Invensys Metering Systems
VXU2 Transceiver

FCC ID: KCHVXU3600
FCC Rule Part: 101

General Overview

A description of the theory of operation and product configuration is found in an attachment to this application and report.

SPECIFICATIONS

Transmitter

TX operating frequency:	952-956 MHz
TX output power:	20 watts PEP
Modulation:	AM Dual sideband, 1800 Hz alert tone
	AM Manchester Encoded 1000 BPS
	Modulation is internally generated and limited
Power requirements:	11-16.5 VDC, approx. 10 A maximum current draw
Antenna connector:	N- type
Frequency Tolerance	.00015% , ±1428 Hz, ±1435 Hz
	-30 to +50 C
	85%-115% supply voltage at 20C

Receiver

RX Operating Frequency	902-928 MHz
Modulation:	Direct Sequence Spread Spectrum

Block diagram and theory of operation is provided in a separate attachment.

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2.

1.1307(b) RF exposure information is provided in a separate attachment in the form of maximum permissible exposure (MPE) data.

2.1033(c)1 Applicant: Invensys Metering Systems Inc.
450 N. Gallatin Avenue
Uniontown, PA 15401

2.1033(c)2 FCC ID: KCHVXU3600

2.1033(c)3 Installation instructions are found in separate document.

2.1033(c)4 Emission type: Dual sideband AM

Emission designator: 3K60A1D (1800 Hz signaling tone)
4K40A1D (1kbps Manchester)

2.1033(c)5 Frequency range: 952.00625 - 952.99375 MHz
956.25625 - 956.44375 MHz

2.1033(c)6 Range of Operating Power

41.3 dBm into dipole (41.3 dBm ERP)

2.1033(c)7 Maximum Power Rating

41.3 dBm measured

Maximum allowed per 101.147(b)5: 25 watts ERP (44 dBm ERP)

2.1033(c)8 Applied voltages and currents into the final transistor elements

Refer to schematics, separate submission accompanying this application

2.1033(c)9 Tune-up procedure

Refer to installation instructions..

2.1033(c)10 Circuit and Functional Block Diagram, Description of Circuitry

Complete product schematics are provided in separate attachments.
Circuit description and theory of operation are found in separate attachment.

2.1033(c)11 FCC ID Label

Refer to separate attachment.

2.1033(c)12 Product Photographs

Refer to separate attachment.

2.1033(c)13 Description of Modulation System

Dual sideband AM. Refer to theory of operation, separate attachment

2.1033(c)14 Test Data per 2.1046 – 2.1057

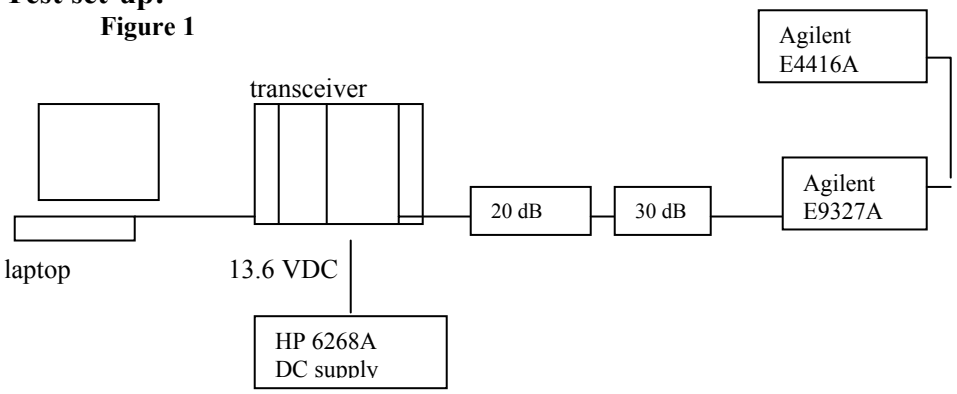
2.1046 RF Output Power Measurements

Measurement equipment used:

Agilent E44164A Power Meter
Agilent E9327A Power sensor (average power detector setting)

Test set-up:

Figure 1



Test Procedures

1. Set the transmitter to produce maximum modulated power at the desired frequency
2. Read mean power directly from Agilent E4416A

Test Results

F(MHz)	P out w/1800Hz Modulation	Pout w/ Manchester Encoded Input
956.350	41.1 dBm	41.2 dBm
952.8375	41.3 dBm	41.2 dBm

Section 2.1047 Modulation Characteristics
Requirement/Limit: 101.111(a)5

(5) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a 12.5 KHz bandwidth, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 log (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 log (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 (fd/5.3) decibels; and

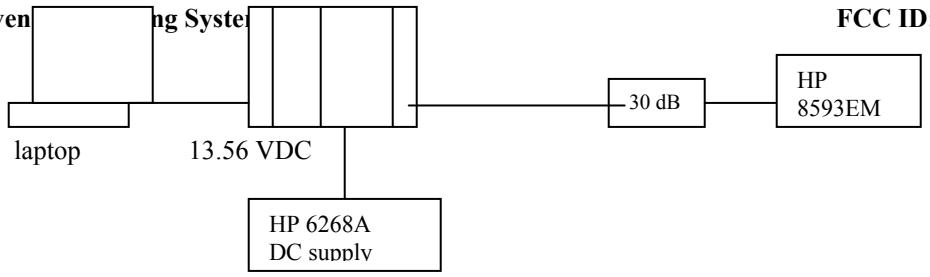
(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 log (P) or 70 decibels, whichever is the lesser attenuation (= -20 dBm)

Measurement equipment used:

HP 8563E Spectrum Analyzer
Coaxial attenuator
Coaxial cable, 3ft (Cable loss less than .3 dB at 956 MHz)

Test set-up:

Figure 2



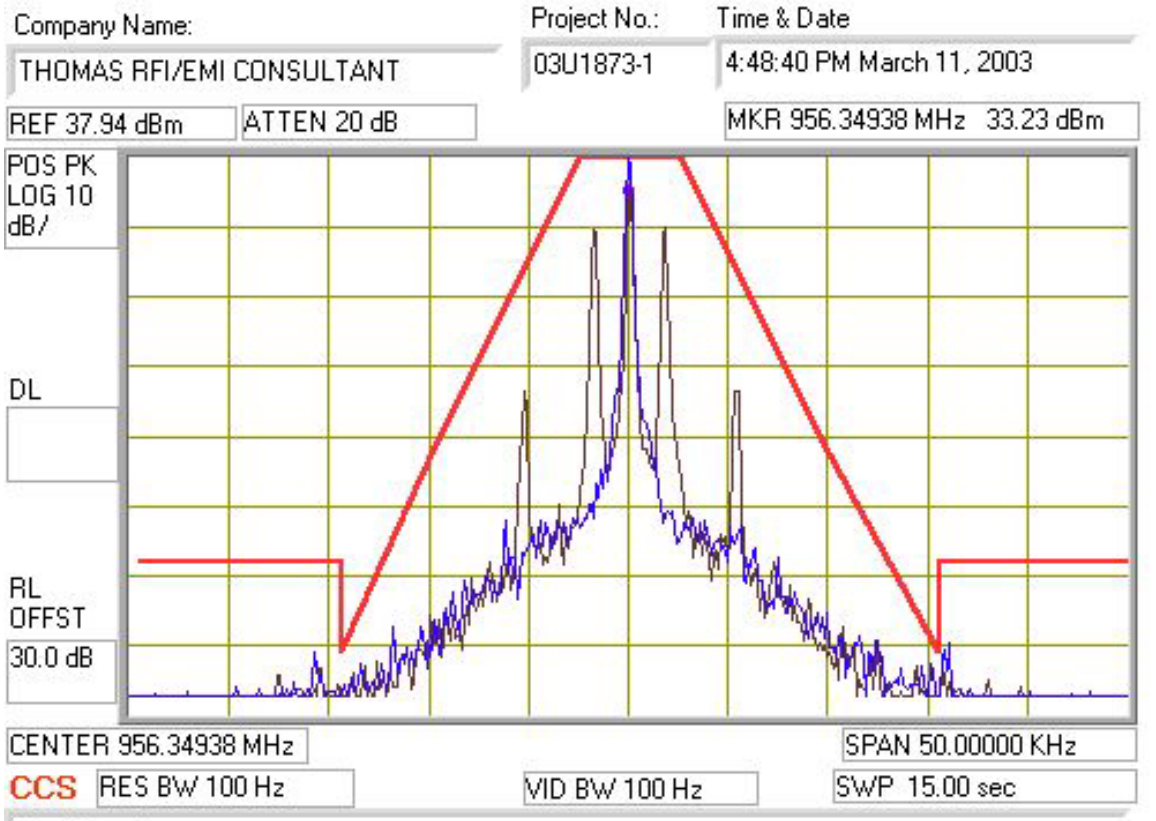
Test Procedures

Software was run to produce two different modulations; 1800 Hz tone AM
1 kbps Manchester encoding

Test Results

PASS. Refer to attached spectrum analyzer charts for two channels:
Emissions are shown with mask lines superimposed on spectrum analyzer charts.

