ACLARA TECHNOLOGIES LLC

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ENGINEERING TEST REPORT

RADIO-FREQUENCY EMISSIONS TEST REPORT

FOR

ELECTRIC METER
TRANSMITTING UNIT (MTU)
with RECEIVER

Model 14280A
FCC ID: LLB14280A
IC: 4546A-14280A

September 27, 2012

Report Prepared by

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Agency Certification Control Technician

TEST REPORT

INTRODUCTION

The Hexagram Model 14280A transceiver is a "Meter Transmitting Unit" (MTU) designed to provide remote meter reading capability for Landis+Gyr type AX Focus electric meters. The transceiver is AC line powered with a battery back-up and is installed inside the electric meter housing. The transmitter provides short, intermittent radio frequency transmissions to provide meter reads, alarms and other required information. A microprocessor provides timing, control and data processing functions.
The antenna is mounted outside the meter housing but within the transparent globe that protects the meter and would only be accessible to authorized personnel. The antenna is connected to the MTU circuit with a specially designed clip to mount to the circuit board. The receiver can be used for upgrading firmware, requests for meter reads or other options available in the system. Due to availability considerations three different units were used for testing. The serial number of each unit tested is shown in the appropriate section. There are no operational differences in the hardware or firmware of the units tested. This report presents the data obtained in support of an application for certification of compliance to Part 90 of the FCC Rules & Regulations.

MEASUREMENTS PERFORMED

LOW FREQUENCY EMISSIONS

Low frequency emissions from the 14280A were examined from 30 kHz to 330 MHz using a loop antenna and a biconical antenna. Scans were made between 330 and 1000 MHz with a ETS-Lindgren broad-band horn antenna. Any detected, non-harmonic emissions were checked using tuned dipoles.

All emissions observed between 30 kHz and 1 GHz, other than the harmonics of the transmitter were determined to be more than 30 dB below the limit levels of Part 90.210 and RSS-119, Iss.3.

TEST EQUIPMENT USED

Spectrum Analyzer	Hewlett-Packard Model 8593EM Spectrum Analyzer SN: 3536A00147 Cal Due: 8/24/2012
Antennas	AH Systems Model SAS-563B Active loop Antenna SN: 424 Frequency Range 30 kHz – 30 MHz Cal Date: 2/21/2012 Cal Due: 2/21/2013
	ETS Lindgren Model 3121C-DB4 Tuned Dipole SN: 69062 Frequency Range 400 – 1000 MHz Cal Date: 8/22/2012 Cal Due: 8/22/2013
	ETS-Lindgren Model 3106B Waveguide Horn SN: Cal: N/A
	AH Systems Model SAS-540 Biconical SN: 705 Frequency Range 20 MHz – 330 MHz Cal Due: 9/23/2012
Tests Performed:	September 19 – 21, 2012

Unit Tested: 14280A SN: 14280003

POWER OUTPUT AND SPURIOUS EMISSIONS

Within the tuning range of 450 – 470 MHz, the transmitter portion of the Model 14280A (EUT) was examined at three fundamental frequencies and their harmonics. All measurements below 1 GHz were made at a 3-meter distance on the Smith Electronics open area test site located at 8200 Snowville Road, Brecksville, OH. Data pertinent to this site is on file with the FCC (Reg. #90938) and IC Canada (4541A-1). The harmonic measurements above 1 GHz were made at a distance of 1 meter over a suitable ground plane. The measurements were made using the substitution method described in TIA/EIA-603-C.

Tuned dipoles were used for measurements below 1000 MHz and a wave-guide antenna was used above 1000 MHz. A spectrum analyzer was used as a receiver.

The transmitter, installed in a non-powered meter, was placed on a remotely rotatable, non-conducting test stand. This general set up is shown in Pictorial 1. Because of the intermittent nature of the normally operating transmitter, the transmitter was forced to transmit continuously for these measurements. Power to the meter necessary to sustain the transmission was provided by an external 12 V battery positioned in the meter box.

With the transmitter powered and the test receiver tuned to the unmodulated signal, the transmitter under test was rotated to the position of maximum signal. The receiving antenna was then varied between 1 and 4 meters in height to again maximize the signal. Measurements were made with the antennas positioned both vertically and horizontally and the maximum signals recorded.

Peak detection was used for the signals below 1000 MHz and average detection above 1000 MHz.

After the maximum received meter readings were obtained for each frequency and polarity, the transmitter under test was removed from the area and replaced by a signal generator and transmitting antenna. With the transmit antenna placed as close as possible to the position of the test unit, the signal generator was activated at a test frequency. With the signal detected, the receiving antenna was positioned for maximum reception. The signal generator output was then adjusted until the received signal was equal to the previously received signal from the unit under test. These measurements were repeated for each frequency and antenna orientation and the maximum values obtained are noted in Tables 1a – 1c.

