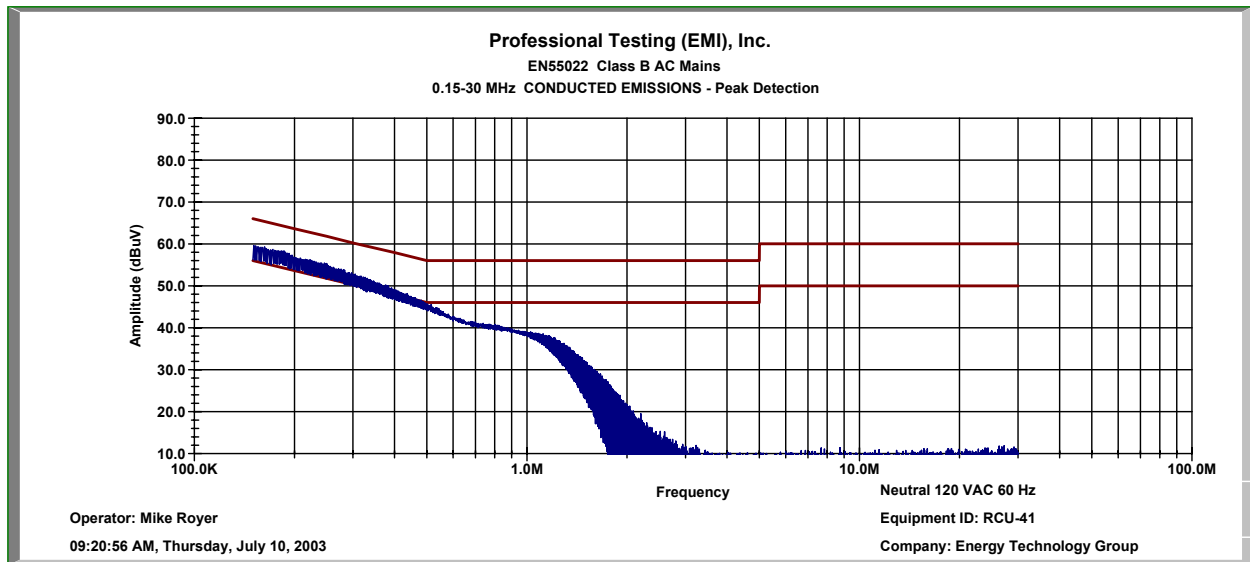
Appendix A **Emissions Data Sheets**

Transmitted power Table

Frequency (MHz)	902.4	913.5	926.4
Limit (Watts)	1.0	1.0	1.0
Measurement (Watts)	.89	.81	.51
Margin (Watts)	.11	.19	.49

Measured with HP436 Power Meter

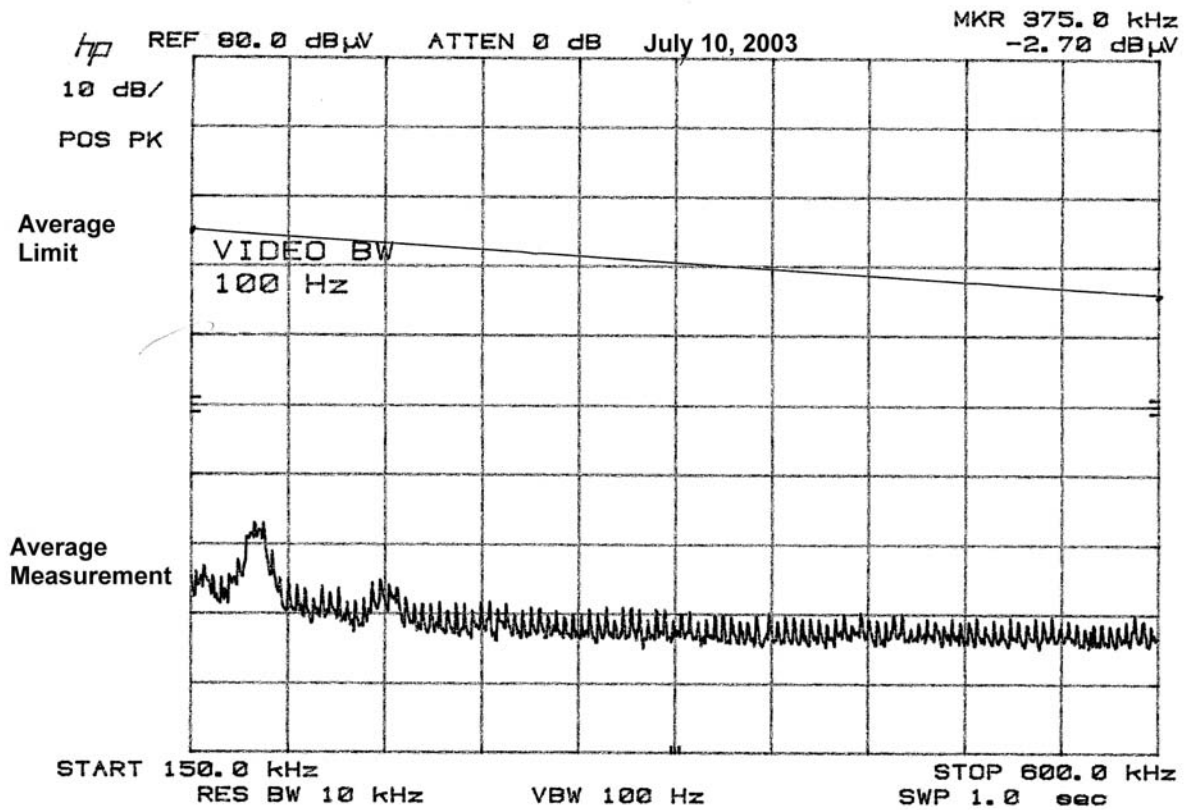
Conducted Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter



