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TEST REPORT

Project Number 14130

Report Issue Date: 04/30/2014

Applicant:

Aclara RF Systems
30400 Solon Road
Solon, Ohio
44139

Product:

Model - 101-2013-001
Description: Automated Leak detection device (Zone Scan)

FCC ID: LLB2013001
IC ID: 4546A-2013001

Test dates: 02/12/2014 – 04/24/2014   Receive Date: 02/11/2014

For the purpose of demonstrating compliance with
FCC Part 90 & Industry Canada RSS-119 & RSS:GEN

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FCC Registered Test Site Number: 160606
Industry Canada Registered Test Site Number: IC 2087A-1

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Test Procedures

EUT description: The Model - 101-2013-001 transceiver is designed to provide automated leak detection in a public water system. The transceiver is mounted inside of a water pipe. The transmitter provides a very short intermittent RF transmission to provide a remote reading of the meter. A microprocessor provides timing, control and data processing functions. The built in antenna is inaccessible to the user and no provision is made for an external antenna. The receiver can be used to request a meter reading or other options available in the system.

Power Output: The EUT operates in the frequency range of (450 - 470) MHz. The first step in the measurement process was to measure the field strength of the fundamental frequency at the lowest, highest and middle operating frequency. These measurements are made in both the vertical and horizontal polarity. The maximum field strength is reported by raising and lowering the measuring antenna height between (1-4) meters and by rotating the EUT (360) degrees. The measurement distance is (3) meters. Measurements made per ANSI/TIA-603-C-2004.

The field strength measurements continue as described above for up to the tenth harmonic of each fundamental frequency.

Once the field strength of each signal is recorded, the EUT is replaced with a substitution antenna and signal generator. The substitution antenna is placed at the same height as the EUT had been. The combination of antenna and signal generator is then adjusted to reproduce the recorded field strength at each frequency. The ERP is then calculated by the following:

ERP = PG - CL + ANT

ERP = Effective Radiated Power (dBm)
PG = Signal Generator Output (dBm)
CL = Cable loss (dB)
ANT = antenna gain (dBd)
dBd = (antenna gain dBi) - (2.2 dB)

Occupied Bandwidth: The occupied bandwidth was measured with the EUT set to the middle of the operating frequency range. The emissions mask used was that specified in Part 90.210 (d).

Radiated Spurious Emissions: The radiated spurious emissions measurements were measured with the EUT set to low, medium and high transmit frequencies. Based upon the low output power of this device, all spurious and harmonic signals are limited to (-20) dBm. This is based upon the calculation stated in 90.210(d)(3). The field strength of the spurious emissions were measured in the same manner as the power output measurements and then the substitution method was used to establish the power level expressed in dBm. Measurements made per ANSI/TIA-603-C-2004.

Frequency Stability vs. Supply Voltage: One of the internal batteries was disconnected and replaced with an external variable power supply. The frequency was measured at the normal battery voltage of (7.20) VDC and again with the external power supply adjusted to an (85%) level or (6.12) volts. This was repeated with the external DC voltage adjusted to (8.28) VDC. The maximum allowed deviation is (2.5) ppm or (1,150) Hz at (460) MHz.

Frequency Stability vs. Temperature: The fundamental frequency was measured at an ambient temperature of (20) degrees C and recorded. The transmitter was then placed in an environmental chamber that was adjusted until a low temperature of (-30) degrees C was achieved. The transmitter was allowed to stabilize for (20) minutes at this temperature and then the frequency was again measured with a spectrum analyzer. The chamber was allowed to warm to (-20) degrees C and the measurement process was repeated. The environment was moved to a maximum temperature of (+70) degrees C in (10) degree increments, allowed to stabilize for (10) minutes and the frequency was re-measured. The maximum allowed deviation is (2.5) ppm or (1,150) Hz at (460) MHz.