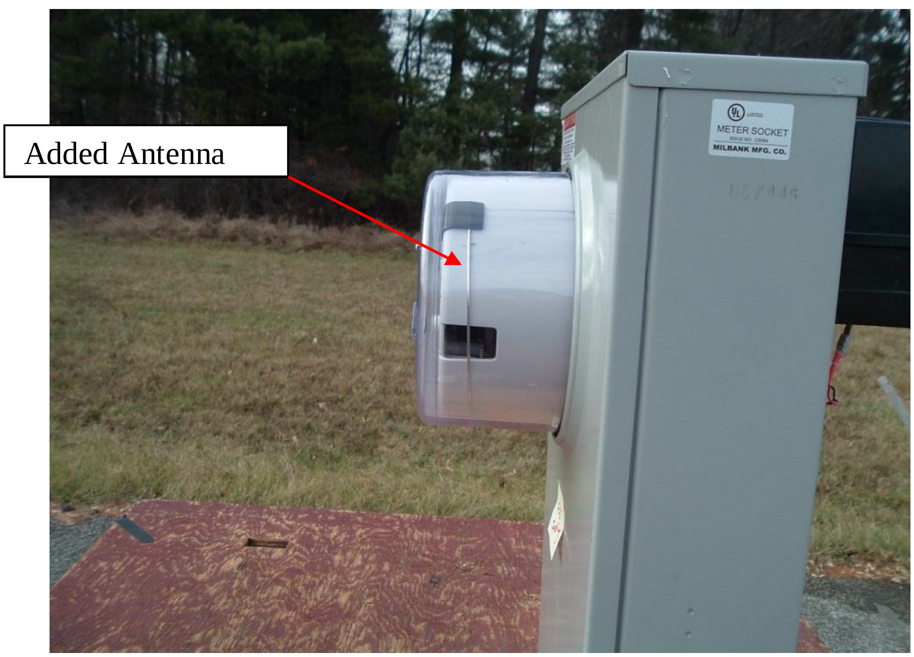
In order to convert the signal generator output value to equivalent radiated power from a dipole, the following equation is used:

$$P_d = P_g - \text{cable loss(dB)} + \text{antenna gain(dB}_d\text{)}$$

where: P_d is the dipole equivalent power in dBm, P_g is the generator output into the substitution antenna, also in dBm, and "antenna gain" is the dB gain of the substitution antenna with respect to a theoretical dipole.

According to 90.210(d)(3) all emissions greater than 12.5 kHz from the center of the authorized band shall be attenuated below the unmodulated carrier by 50 + 10log(P).
The determined power outputs, the required harmonic attenuation as well as the attenuation for each harmonic are found in Tables 1a – 1c.

The frequency range from 30 kHz to 5 GHz was examined for emissions and no emissions other than those presented in this report were within 30 dB of the limiting value.



PICTORIAL 1
ACLARA MODEL 14280A MTU
OUTPUT POWER AND SPURIOUS EMISSIONS
TYPICAL TEST SETUP

TABLE 1a
ACLARA MODEL 14280A TRANSMITTER
SUBSTITUTION METHOD
450 MHz

Horizontal 3 meter measurement using tuned dipole antenna

Freq. (MHz)	Gen. Output (dB)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (dBm)	Difference (dB)
450	8.7	2.3	-1.1	5.3	
900	-41.4	3.2	-0.4	-45	50.3

Output = 5.3 dBm
= 0.003 W
Req. Att.= 25.3 dBm

Horizontal 1 meter measurement using horn antenna

Freq. (MHz)	Gen. Output (dBm)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (Dbm)	Difference (dB)
1350	-45.6	0.8	6.4	-40.0	45.3
1800	-53.7	1.0	6.9	-47.8	53.1
2250	-61.3	1.2	6.9	-55.6	60.9
2700	-47.6	1.3	7.5	-41.4	46.7
3150	-58.5	1.4	8.3	-51.6	56.9
3600	-63.2	1.6	8.3	-56.5	61.8
4050	-65.2	1.7	8.2	-58.7	64.0
4500	-63.0	1.8	9.6	-55.2	60.5

Vertical 3 meter measurement using tuned dipole antenna

Freq. (MHz)	Gen. Output (dB)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (dBm)	Difference (dB)
450	15.1	2.3	-1.1	11.7	
900	-39.0	3.2	-0.4	-42.6	54.3

Output = 11.7 dBm
= 0..015 W
Req. Att.= 21.7 dBm

Vertical 1 meter measurement using horn antenna

Freq. (MHz)	Gen. Output (dBm)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (Dbm)	Difference (dB)
1350	-36.6	0.8	6.5	-30.9	-40.8
1800	-33.2	1.0	7.4	-26.8	-36.7
2250	-58.4	1.2	6.2	-53.4	-63.3
2700	-56.3	1.3	6.4	-51.2	-61.1
3150	-63.1	1.4	7.2	-57.3	-67.2
3600	-60.1	1.6	8.3	-53.4	-63.3
4050	-54.5	1.7	8.0	-48.2	-58.1
4500	-58.1	1.8	8.6	-51.3	-61.2

TABLE 1b
ACLARA MODEL 14280A TRANSMITTER
SUBSTITUTION METHOD
460 MHz

Horizontal 3 meter measurement using tuned dipole antenna

Freq. (MHz)	**Gen. Output (dB)**	**Coax Loss (dB)**	**Ant. Gain (dBd)**	**Dipole Eq. Power (dBm)**	**Difference (dB)**
460	16.6	2.3	-1.3	13.0	
920	-31.1	3.3	0.3	-34.1	47.1