Average Conducted Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

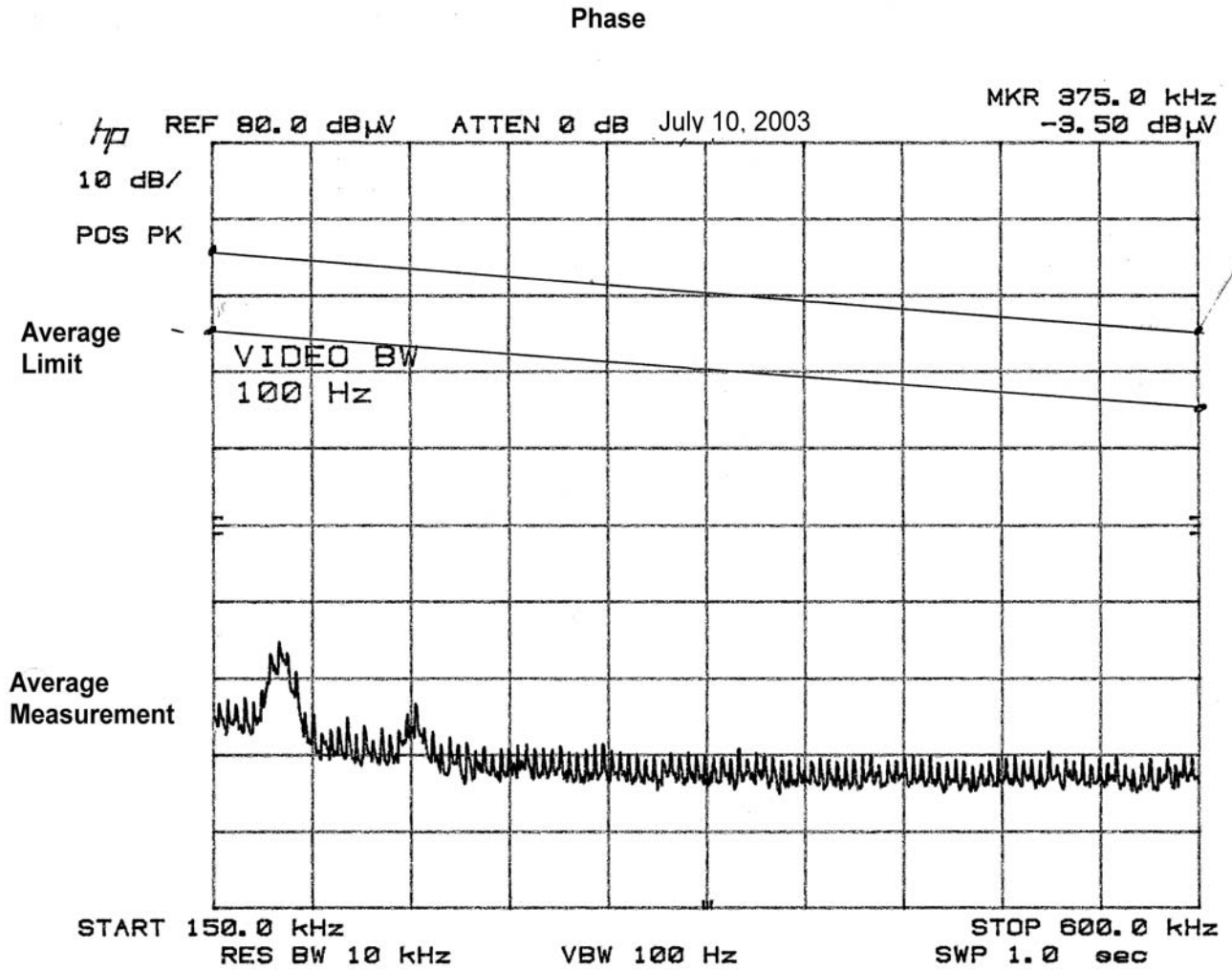
Average Detection

Neutral



Average Conducted Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Average Detection



Antenna Gain Determination Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

DATE: July 10, 2003
 PROJECT #: 04035-10

DETECTOR FUNCTION: Peak
 MEASUREMENT DISTANCE (m): 3

Antenna Polarization: Horizontal

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Gain (dBi)
902.4	0	1.5	86.3	0.0	25.2	11.5	123.0	124.7	-1.7