Channel Mask for fo = 956.3495 MHz 1800 Hz modulation



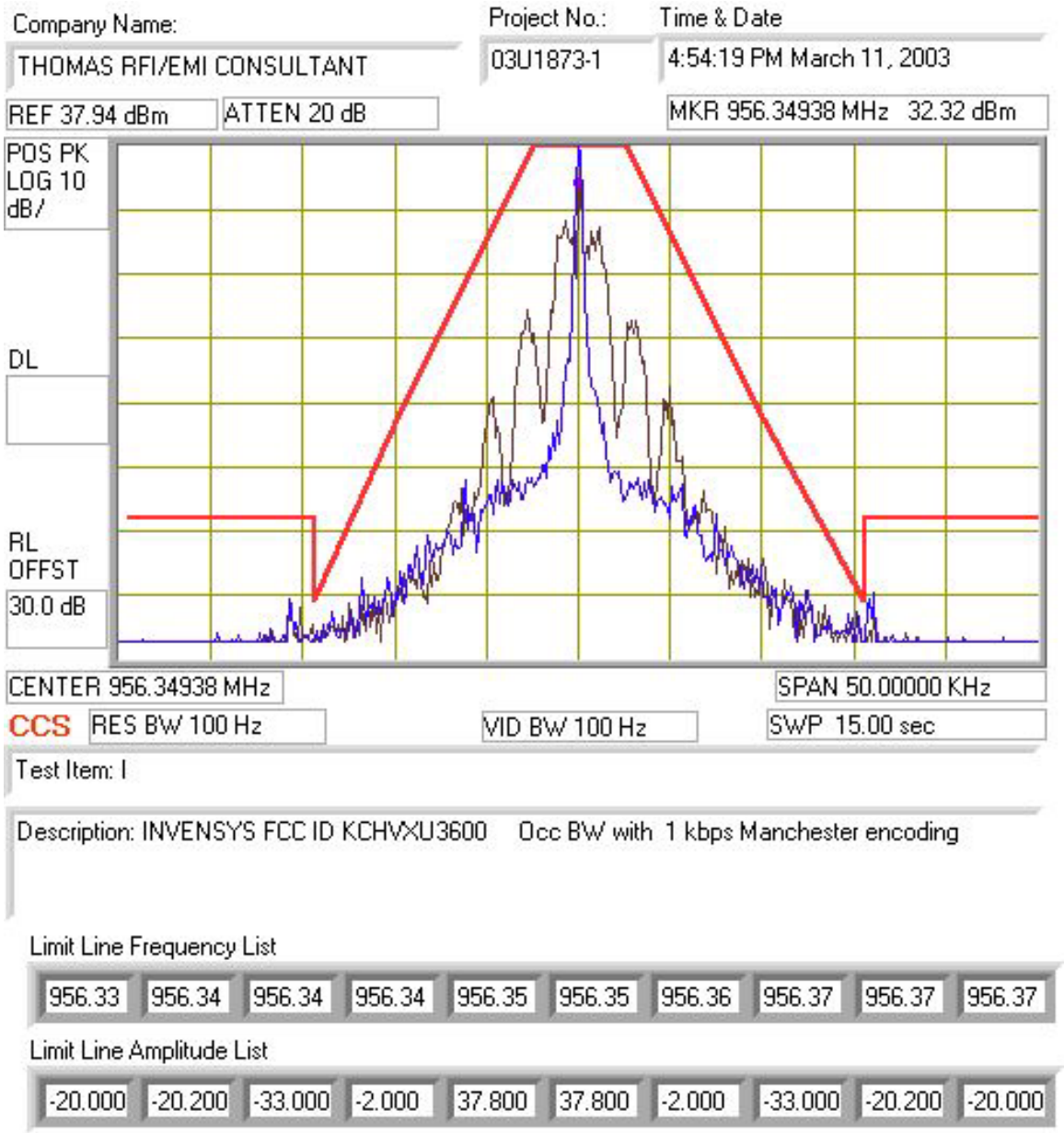
Limit Line Frequency List

956.33	956.34	956.34	956.34	956.35	956.35	956.36	956.37	956.37	956.37

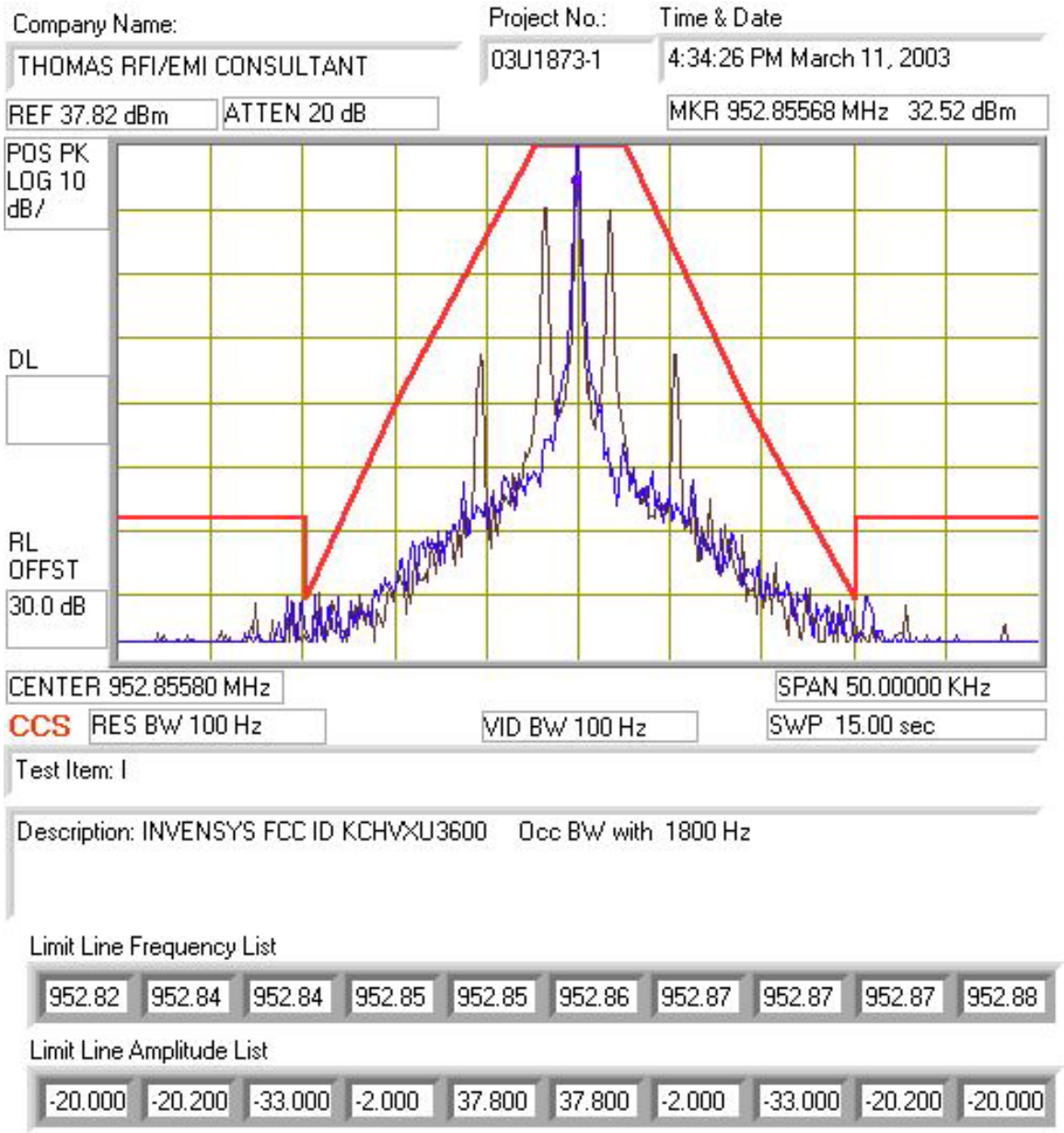
Limit Line Amplitude List

-20.000	-20.200	-33.000	-2.000	37.800	37.800	-2.000	-33.000	-20.200	-20.000

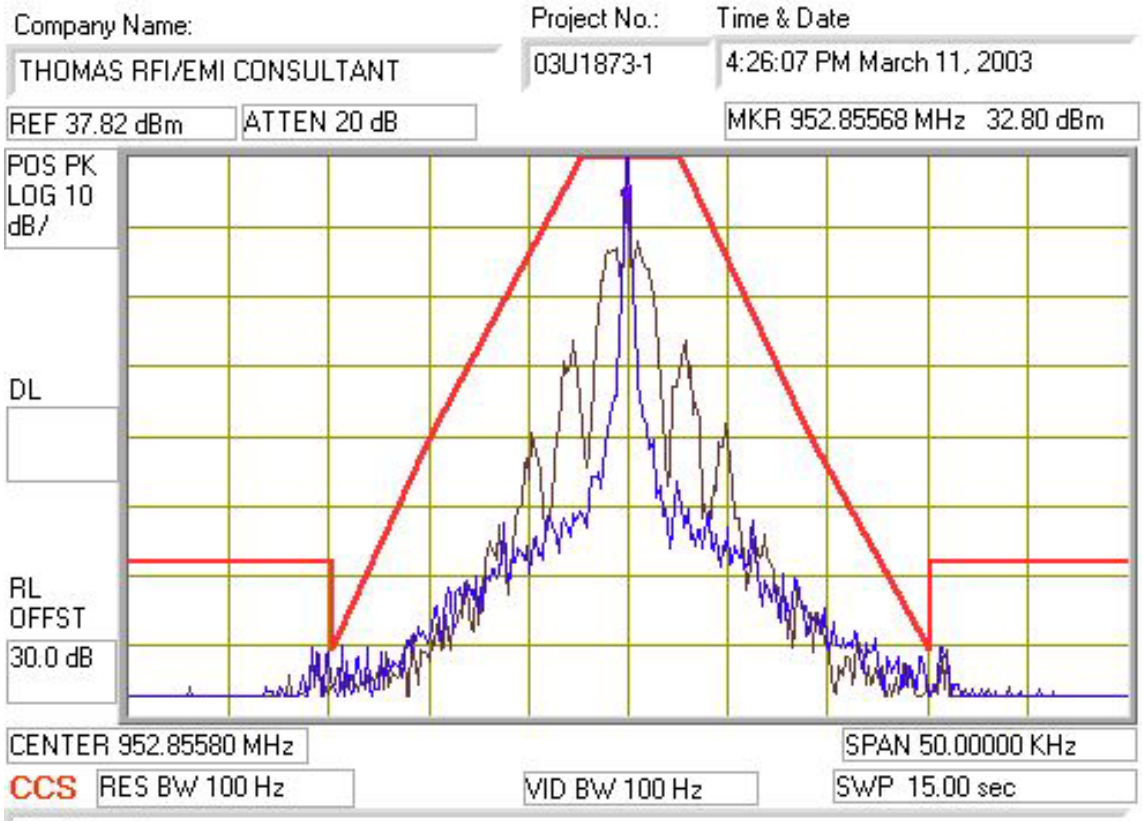
Channel mask for fo= 956.3495 MHz 1 kbps Manchester



Channel Mask for fo = 952.85575 MHz 1800 Hz modulation



Channel mask for fo = 952.85575 MHz 1 Kbps Manchester



Limit Line Frequency List

952.82	952.84	952.84	952.85	952.85	952.86	952.87	952.87	952.87	952.88

Limit Line Amplitude List

-20.000	-20.200	-33.000	-2.000	37.800	37.800	-2.000	-33.000	-20.200	-20.000

Section 2.1049 Occupied Bandwidth
Requirement/Limit: 101.109

12.5 kHz

Measurement equipment used:

HP 8563E Spectrum Analyzer
Coaxial attenuators (3dB and 10 dB)
Coaxial cable, 3ft

Test set-up:

Refer to Fig. 2

Test Procedures and Results:

Occupied bandwidth was measured manually using analyzer MARKER function .

For 1800 Hz tone: occupied BW = 3600 Hz
For 1kbps Manchester encoding: occupied BW = 4400 Hz

Occupied bandwidth is per definition in Rule para. 2.1 (99%, or 20 dB BW)

Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals
Requirement/Limit: 101.111(a)5

Measurement equipment used:

HP 8593EM Spectrum Analyzer
Coaxial attenuator, 20 dB
Coaxial cable, 3ft

Test set-up:

Refer to Figure 2 above

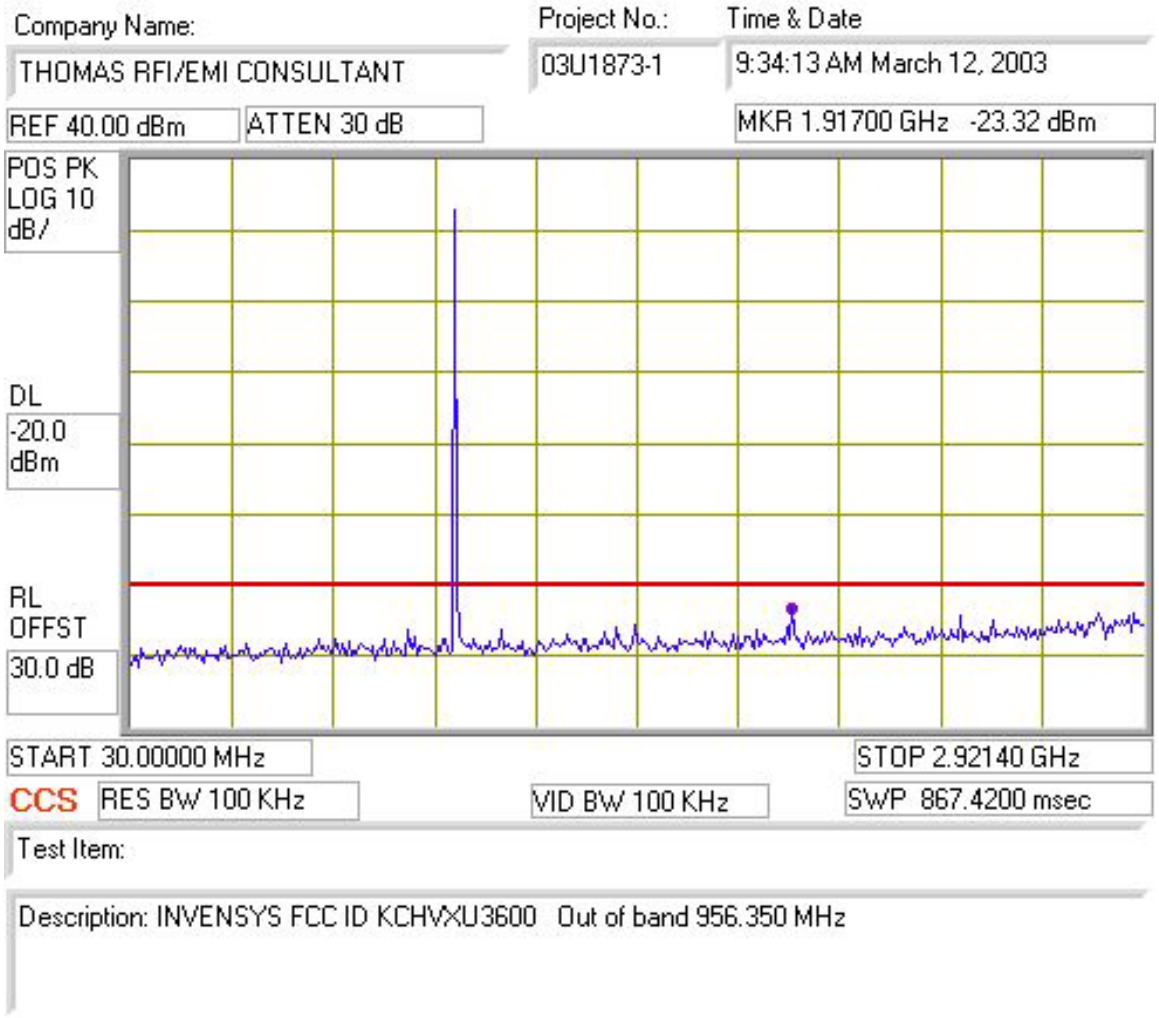
Test Procedures

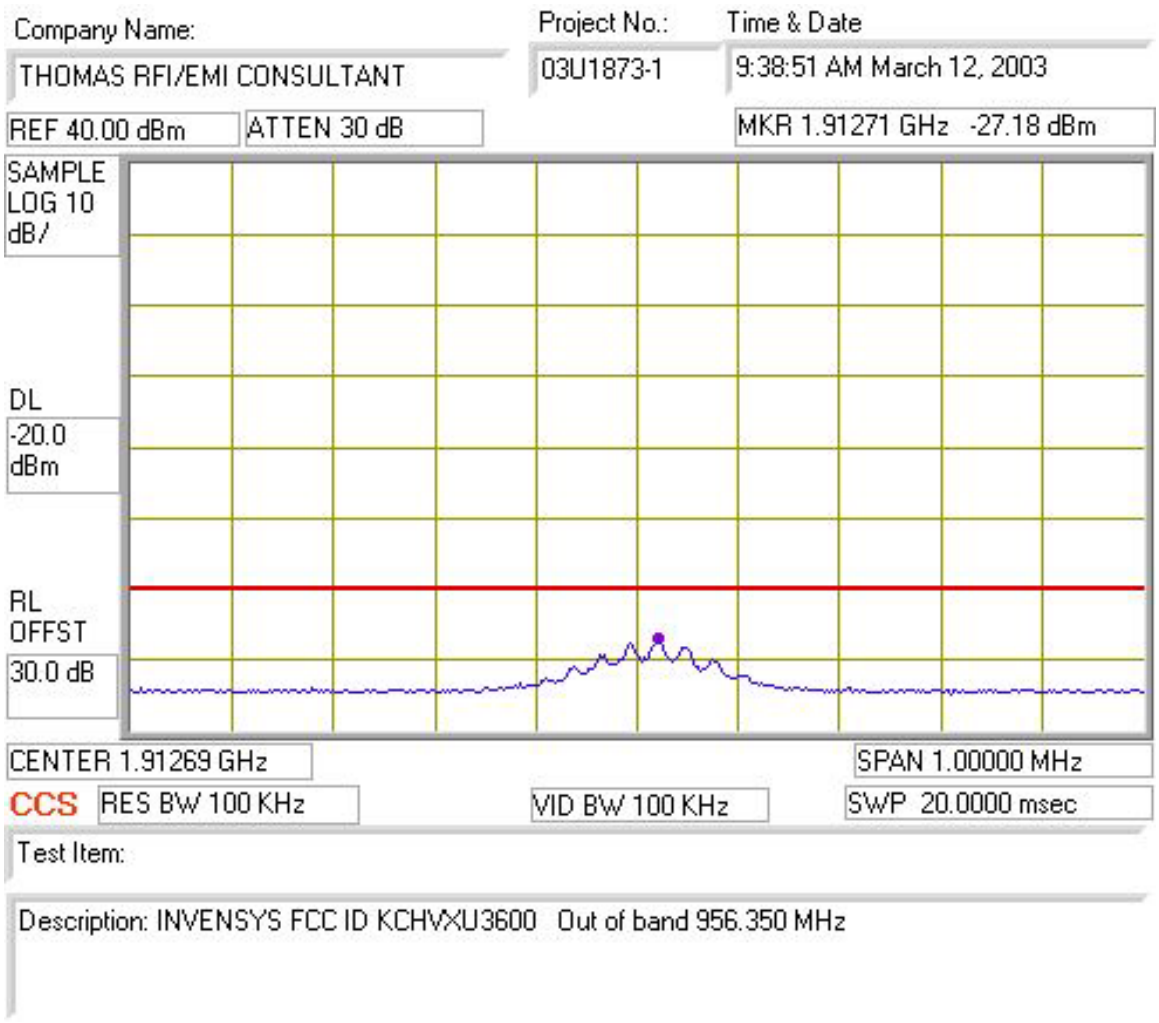
1. Set spectrum analyzer to TX output center frequency, RES BW = 100 kHz, VID BW = 100 kHz Hz.
2. Set spectrum analyzer to record Average reading.
3. Set DISPLAY LINE to a level 60 dB below flat top peak
4. Record transmitter output spectrum from 1 MHz to 10^{th} harmonic of TX output frequency
5. Plot spectrum analyzer output traces.