Output = 13.0 dBm
= 0.020 W
Req. Att.= 33.0 dBm

Horizontal 1 meter measurement using horn antenna

Freq. (MHz)	**Gen. Output (dBm)**	**Coax Loss (dB)**	**Ant. Gain (dBd)**	**Dipole Eq. Power (Dbm)**	**Difference (dB)**
1380	-43.7	0.9	6.5	-38.1	51.1
1840	-45.1	1.0	6.9	-39.2	52.2
2300	-46.3	1.2	7	-40.5	53.5
2760	-43.8	1.3	7.7	-37.4	50.4
3220	-46.4	1.4	8.3	-39.5	52.5
3680	-55.3	1.6	8.2	-48.7	61.7
4140	-57.3	1.7	8.5	-50.5	63.5
4600	-53.1	1.8	9.5	-45.4	58.4

Vertical 3 meter measurement using tuned dipole antenna

Freq. (MHz)	**Gen. Output (dB)**	**Coax Loss (dB)**	**Ant. Gain (dBd)**	**Dipole Eq. Power (dBm)**	**Difference (dB)**
460	23	2.3	-1.3	19.4	
920	-27.8	3.3	0.3	-30.8	50.2

Output = 19.4 dBm
= 0.087 W
Req. Att.= 39.4 dBm

Vertical 1 meter measurement using horn antenna

Freq. (MHz)	**Gen. Output (dBm)**	**Coax Loss (dB)**	**Ant. Gain (dBd)**	**Dipole Eq. Power (Dbm)**	**Difference (dB)**
1380	-39.5	0.9	6.5	-33.9	53.3
1840	-46.8	1.0	6.9	-40.9	60.3
2300	-51.8	1.2	7	-46	65.4
2760	-41.6	1.3	7.7	-35.2	54.6
3220	-47.6	1.4	8.3	-40.7	60.1
3680	-53.7	1.6	8.2	-47.1	66.5
4140	-52.9	1.7	8.5	-46.1	65.5
4600	-54.2	1.8	9.5	-46.5	65.9

TABLE 1c
ACLARA MODEL 14280A TRANSMITTER
SUBSTITUTION METHOD
470 MHz

Horizontal 3 meter measurement using tuned dipole antenna

Freq. (MHz)	Gen. Output (dB)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (dBm)	Difference (dB)
470	13.9	2.4	-1.4	10.1	
940	-30.9	3.3	0.5	-33.7	43.8

Output = 10.1 dBm
= 0.010 W
Req. Att.= 30.1 dBm

Horizontal 1 meter measurement using horn antenna

Freq. (MHz)	Gen. Output (dBm)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (Dbm)	Difference (dB)
1410	-41.5	0.9	6.6	-35.8	45.9
1880	-48.0	1.0	6.9	-42.1	52.2
2350	-54.9	1.2	7.0	-49.1	59.2
2820	-46.6	1.3	7.8	-40.1	50.2
3290	-61.0	1.5	8.3	-54.2	64.3
3760	-53.3	1.6	8.2	-46.7	56.8
4230	-59.0	1.7	8.8	-51.9	62.0
4700	-62.6	1.8	9.5	-54.9	65.0

Vertical 3 meter measurement using tuned dipole antenna

Freq. (MHz)	Gen. Output (dB)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (dBm)	Difference (dB)
470	19.9	2.3	-1.4	16.2	
940	-30.8	3.3	0.5	-33.6	49.8

Output = 16.2 dBm
= 0.042 W
Req. Att.= 36.2 dBm

Vertical 1 meter measurement using horn antenna

Freq. (MHz)	Gen. Output (dBm)	Coax Loss (dB)	Ant. Gain (dBd)	Dipole Eq. Power (Dbm)	Difference (dB)
1410	-45.8	0.9	6.6	-40.1	56.3
1880	-49.6	1.0	6.9	-43.7	59.9
2350	-57.5	1.2	7.0	-51.7	67.9
2820	-43.6	1.3	7.8	-37.1	53.3
3290	-60.8	1.5	8.3	-54	70.2
3760	-50.1	1.6	8.2	-43.5	59.7
4230	-54.7	1.7	8.8	-47.6	63.8
4700	-63.7	1.8	9.5	-56	72.2

TEST EQUIPMENT USED

Spectrum Analyzer	Rohde & Schwarz Model FSL6 Spectrum Analyzer SN: 100602 Cal Date: 8/14/2012 Cal Due: 8/14/2013
Antennas	A.H. Systems Model FCC-4 Tuned Dipole SN: 592A Receive Only Frequency Range 325 – 1000 MHz Cal N/A
	ETS-Lindgren Model DB-4 Tuned Dipole SN: 69062 Transmit Only Frequency Range 400 – 1000 MHz Cal Date: 8/2/2012 Cal Due: 8/2/2013
	ETS-Lindgren Model 3115 Double Ridged Guide Horn SN: 69713 Receive Only Frequency Range 0.75 – 18 GHz Cal N/A
	ETS-Lindgren Model 3115 Double Ridged Guide Horn SN: 69712 Transmit Only Frequency Range 0.75 – 18 Cal Date: 8/2/2012 Cal Due: 8/2/2013
Signal Generator	Hewlett-Packard Model 8340B, S/N 3010A01889 Cal Date: 6/29/2012 Cal Due: 6/29/2013
Miscellaneous	12.2 m RG-213/U coaxial cable
	22.5 m LMR-400 coaxial cable
	3.0 m RG-213/U coaxial cable
	3.0 m RG-213/U coaxial cable
Tests Performed	August 31 - September 4-, 2012

Unit Tested: 14280A SN: 14280003

OCCUPIED BANDWIDTH

The emissions close to the center of the specified channel are limited by the emissions masks described in FCC ¶90.210 and RSS-119, 4.2.2 and Table 3. For the frequency range of the 14280A transmitter, Mask D is specified. From the center frequency of the band ±5.625 kHz, 0 dB of attenuation is required. From 5.625 kHz to 12.5 kHz from the center frequency, attenuation must be at least 7.27(f_d – 2.88 kHz) dB, where f_d is the displacement frequency from the center of the band in kHz.