Antenna Polarization: Vertical

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Gain (dBi)
902.4			74.7	0.0	25.2	11.5	111.4	124.7	-13.3

Note:

1. Calculation of expected field at 3 meters is made assuming that the antenna is an isotropic antenna and using maximum transmitter power.
 $((0.89 \text{ Watts} * 30) ^{0.5}) / 3 \text{ (meters)} = 1.722 \text{ V/m}$
2. The above field was converted to dBuV and is shown as a limit in the radiated emissions data sheet. $\text{dBuV} = 20 * \text{Log}(1.722\text{E}^6) = 124.7 \text{ dBuV}$
3. The EUT was measured and the corrected value was measured as -1.7 dB less than the isotropic calculation.
4. Antenna approximate gain is -1.7 dBi and -7.7 dB less than the +6 dBi allowed.

Test Engineer: Mike Royer

Fundamental Radiated Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

DATE: October 20, 2003
 PROJECT #: 04035-10

DETECTOR FUNCTION: Peak
 MEASUREMENT DISTANCE (m): 3

Antenna Polarization: Horizontal

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Margin (dB)
902.3	300	2.2	79	0.0	24.4	12.4	115.8	115.8
902.3	165	1.4	85	0.0	24.4	12.4	121.8	121.8
902.3	149	1	76.9	0.0	24.4	12.4	113.7	113.7

Antenna Polarization: Vertical

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Margin (dB)
902.3	160	2.1	79.9	0.0	24.4	12.4	116.7	116.7
902.3	334	2.3	81.5	0.0	24.4	12.4	118.3	118.3
902.3	314	2	78.8	0.0	24.4	12.4	115.6	115.6

$$\text{Corrected Level} = \text{Recorded Level} - \text{Amplifier Gain} + \text{Antenna Factor} + \text{Cable Loss}$$

Comment: No other signals within 10dB of the general limit in the range of 30 MHz to 1GHz found.

Test Engineer: Mike Royer

Microwave Radiated Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

DATE: October 27, 2003
 PROJECT #: 04035-10

DETECTOR FUNCTION: Peak
 MEASUREMENT DISTANCE (m): 1

Antenna Polarization: Horizontal

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Corrected Level (dBuV/M)	Limit (dBuV/M)	Margin (dB)
1804.84		1	31.1	0.0	26.7	2.4	60.1		
2707.26		1	23.3	0.0	29.3	3.0	55.6	63.5	-7.9
3609.68		1	25.2	22.9	31.9	3.6	37.8	63.5	-25.7
4512.1		1	38.2	23.2	33.3	4.1	52.4	63.5	-11.1
5414.52			12	23.0	34.9	4.4	28.2	63.5	-35.3
6316.94	noise	floor	17	22.2	35.2	5.1	35.0		
7219.36			22.4	21.4	36.8	5.4	43.2		
8121.78	noise	floor	17	21.2	37.6	5.3	38.7	63.5	-24.8
9024.2	noise	floor	17	21.1	37.3	5.6	38.8		

Antenna Polarization: Vertical

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Corrected Level (dBuV/M)	Limit (dBuV/M)	Margin (dB)
1804.84			55	22.9	26.7	2.4	61.2		
2707.26			44.2	22.6	29.3	3.0	53.9	63.5	-9.6
3609.68			22.5	22.9	31.9	3.6	35.1	63.5	-28.4
4512.1			37	23.2	33.3	4.1	51.2	63.5	-12.3
5414.52			17.1	23.0	34.9	4.4	33.3	63.5	-30.2
6316.94	noise	floor	17	22.2	35.2	5.1	35.0		
7219.36			20.4	21.4	36.8	5.4	41.2		
8121.78	noise	floor	17	21.2	37.6	5.3	38.7	63.5	-24.8
9024.2	noise	floor	17	21.1	37.3	5.6	38.8		