Transient Frequency Behavior: Connect the output of the transmitter under test (EUT) to an attenuator, and this to a directional coupler. Connect an RF Modulation analyzer to the coupled output of the directional coupler, and connect the output of the modulation analyzer to the input on a storage oscilloscope. The output of the directional coupler is mixed, via an RF combining network, with the output of a signal generator. Verify that the EUT signal level present at the combining network output is approximately 40 dB below the maximum input level of the modulation analyzer. Set the signal generator at the same frequency as the EUT, modulated with a 1 kHz tone, with an FM deviation equal to the assigned channel spacing (+12.5 kHz). Adjust the signal generator to provide 20 dB less power at the combiner. . Connect the output of the RF combiner to the modulation analyzer, and the modulation analyzer modulation output port to a vertical input channel of the storage scope. Adjust the horizontal sweep rate on the oscilloscope to 10 msec/div, and the vertical amplitude to display the 1 kHz tone over +/- 4 divisions centered on the display. Reduce the transmit attenuation by 30 dB so that the difference in the power between the reference signal and the EUT signal at the combiner is 50 dB when the EUT is turned on. Switch on the EUT and record the display (for RF Output Power ON). Switch off the transmitter and record the display (for RF Output Power OFF).

Low Frequency Emissions: Low frequency emissions were examined from 30 kHz to 1,000 MHz using a passive loop antenna, biconical antenna and log periodic antenna. All emissions observed between 30 kHz and 1 GHz, other than the harmonics of the transmitter were determined to be more than 20 dB below the limit levels for spurious emissions of Part 90.210 and RSS-119.

Testing Summary

Test	Pass / Fail
Power Output and Spurious Emissions	PASS
Occupied Bandwidth	PASS
Frequency Stability vs. Temperature	PASS
Frequency Stability vs. Supply Voltage	PASS
Transient Stability	PASS

TEST EQUIPMENT CALIBRATION INFORMATION

Manufacturer	Model	Description	Serial Number	Cal Due Date	Cal Cycle
Hewlett Packard	8566B	Spectrum Analyzer	2532A02418	11/05/14	1 year
Hewlett Packard	85662A	Display	2403A07352	11/05/14	1 year
Hewlett Packard	85650A	Quasi-Peak Adapter	2043A00209	11/05/14	1 year
Hewlett Packard	8447D	Preamp	2944A06901	12/10/14	1 year
Hewlett Packard	8449B	Preamp	3008A00320	05/20/14	1 year
Hewlett Packard	8648B	Signal Generator	3443U00312	04/14/14	1 year
Hewlett Packard	8672A	Signal Generator	2211A02426	02/26/15	1 year
Electro-Metrics	BIA-30	Biconical Antenna	3852	04/26/14	1 year
EMCO	3148	Log Periodic Antenna	00075741	02/07/16	2 year
Electro-metrics	LPA-30	Log Periodic Antenna	2280	07/18/14	1 year
Electro-metrics	ALR-25	Loop Antenna	722	09/19/14	1 year
Tektronix	TDS-680B	Oscilloscope	B010311	03/12/15	1 year
Electro-Metrics	3115	Double Ridge Guide Antenna	3810	07/16/15	2 year
ETS Lindgren	3117	Double Ridge Guide Antenna	00109296	02/11/16	2 year
Agilent	7402A	Spectrum Analyzer	US39150137	01/31/15	1 year
Fluke	52	Digital Thermometer	447533	01/10/16	2 year
Hewlett Packard		DC Power Supply	None	N/A	N/A
Fluke	87V	DVM	59250853	02/06/15	1 year
Sun Systems	EC127	Environmental Chamber	EC0154	N/A	N/A
Hewlett Packard	8901B	Modulation Analyzer	3226A	02/07/15	1 year