At more than 12.5 kHz from the band center, the attenuation must be 70 dB or 50 + 10 log(P), whichever is less. The maximum dipole equivalent power was determined to be 19.4 dBm or 0.087 W and 50 + 10 log(0.087) equals 39.4dB. The mask measurement was a radiated measurement, and as seen in Fig. 1, the measured output signal was -11.3 dBm so the maximum allowed is shown on the plot as 40 dB below the measured level.

Both modulated and unmodulated transmissions were stored on the spectrum analyzer display. The plot of Fig. 1 shows both signals with Mask D superimposed on the plot. The plot indicates that the modulated emission does comply with the requirement for occupied bandwidth as found in 90.210.

For purposes of this test, the modulated signal was PN9 modulated at the specified 1200 bits per second data rate. The unmodulated signal transmits as either a high or low deviation. The MTU was set for low deviation.

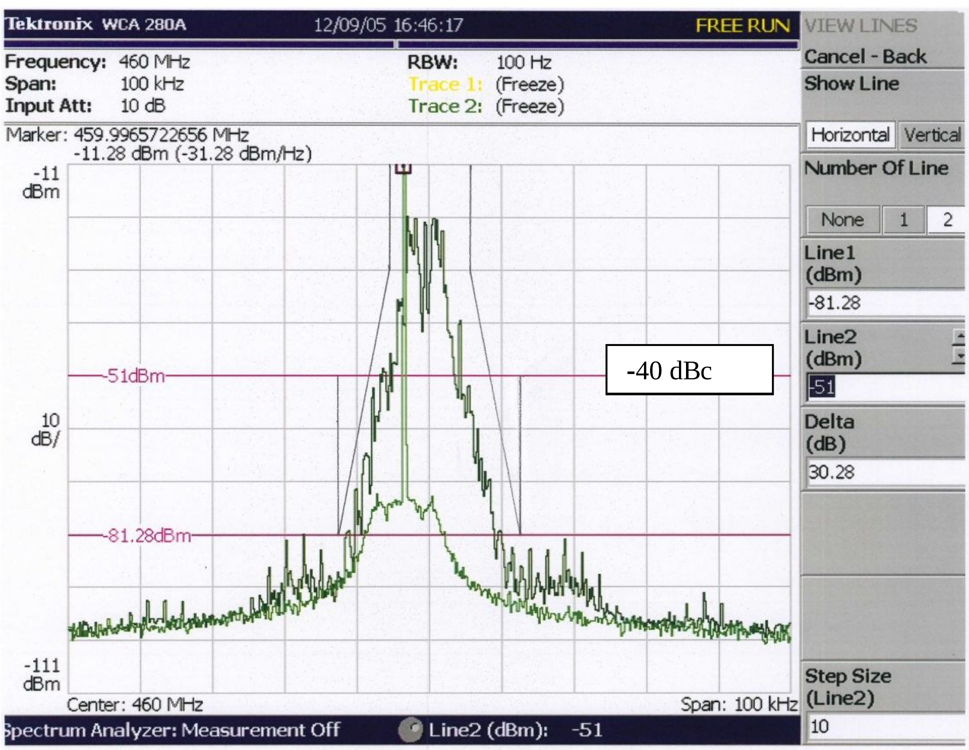


Fig. 1
Aclara Model 14280A
Emissions Mask

TEST EQUIPMENT USED

<u>Spectrum Analyzer</u>	Tektronix Model WCA 280A SN: J300168 Cal Due: 4/27/2013
<u>Antenna</u>	ETS Lindgren Model 3106B Wave Guide Horn SN: 86354 Freq. Range 200 MHz – 3000 MHz Cal: N/A
<u>Test Performed</u>	September 5, 2012

Unit Tested: 14280A SN: 14280003

FREQUENCY STABILITY VS. TEMPERATURE

The temperature stability of the frequency generating components of the transmitter was observed. The transmitter was placed in a temperature chamber with a programming coil that allows a transmission to be requested from outside the chamber. A resistive probe inside the chamber picked up the transmitted signal, which was fed to the spectrum analyzer.

With the transmitter programmed to transmit at 460 MHz, the chamber temperature was set to 20° C. After reaching the set temperature, the transmitter was allowed to temperature stabilize. The transmitted signal was captured by the spectrum analyzer and the frequency was determined. The temperature in the chamber was then increased in 10° intervals to +70° C. At each temperature, at least 30 minutes were allowed for stabilization of the transmitter, a transmission was made and the frequency determined. The temperature was then returned to 20° for a second room temperature reading. The frequency at each temperature was recorded, compared to the 459.999375 MHz reference frequency, and is recorded in Table 2. It can be seen from the table that all readings are within the deviation tolerance of ±2.5 ppm or 1150 Hz at 460.000000 MHz. An unmodulated transmission is offset from the tuned frequency by the deviation amount. The MTU was set to a low offset and the resulting transmission is below the 460 MHz tuned frequency as shown in the table.