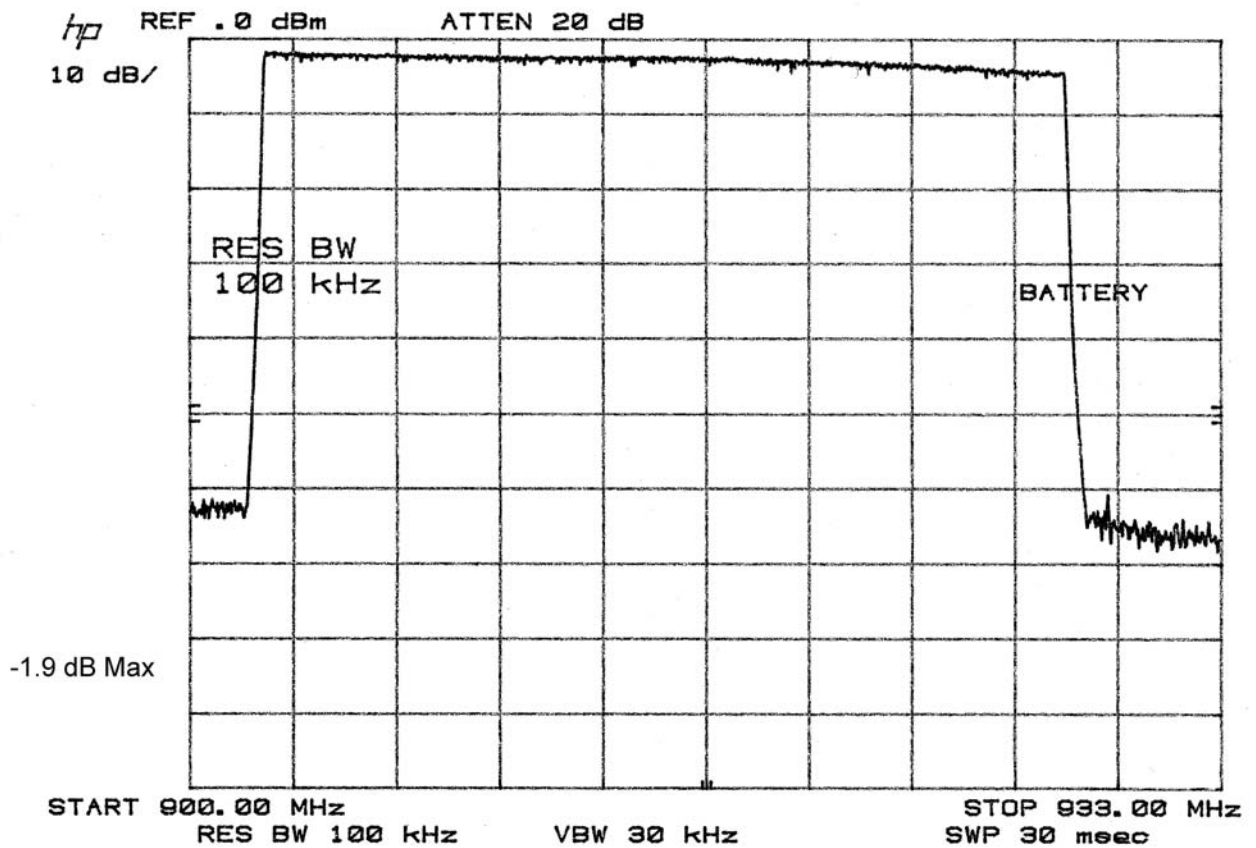
$$\text{Corrected Level} = \text{Recorded Level} - \text{Amplifier Gain} + \text{Antenna Factor} + \text{Cable Loss}$$

Test Engineer: Mike Royer

Appendix B RF Conducted Emissions Data

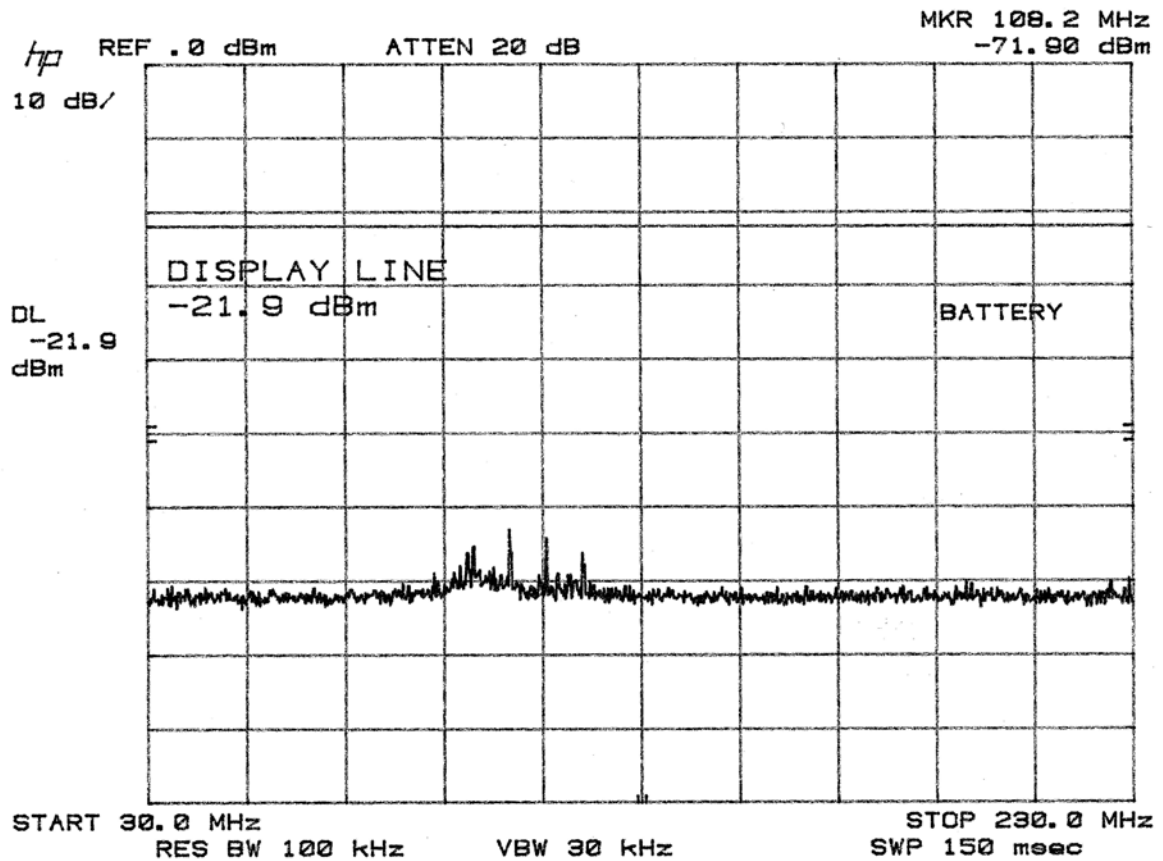
RF Conducted Emissions Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Peak in Band