Power Output and Spurious Emissions

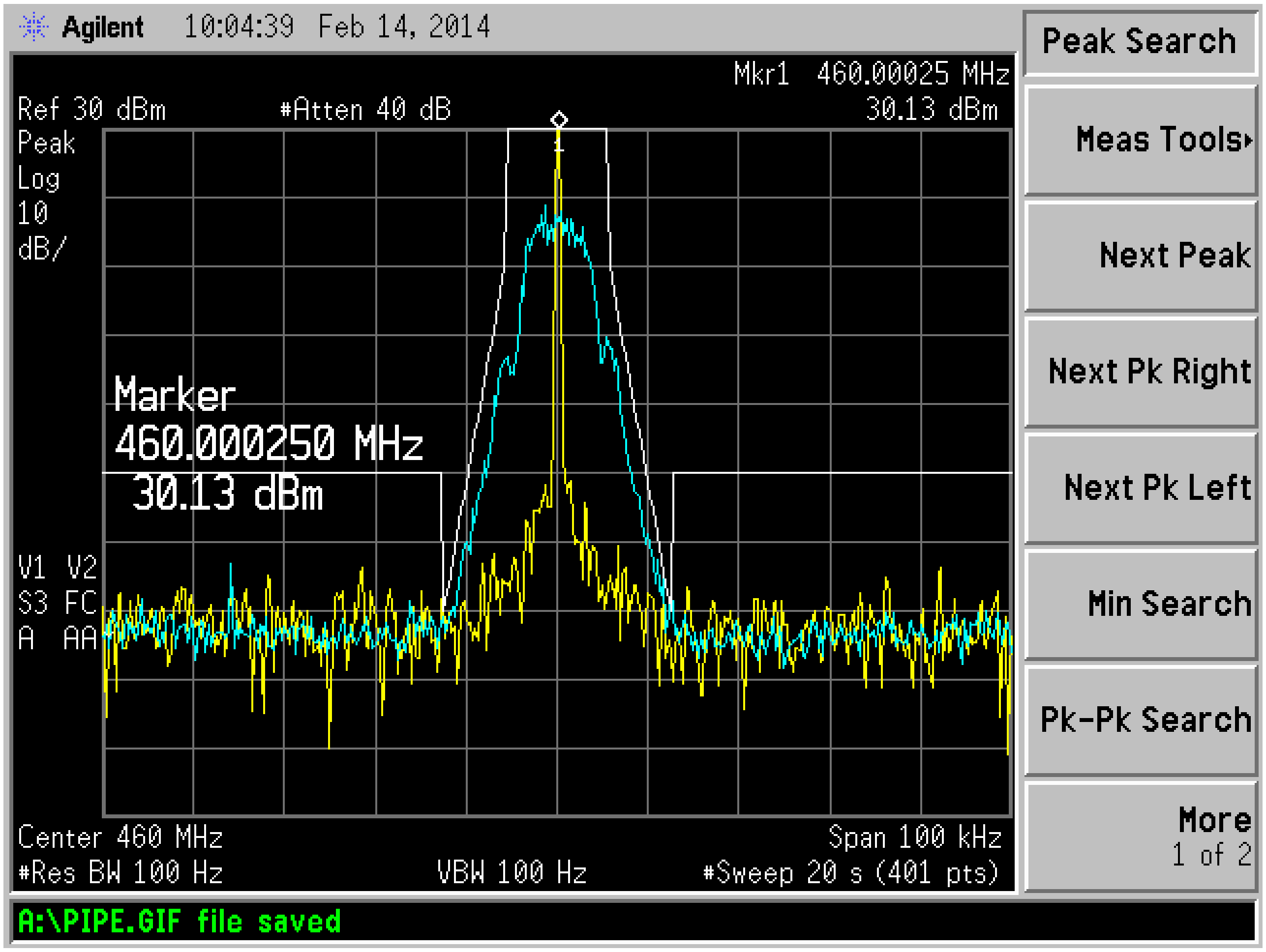
Model - 101-2013-001

02/14/2014 – 04/14/2014

Freq.	Generator	Equivalent	Antenna	Limit	Margin
MHz	Level	Power	Polarity		
	dBm	dBm	V/H	dBm	dB
450	18.0	21.1	V		
900	-33.9	-31.7	V	-20.0	-11.7
1350	-42.1	-41.5	V	-20.0	-21.5
1800	-44.1	-41.6	H	-20.0	-21.6
2250	-40.8	-38.2	V	-20.0	-18.2
2700	-43.7	-40.4	V	-20.0	-20.4
3150	-47.1	-43.0	V	-20.0	-23.0
3600	-44.5	-39.5	H	-20.0	-19.5
4050	-42.0	-36.3	V	-20.0	-16.3
4500	-45.9	-39.5	V	-20.0	-19.5
460	19.7	23.0	V		
920	-35.3	-33.1	V	-20.0	-13.1
1380	-40.1	-39.5	V	-20.0	-19.5
1840	-46.4	-43.9	V	-20.0	-23.9
2300	-44.2	-41.7	H	-20.0	-21.7
2760	-43.8	-37.4	H	-20.0	-17.4
3220	-42.0	-38.6	V	-20.0	-18.6
3680	-41.9	-37.6	H	-20.0	-17.6
4140	-42.7	-34.4	V	-20.0	-14.4
4600	-36.6	-33.8	H	-20.0	-13.8
470	14.0	17.0	V		
940	-36.6	-33.1	H	-20.0	-13.1
1410	-38.9	-37.4	V	-20.0	-17.4
1880	-40.4	-37.3	V	-20.0	-17.3
2350	-42.4	-38.9	V	-20.0	-18.9
2820	-42.8	-37.7	H	-20.0	-17.7
3290	-45.6	-42.3	H	-20.0	-22.3