TABLE 2
FREQUENCY STABILITY VS. TEMPERATURE

Tuned Frequency: 460.000000 MHz*

Temperature ° C	**Measured Frequency** MHz	Dev. Hz	Dev. ppm
+20	459.999375	0	0.000
+30	459.999375	0	0.000
+40	459.999343	-32	-0.070
+50	459.999312	-63	-0.137
+60	459.999468	93	0.202
+70	459.999500	125	0.272
+80	459.999687	312	0.678
+20	459.999500	125	0.272
+10	459.999562	187	0.407
0	459.999593	218	0.474
-10	459.999406	31	0.067
-20	459.999531	156	0.339
-30	459.999625	250	0.543
+20	459.999343	-32	-0.070

*Reference Frequency= 459.3999375

FREQUENCY STABILITY VS. SUPPLY VOLTAGE

To vary the DC test voltage, a variable DC power supply was inserted in place of the lithium cell. The frequency was measured at the TIA-603-C default standard test voltage of lithium ion cells. Measurements were also made at voltages down to and below the 85% level of 3.18 Volts.

With the battery reinstalled, the AC voltage to the electric meter was also varied from the standard operating point of 240 VAC to the ±15% values shown in the table below.

With the voltage set to a measurement point, the transmitted signal was captured by a spectrum analyzer and the frequency value determined. The frequencies are compared to the tuned frequency. The data for these measurements are found in Table 3. Again, it can be seen that all values obtained are within the deviation limit of ±2.5 ppm or 1150 Hz at the 460 MHz reference frequency. For this MTU, the unmodulated signal was set to deviate high rather than low.

TABLE 3
FREQUENCY STABILITY VS. SUPPLY VOLTAGE

460 MHz

INPUT Volts	**Measured Frequency** MHz	Dev. Hz	Dev. ppm
3.75 VDC	460.002104	-9	0.0196
3.60 VDC	460.002113 *	0	0.0000
3.19 VDC	460.002094	-19	0.0413
3.06 VDC	460.002094	-19	0.0413

* = Reference frequency

276VAC	460.002152	-10.00	-0.022
240 VAC	460.002162 *	0.00	0.000
204 VAC	460.002152	-10.00	-0.022

* = Reference frequency

TEST EQUIPMENT USED

<u>Spectrum Analyzer</u> (Real time)	Tektronix Model WCA 280A (Voltage) SN: J300168 Cal Due: 4/27/2013 Sony/Tektronix Model 3086 (Temperature) SN: J300195 Cal Due: 9/16/2012
<u>Antenna</u>	Short Whip (Voltage) Resistor Probe (Temperature)
<u>DC Power Supply</u>	MPJA DC Regulated Power Supply (Voltage) SN: 012021 Cal: N/A
<u>Digital Multi-Meter</u>	Fluke Model 179 (Voltage) SN: 46440070 Cal. Due: 7/17/2013
<u>Temperature Chamber</u>	Test Equity Model 115 (Temperature) Cal. due: 2/17/2014
<u>Tests Performed</u>	Temperature Sept. 10-11, 2012 Voltage Sept. 10, 2012
Temperature & Voltage	Unit Tested 14280A Voltage: SN: 142800017 (AC) Voltage: SN: 142800019 (DC) Temperature: SN: 14280003

TRANSIENT STABILITY

The transient stability measurements indicate the variation in tuned frequency during the brief interval of time during the start of the transmission and at the end of the transmission.

The Model 14280A transmitter was tested for transient frequency behavior using the test method of TIA/EIA-603-C. A block diagram of the test setup is seen in Fig. 2. An Aclara model 9975G-WB receiver was used. The storage oscilloscope was triggered by the output of the RSSI output of the receiver. Appropriate delay was provided by the digital delay circuitry of the oscilloscope. The 1 kHz test signal was provided by the Hewlett-Packard signal generator. The generator's output control was used to insure that the test signal was at least 50 dB below the received signal level from the 14280A.