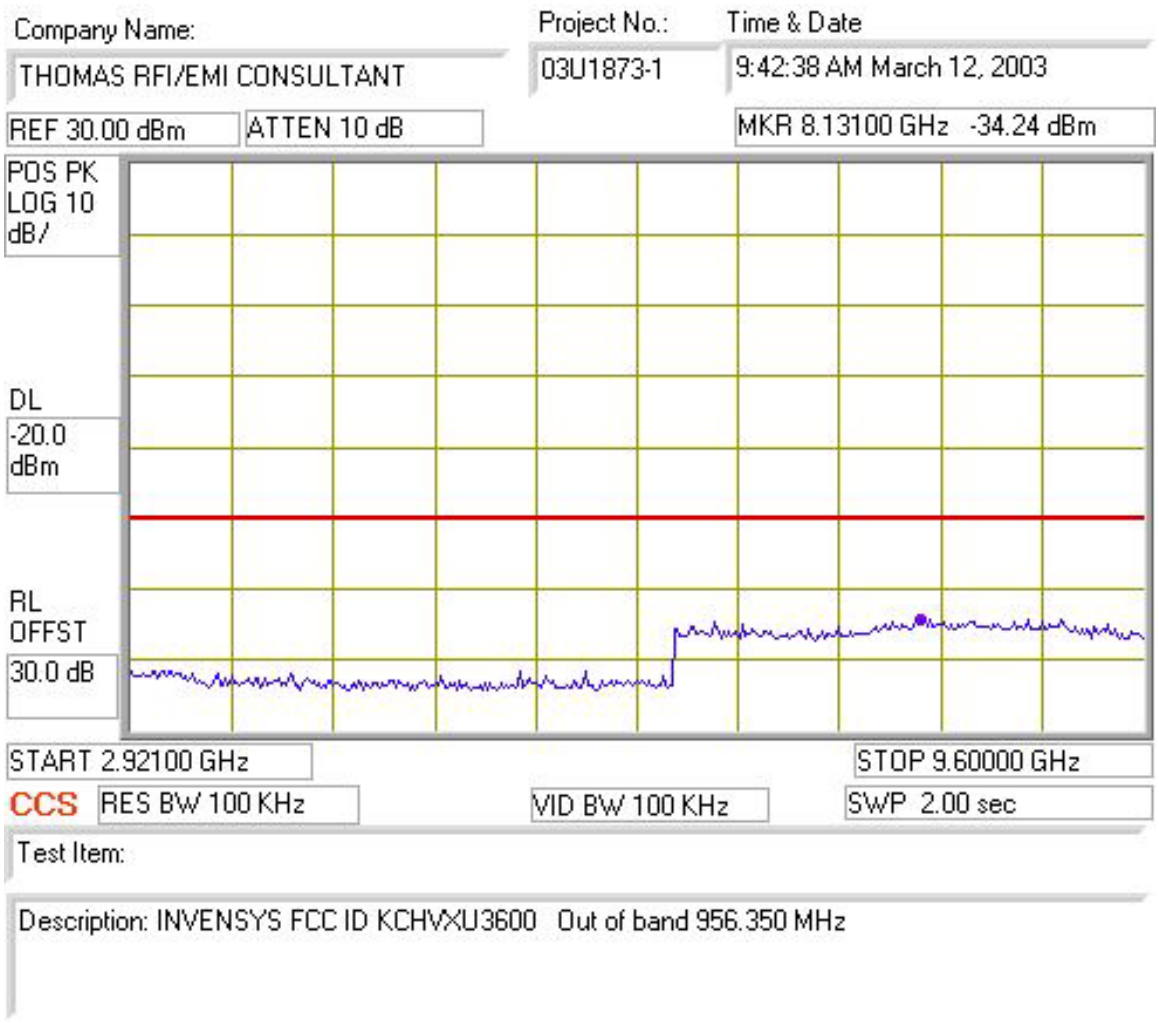
Test Results

PASS. Refer to data plots below.

Spurious Emissions, Antenna Conducted Output Spectrum Analyzer Graph




Company Name:
THOMAS RFI/EMI CONSULTANT
Project No.:
03U1873-1
Time & Date
9:38:51 AM March 12, 2003
REF 40.00 dBm
ATTEN 30 dB
MKR 1.91271 GHz -27.18 dBm
SAMPLE
LOG 10
dB/
DL
-20.0
dBm
RL
OFFST
30.0 dB
CENTER 1.91269 GHz
SPAN 1.00000 MHz
CCS
RES BW 100 KHz
VID BW 100 KHz
SWP 20.0000 msec
Test Item:
Description: INVENSYS FCC ID KCHVXU3600 Out of band 956.350 MHz

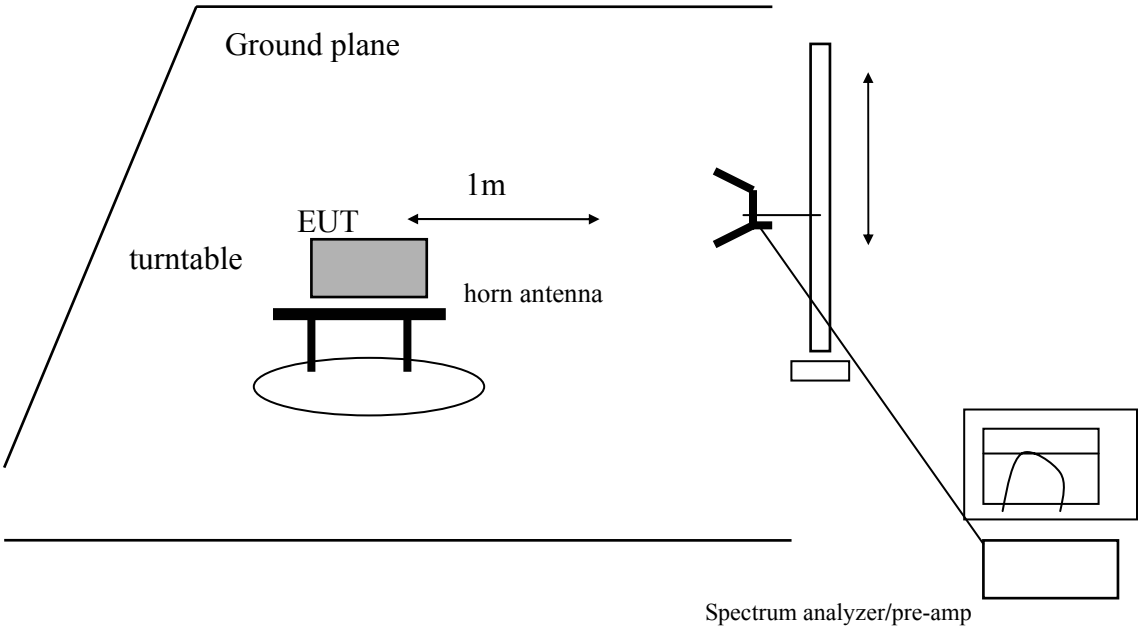

Company Name:
THOMAS RFI/EMI CONSULTANT
Project No.:
03U1873-1
Time & Date
9:42:38 AM March 12, 2003
REF 30.00 dBm
ATTEN 10 dB
MKR 8.13100 GHz -34.24 dBm
POS PK
LOG 10
dB/
DL
-20.0
dBm
RL
OFFST
30.0 dB
START 2.92100 GHz
STOP 9.60000 GHz
CCS
RES BW 100 KHz
VID BW 100 KHz
SWP 2.00 sec
Test Item:
Description: INVENSYS FCC ID KCHVXU3600 Out of band 956.350 MHz