3760	-43.6	-40.9	H	-20.0	-20.9
4230	-44.1	-38.5	V	-20.0	-18.5
4700	-42.7	-39.6	V	-20.0	-19.6

The spurious emissions shown above meet the requirements of Part 90.120 (d) (3) defined as: On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

OCCUPIED BANDWIDTH



The above plot demonstrates that the EUT meets the 90.210 Emission Mask D requirements:

(d) Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission 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 f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd-2.88 kHz) dB.

FREQUENCY STABILITY VS TEMPERATURE

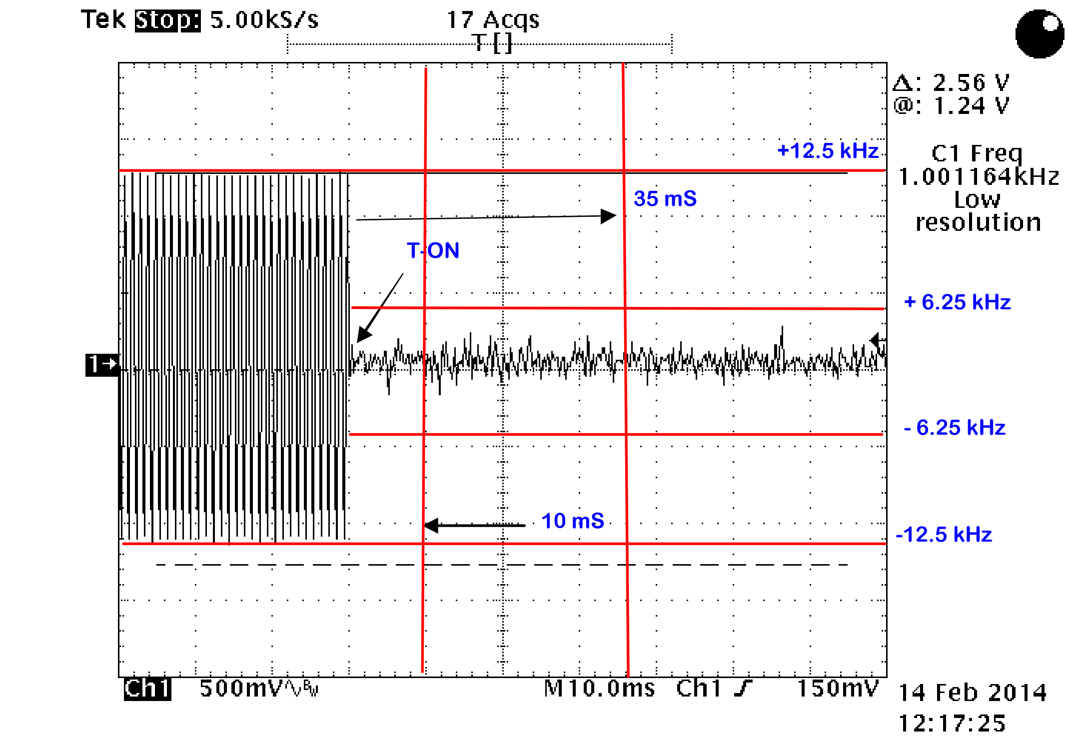
Model -->	101-2013-001		4/22/2014
Temperature	Measured Freq	Deviation	Deviation
Degrees C	Hz	Hz	PPM
-30	460,000,074	074	0.16
-20	460,000,105	105	0.22
-10	460,000,057	57	0.12
0	460,000,031	31	0.07
10	460,000,011	11	0.02
20	460,000,026	26	0.06
30	460,000,006	6	0.01
40	459,999,953	-47	0.10
50	459,999,926	-74	0.16
60	459,999,926	-74	0.16
70	459,999,956	-44	0.50
	Limit = 2.5 ppm		