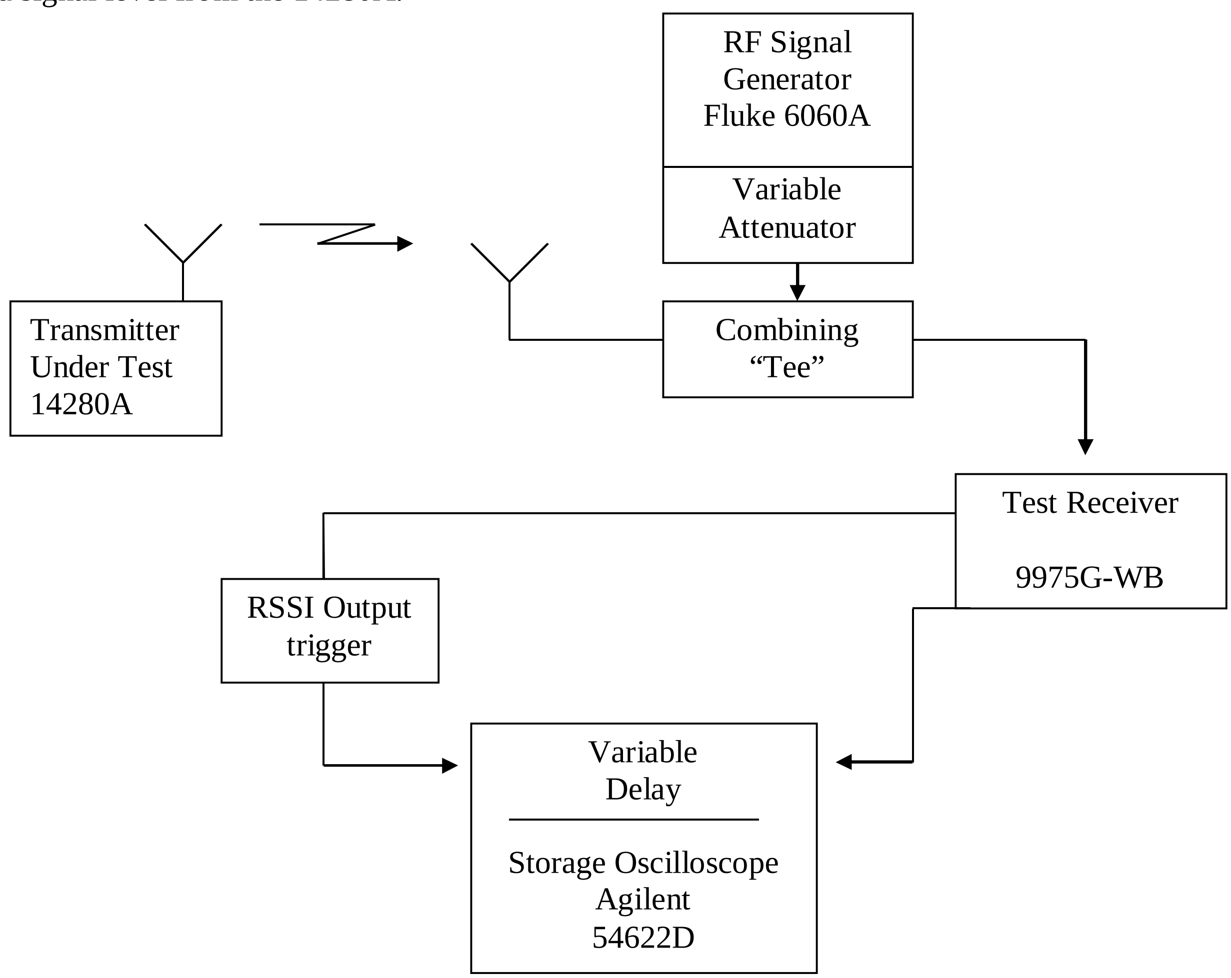


Fig. 2
Transient Frequency Behavior
Test Setup

Test Requirements

The test requirements per 90.214 are:

1. Frequency deviation during t_1 (10 ms duration after t_{on}) may be greater than ±12.5 kHz because the output power is less than 6 Watts.

2. Frequency deviation during t_2 (25 ms duration after t_1) must be less than ±6.25 kHz.

3. Frequency deviation after t_2 must be less than ±2.5 ppm, or ±1150 Hz at 460 MHz.

4. Frequency deviation during t_3 (10 ms duration after transmitter is turned off) may exceed ±12.5 kHz because output power is less than 6 Watts.

Test Data

Figures 3 through 7 show the Model 14280A transient frequency characteristics. The limit masks are indicated on each of the figures.