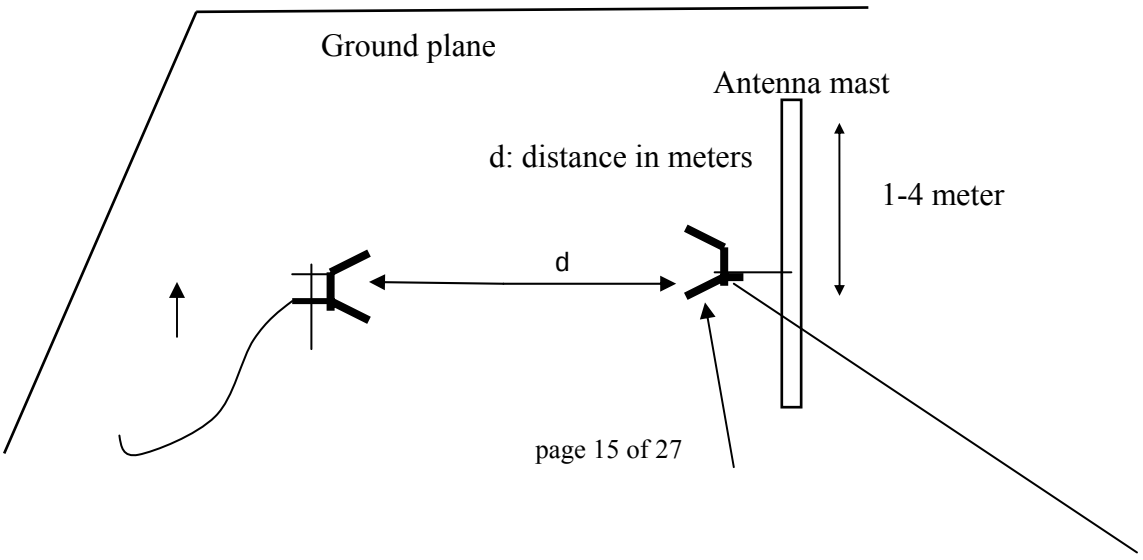
Section 2.1053 Field Strength of Spurious and Harmonic Radiation
Requirement/Limit: 101.111(a)5

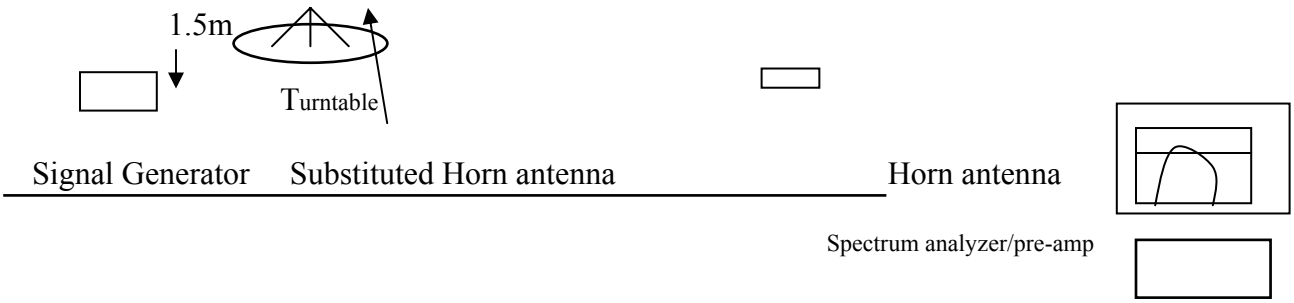
Measurement Equipment Used:

HP 8595EM Spectrum Analyzer
EMCO 3115 Horn antenna, 1- 18 GHz
Antenna Research Associates MWH 1826/B, 18 - 26.5 GHz
HP 8449D pre-amplifier
HP 83732B synthesized signal generator

Test Set-Up







Minimum Requirement

-20 dBm ERP beyond 250% of authorized bandwidth

Test Method

The antenna output port of the EUT was terminated with a 50 ohm load. With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was raised and lowered in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 10 fo.

The EUT was removed and was replaced by a substitution antenna connected via coax to a signal generator. The generator output was set to each emission frequency detected, the search antenna was raised and lowered, the turntable was rotated, until the maximum emission level was obtained. The signal generator output level was adjusted to match the radiated emission level from the EUT. After correcting for substitution antenna factor and generator cable loss, output power level is compared to the limit.

Test Results

Pass. All emissions detected were at least 14.7 dB below limits. Refer to test data below.

Compliance Certification Services, Morgan Hill Open Field Site

Test Engr: William Zhuang
Project #:
Company: Invensys Metering Systems
EUT Descrip.: 20 watt Part 101 Transceiver
FCC ID: KCHVXU3600
Test Target: -20 dBm EIRP out of band
Mode Oper: 1800 Hz modulation

Frequency (GHz)	SA reading (dBuV)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
1.913	**49.6**	-50.00	1.04	7.80	5.65	-43.24	-20.00	-23.24
1.913	**53.6**	-47.00	1.04	7.80	5.65	-40.24	-20.00	-20.24
2.869	**54.2**	-47.00	1.26	8.80	6.65	-39.46	-20.00	-19.46
2.869	**46.91NF**		1.26	8.80	6.65		-20.00	
3.825	**41.69NF**		1.43	9.50	7.35		-20.00	
3.825	**54.8**	-42.80	1.43	9.50	7.35	-34.73	-20.00	-14.73
4.782	**49.4**	-48.60	1.04	7.80	5.65	-41.84	-20.00	-21.84
4.782	**43.19NF**		1.04	7.80	5.65		-20.00	
5.738	**40.42NF**		1.26	8.80	6.65		-20.00	
5.738	**49.3**	-44.00	1.26	8.80	6.65	-36.46	-20.00	-16.46
6.694	**45.1**	-45.80	1.43	9.50	7.35	-37.73	-20.00	-17.73
6.694	**38.91NF**		1.43	9.50	7.35		-20.00	

NF - Noise floor, no emission from EUT
To 10th harmonic: no emissions detected.

Note: Completed scan from 30MHz to 10 GHz.

EPR = SG reading - CL + Gain (dBd)
Gain (dBd) = Gain (dBi) - 2.15
Margin = EPR - Limit

SA: Spectrum Analyzer, HP 8593EM, S/N: 3710A00205
SG: Signal Generator, HP 83732B, S/N: US34490599
TX Antenna: Dipole, Compliance Design, Roberts, S/N: 116
Horn, EMCO 3115, S/N: 6717

CL: cable loss (5ft), FLEXCO
Pre-Amp: Miteq NSP2600 -44, S/N: 646456
RX Antenna: Bicon, Eston 94455-1, S/N: 1214
LP, EMCO 3146, S/N: 3163
Horn, EMCO 3115, S/N: 6739

2.1055 Frequency Stability

Requirement/Limit: Section 101.107

Frequency Tolerance : .00015% (1.5 parts per million)
= ±1434 Hz at 956 MHz
= ±1428 Hz at 952 MHz

Temperature Range: -30C to +50 C
Supply Voltage Range: 85% - 115% nominal 13.6 VDC (11.6 - 15.6 VDC)

Temperature v Frequency, -30C to +50C

c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0[deg] centigrade and +30[deg] centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10[deg] centigrade above the respective beginning ambient temperature level.

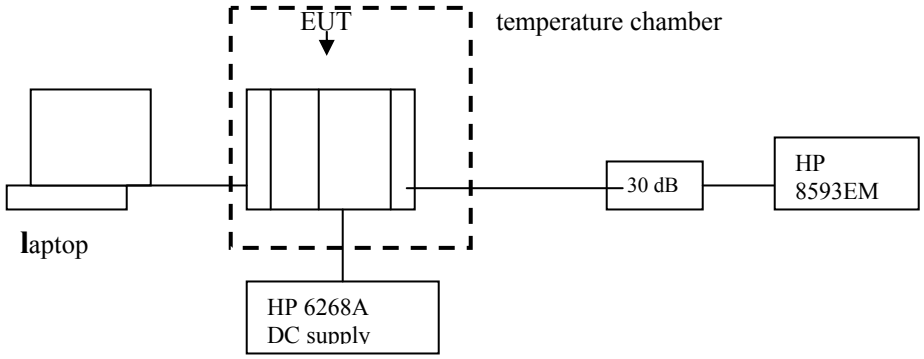
(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

Measurement Equipment Used

HP 8593EM Spectrum analyzer

Test Setup

Figure 3



Test Procedures

1. The temperature stabilization characteristics of the OCXO were determined first. At –30C, the transmitter was allowed to stabilize with TX power off. The transmitter was activated, the frequency was measured and recorded. The frequency was measured once per minute after that until it was determined that frequency had stabilized. This process was repeated at 0C and +30C.
2. After stabilization tests in 1 were concluded the transmitter was allowed to stabilize at every 10 degrees C from –30C to +50C.