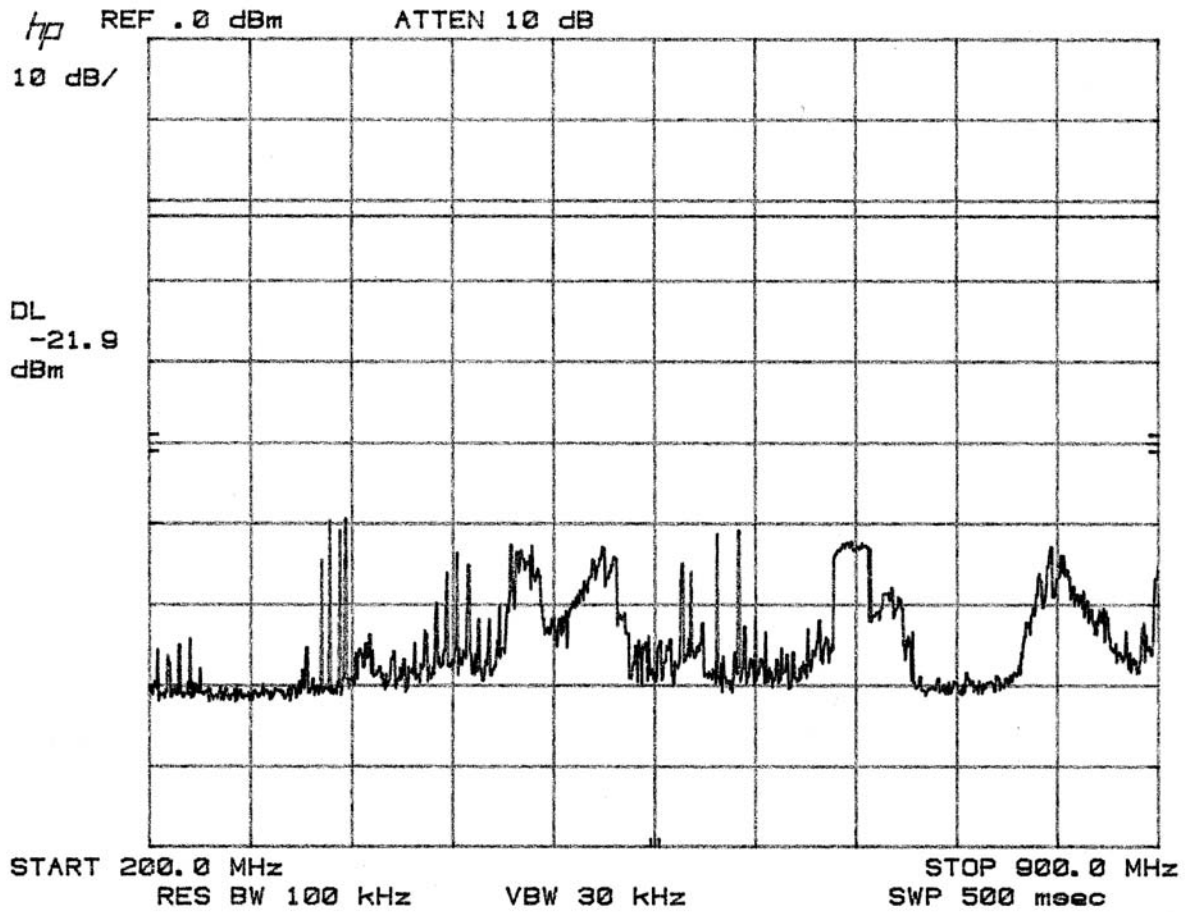
RF Conducted Emissions Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Below Band Signals