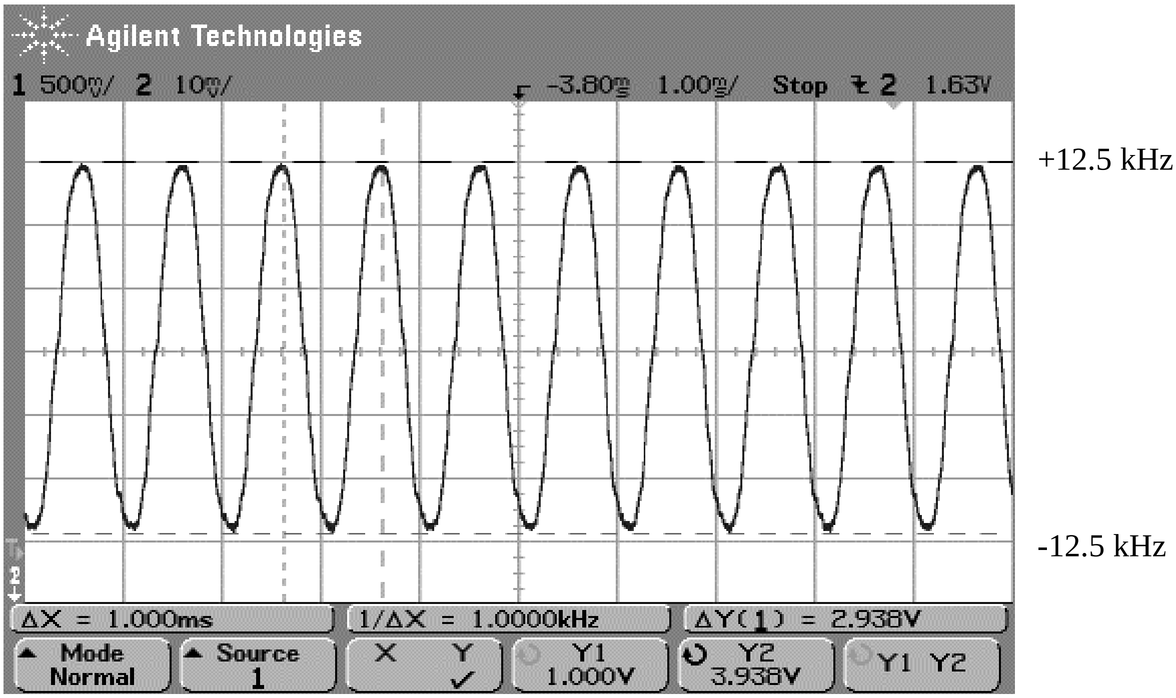


Fig. 3 ±12.5 kHz modulated test signal .

±12.5 kHz = 2.94 V
±6.25 kHz = 1.47 V
±1.15 kHz = 258 mV

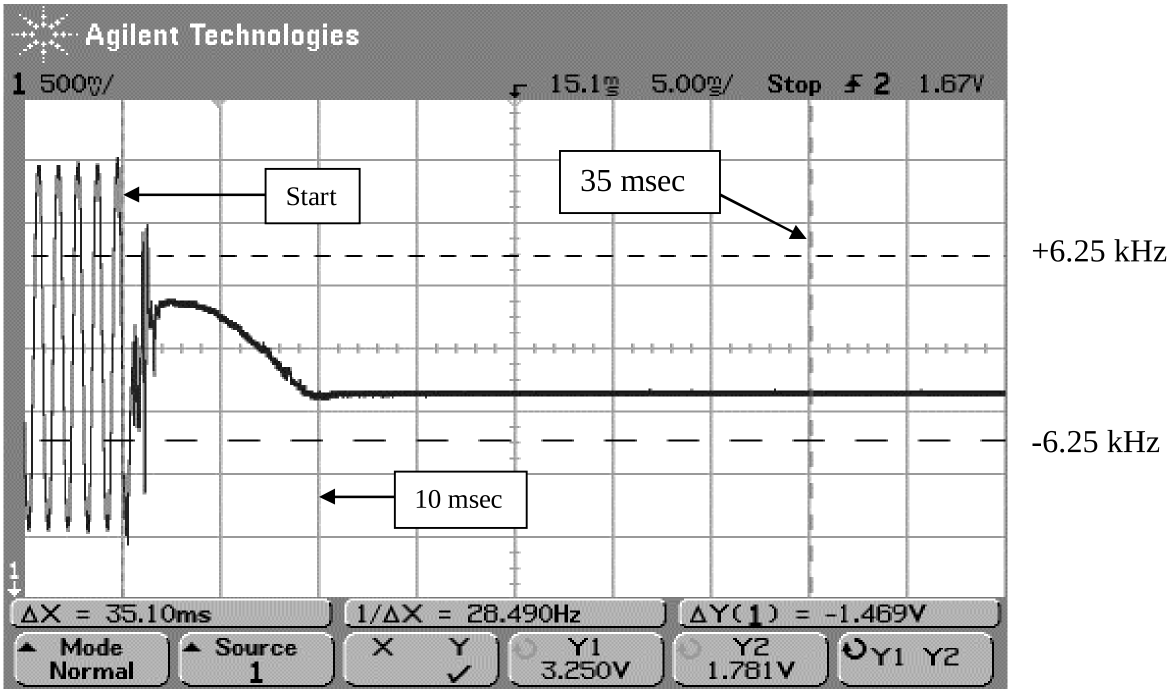


Fig. 4 Start of Transmission

Note: The unmodulated signal is deviated high or low. In this case it is low.