Test Results

Refer to table below.

Operating Voltage v Frequency

Measurement Equipment Used

HP 8593EM Spectrum analyzer

Test Setup

Refer to Figure 3

Test Procedures

At 25C the power supply voltage was varied between 85% and 115% nominal.

Test Results

No detectable variation. over voltage excursion.

f set to 956.350 000 MHz
Allowed variation: 1434.5 Hz

Time after turn on	-30 C	0C	+30C
0	956.349 500	956.349 580	956.349 700
1 min	.349 500	.349 640	. 349 720
2 min	.349 500	.349 650	. 349 745
3 min	.349 515	.349 660	.349 765
4 min	. 349 515	.349 655	.349 775
5 min	. 349 535	.349 675	.349 785
6 min	. 349 525	.349 655	.349 775
7 min	.349 535	.349 685	.349 780
8 min	. 349 545	.349 665	.349 780
9 min	***.349 540***	***.349 675***	***.349 780***
10 min	.349 540	.349 670	.349 775

Data indicates that frequency remains within allowable tolerance under all conditions, even from a cold start. As such, no special user manual instructions are required regarding transmitter minimum warm-up time.

Frequency v Temperature (after allowing TX to stabilize)
f set to 956. 350 000 MHz

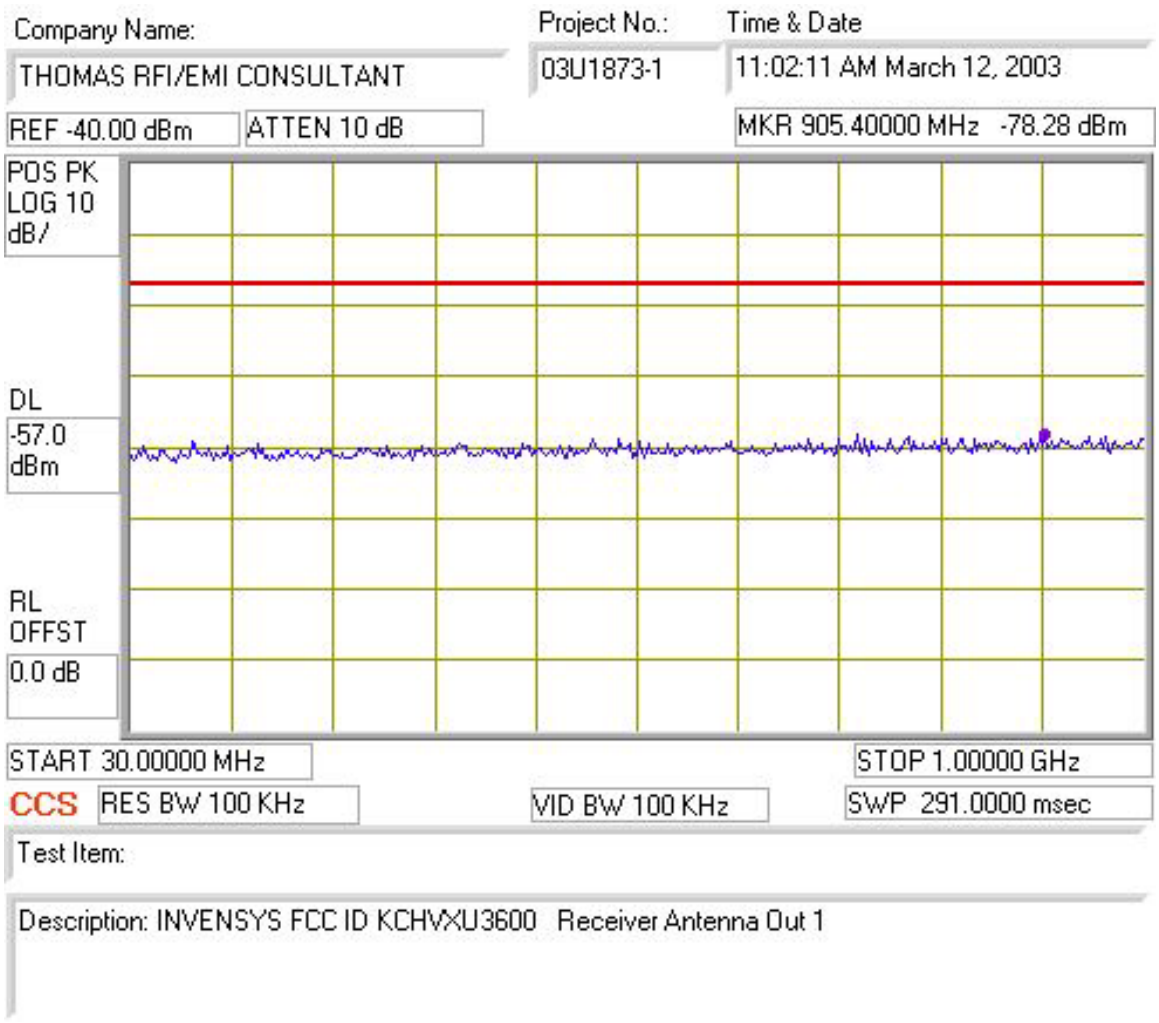
Temperature	Frequency	Difference, Hz	Limit
-30C	956. 349 540	-560	±1434.5 Hz
-20C	956. 349 585	-415	
-10C	956, 349 628	-372	
0C	956. 349 675	-325	
10C	956. 349 723	-277	
20C	956. 349 774	-226	
30C	956. 349 780	-220	
40C	956. 349 828	-172	
50C	956. 349 879	-121	