Assigned Frequency = 460.000000 MHz

FREQUENCY STABILITY VS VOLTAGE

Voltage Input	Output Frequency (Hz)	Deviation (Hz)	Deviation (ppm)
6.12 VDC	459999970	30	0.065
7.20 VDC	459999972	28	0.061
8.28 VDC	459999975	25	0.054
	Assigned Frequency = 460,000,000 Hz		

The maximum allowed deviation is (2.5) ppm or (1,150) Hz at (460) MHz.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-12.5 kHz
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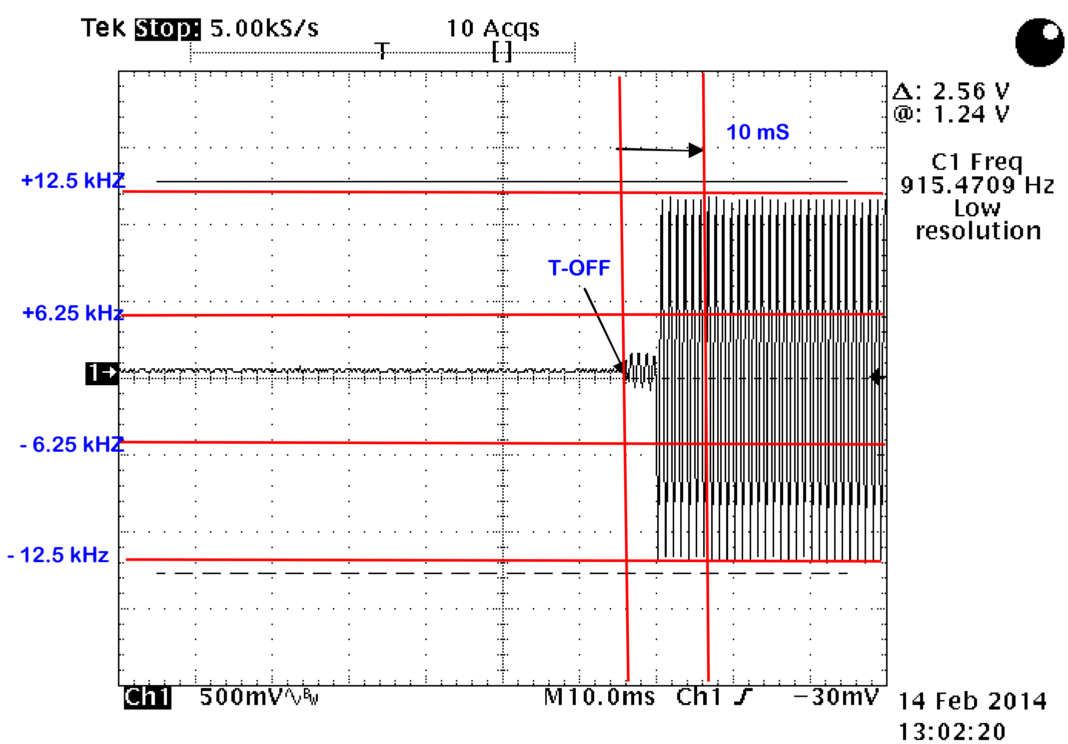
M10.0ms Ch1 150mV
14 Feb 2014
12:17:25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+6.25 kHz
- 6.25 kHZ
- 12.5 kHz
Ch1 500mV
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14 Feb 2014
13:02:20

OUTPUT POWER AND SPURIOUS EMISSIONS
SETUP PHOTOGRAPHS