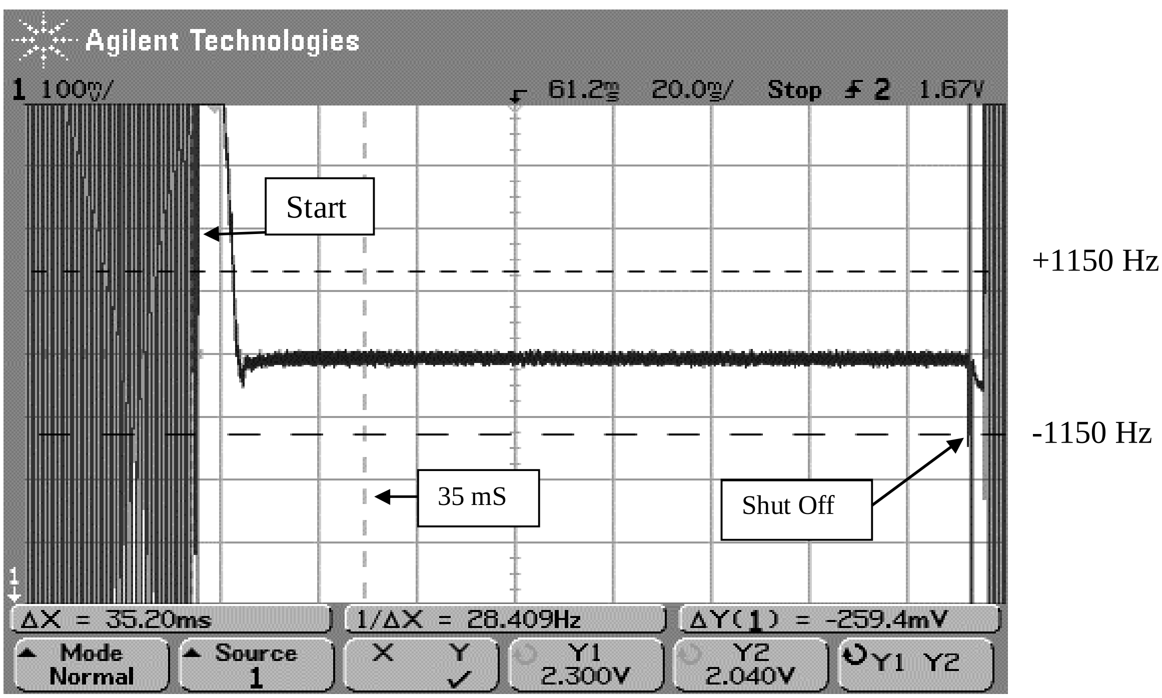


Fig. 5 Full Transmission

Note: Display was adjusted to show variation of unmodulated signal within limits.

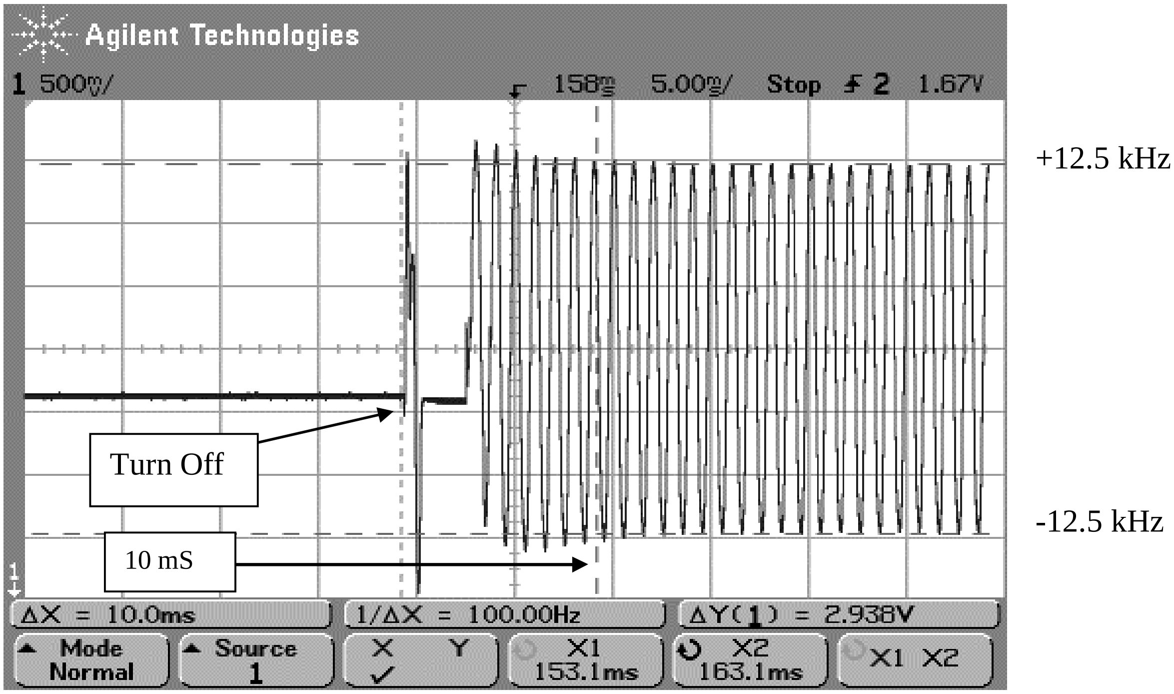


Fig. 6 Turn Off Transient

The modulated signal appears well within the allowed 10 ms and does not exceed ±12.5 kHz beyond 10 ms.

TEST EQUIPMENT USED

Signal Generator	Fluke Model 6060A Signal Generator SN: 3675006 Cal Due: 7/18/2013
Test Receiver	Aclara 9975G-WB w/ RSSI trigger output
Oscilloscope	Agilent Model 54622D SN: MY40003551 Cal Due: 7/17/2013
Test Performed	September 6, 2012

Unit Tested: 14280A SN: 14280003

TEST INFORMATION

SUMMARY

The Aclara Model 14280A transmitter has been shown to be capable of complying with those requirements of the Federal Communications Commission for a Part 90 transmitter as well as the Industry Canada requirements of RSS-119, Issue 11that are covered by this report.

EQUIPMENT UNDER TEST	MTU Transmitter, Model 14280A
MANUFACTURER	Aclara, Inc. 30400 Solon Rd. Solon, OH 44139
TEST DATES	August 31 – September 27, 2012
OPEN AREA TEST SITE	Smith Electronics, Inc. 8200 Snowville Road Cleveland, OH 44141 (330) 289-9306 FCC (Reg. #90938) IC (4541A-1)