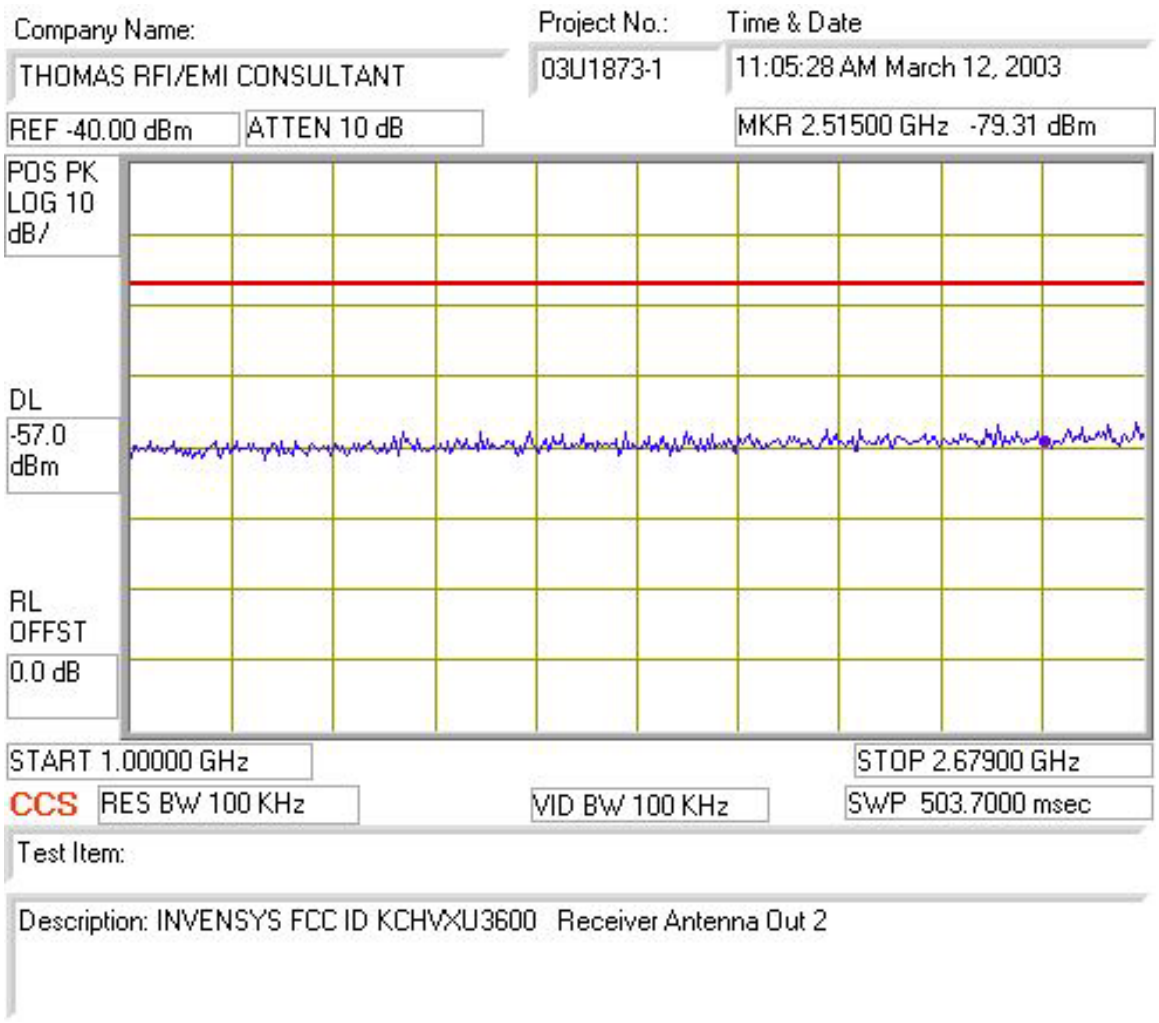
Part 15.111 Antenna Conducted Receiver Emissions

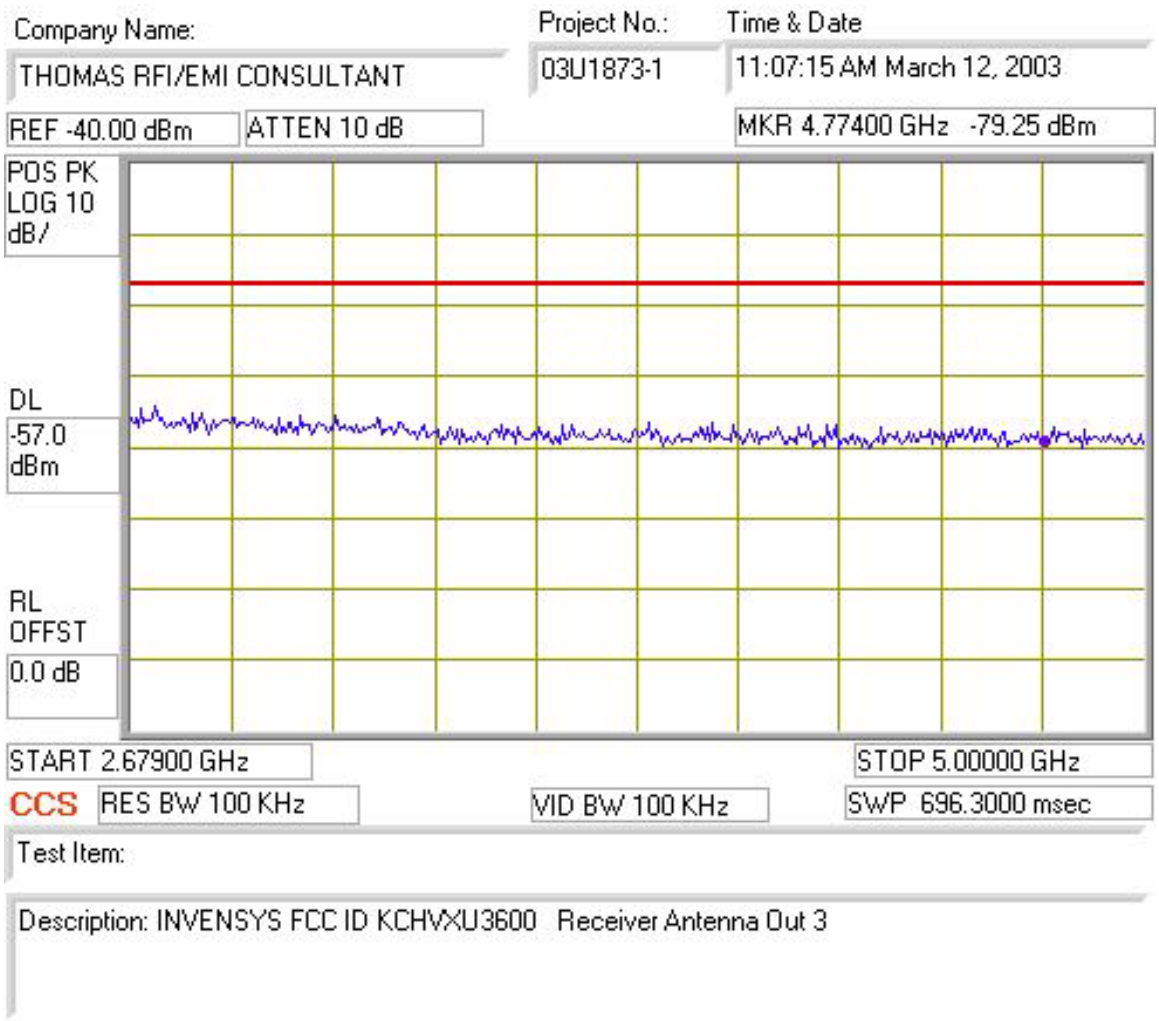
Antenna conducted emissions per 15.111 are presented below. All emissions were more than 20 dB below emissions.

15.109 Receiver Radiated Emissions

Receiver radiated emissions tests were performed concurrently with TX radiated emissions tests. No emissions were detected from the spread spectrum receiver portion of the EUT.


Company Name:
THOMAS RFI/EMI CONSULTANT
Project No.:
03U1873-1
Time & Date
11:02:11 AM March 12, 2003
REF -40.00 dBm
ATTEN 10 dB
MKR 905.40000 MHz -78.28 dBm
POS PK
LOG 10
dB/
DL
-57.0
dBm
RL
OFFST
0.0 dB
START 30.00000 MHz
STOP 1.00000 GHz
CCS
RES BW 100 KHz
VID BW 100 KHz
SWP 291.0000 msec
Test Item:
Description: INVENSYS FCC ID KCHVXU3600 Receiver Antenna Out 1


Company Name:
THOMAS RFI/EMI CONSULTANT
Project No.:
03U1873-1
Time & Date
11:05:28 AM March 12, 2003
REF -40.00 dBm
ATTEN 10 dB
MKR 2.51500 GHz -79.31 dBm
POS PK
LOG 10
dB/
DL
-57.0
dBm
RL
OFFST
0.0 dB
START 1.00000 GHz
STOP 2.67900 GHz
CCS
RES BW 100 KHz
VID BW 100 KHz
SWP 503.7000 msec
Test Item:
Description: INVENSYS FCC ID KCHVXU3600 Receiver Antenna Out 2



Test Site

All testing was performed at Compliance Certification Services either by me or under my supervision. Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.

Test dates: 12 and 13 March 2003 (2 days)
18 March 2003 (half day)

THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals
Agent for Invensys Metering Systems