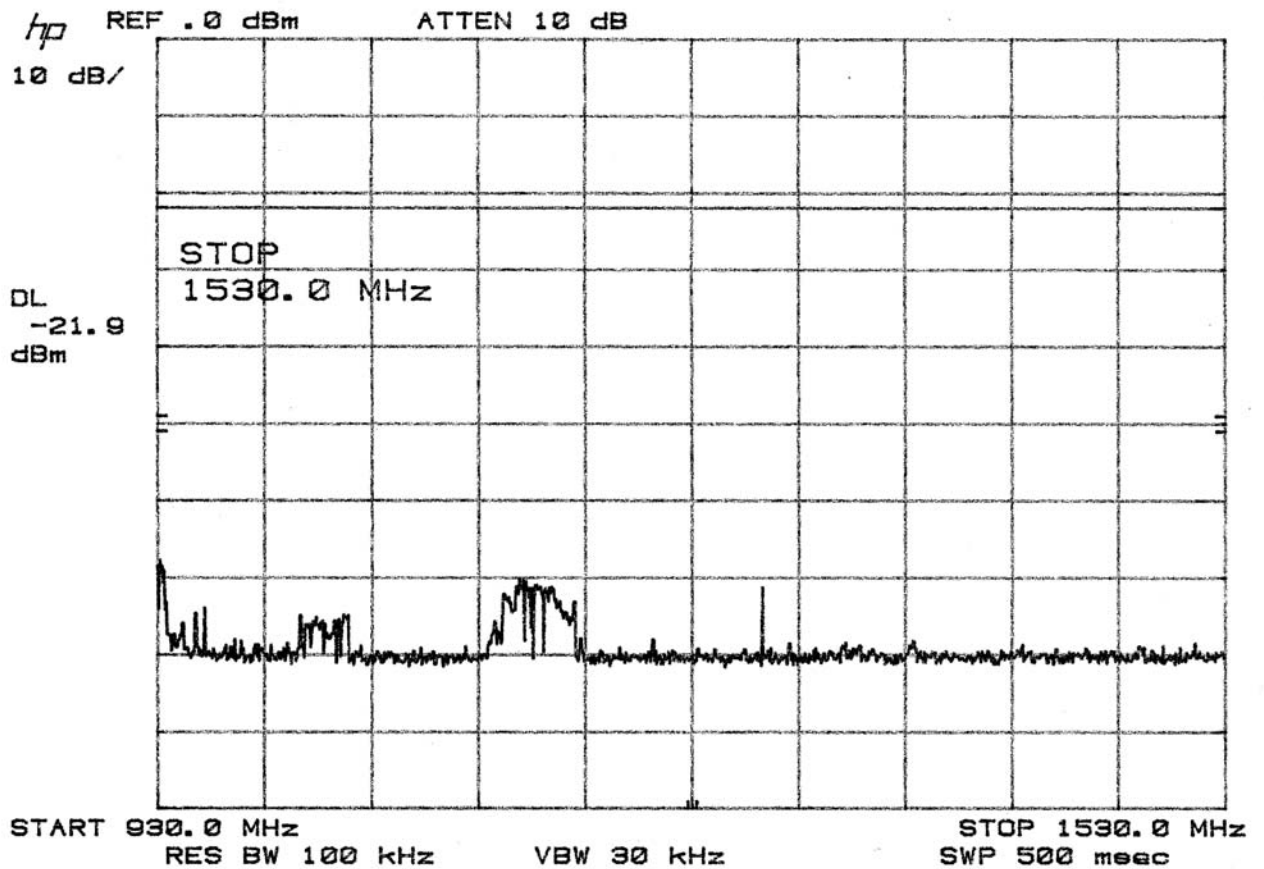
RF Conducted Emissions Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Below Band Signals



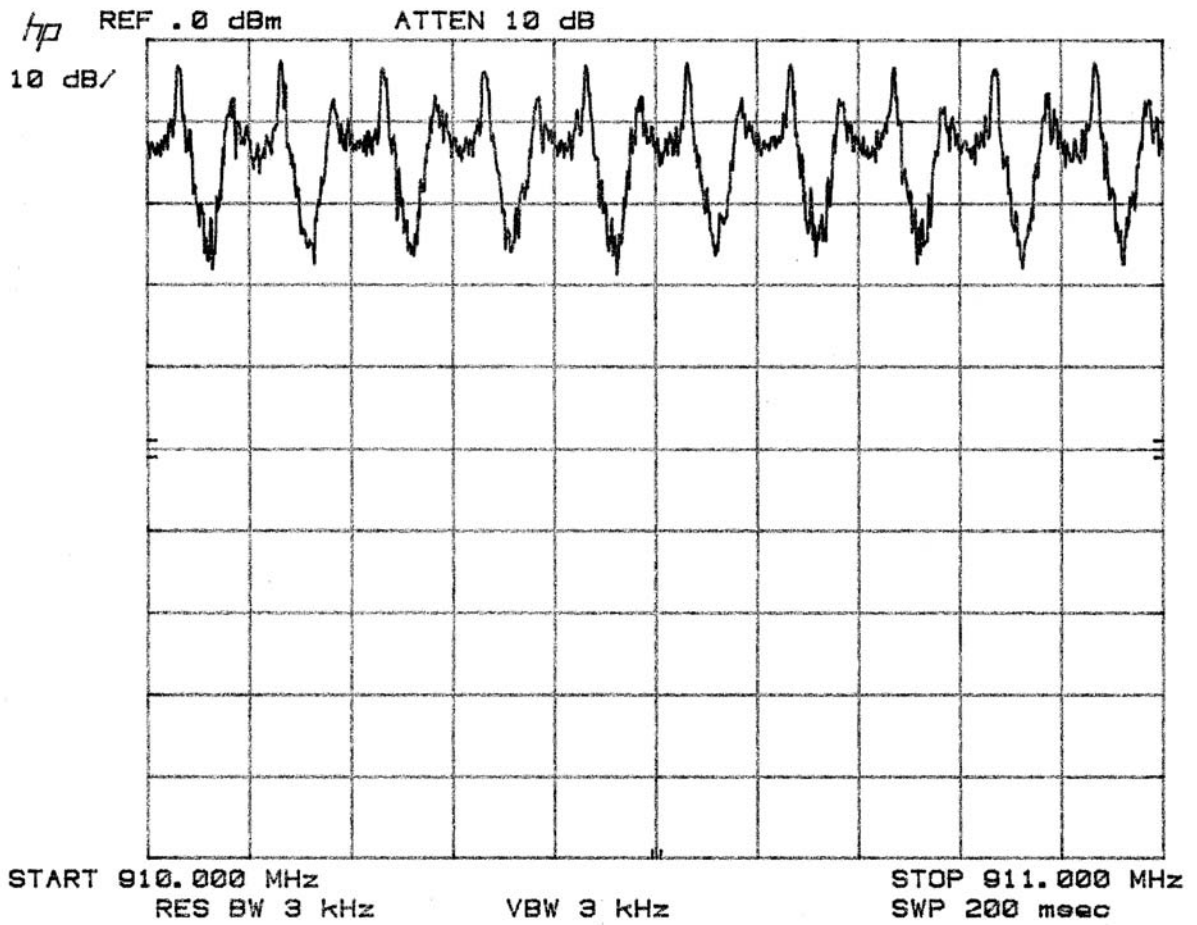
RF Conducted Emissions Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Above Band Signals



RF Conducted Emissions Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

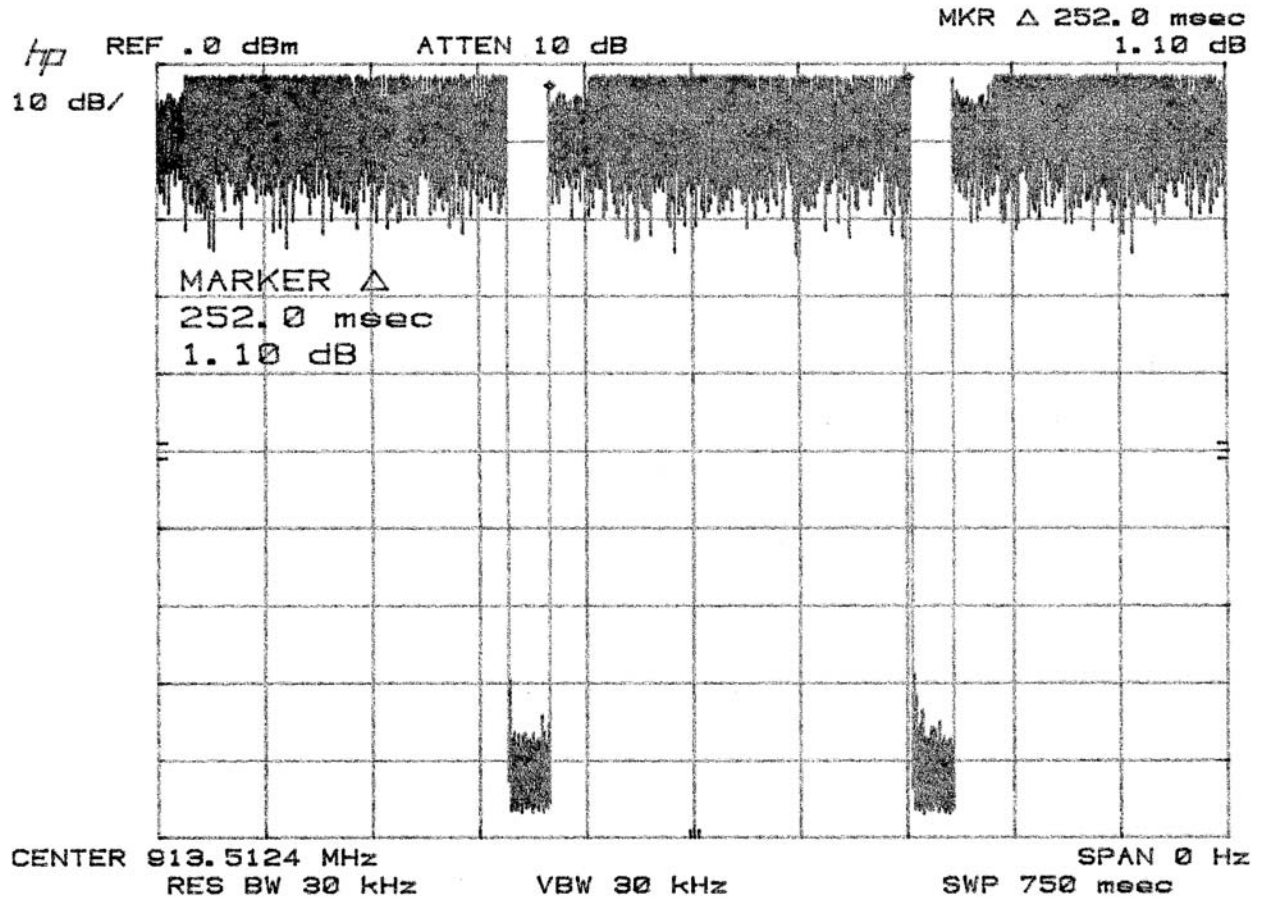
10 Channels in 1 MHz



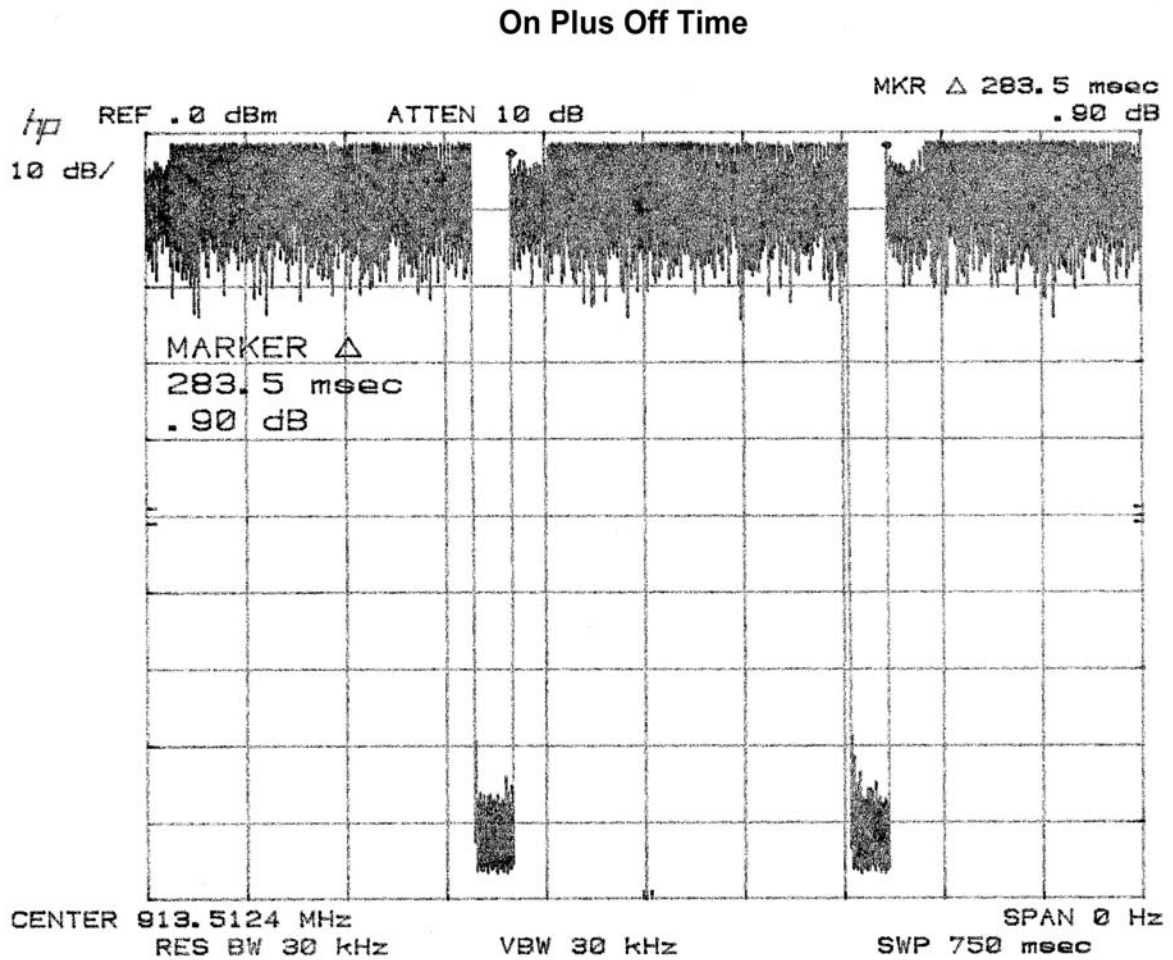
Appendix C **Channel Occupancy**

Channel Occupancy Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Channel Occupancy - Equal Average Usage
On Time



Channel Occupancy Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter



Channel Occupancy Data Sheet
Energy Technology Group, Inc.
RCU-41 Transmitter

Channel Repeat Time 72.30

