Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 90.217(b)

FCC ID:	2AB6OTR7400
Model:	TR-7400
APPLICANT:	Long Range Systems, LLC 4550 Excel Parkway, Suite 200 Addison, TX 75001
TEST SITE(S):	National Technical Systems - Plano 1701 E. Plano Pkwy #150 Plano, TX 75074
REPORT DATE:	Sep 2 2014
TEST DATES:	April 1 2014, April 28 2014, August 28 2014
TOTAL NUMBER OF PAGES:	25

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	May 8, 2014	First Release	YF
1	Aug 20, 2014	FCC ID and Model change per client's request	YF
2	Sep 2, 2014	To address TCB comments	YF

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SCOPE

An electromagnetic emissions test has been performed on the Long Range Systems Model TR-7400, pursuant to the following rules:

FCC Part 90.217

Conducted and radiated emissions data has been collected; reduced and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards:

TIA-603-C
FCC Licensed Radio Measurement Guidance KDB 971168

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height and antenna polarization when applicable.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Long Range Systems Model TR-7400 complied with the requirements of the following regulations:

FCC Part 90.217(b)

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

Test results recorded herein are based on a single type test of Long Range Systems Model TR-7400 and therefore apply only to the tested sample.

The sample was selected and prepared by Mike Williams of Long Range Systems. It was received on Apr 1, 2014 and was tested on Apr 1, Apr 28 and August 28, 2014.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

FCC Rule Part	Description	Test Procedure	Measured Value / Comments	Limit / Requirement	Result
2.1047	Modulation	N/A	System uses FSK modulation	Modulation shall be specified	-
2.1049	Occupied Bandwidth	TIA-603-C FCC KDB 971168 D01 v02r01 Section 4.2	11.5kHz	12.5kHz	Complies
2.1046 90.217	Output Power	TIA-603-C FCC KDB 971168 D01 v02r01 Section 5.1.1	20.68dBm (117mW) Conducted	120mW	Complies
2.1051 90.217(b)	Antenna Port Spurious Emissions	TIA-603-C FCC KDB 971168 D01 v02r01 Section 6.0	All emissions < -30dBc	<-30dBc	Complies
2.1053 90.217(b)	Radiated Spurious Emissions	TIA-603-C FCC KDB 971168 D01 v02r01 Section 7.0	All emissions < -30dBc	<-30dBc	Complies
2.1055 90.217(b)	Frequency Stability	TIA-603-C FCC KDB 971168 D01 v02r01 Section 9.0	Emissions remained within 50kHz band	<-30dBc outside 50kHz band	Complies
1.1310	RF Exposure Requirements	N/A	Refer to RF exposure exhibit and user manual statements	Refer to OET 65, FCC Part 1	Complies

MEASUREMENT UNCERTAINTIES

The measurement of uncertainty is not included with the data in this test report.

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

Transmit Frequency:	467.75MHz – 467.75MHz (single channel)
Modulation:	FSK
Transmits:	Paging data only (no voice)
Receive Frequency:	467.75MHz
Intended purpose:	Repeat received paging data
Channel Bandwidth:	12.5kHz
99% Occupied Bandwidth:	11.5kHz (Measured)
Output Power:	20.68dBm = 117mW Peak (Measured at the antenna port)
Antenna:	2dBi detachable omnidirectional rubber duck with BNC connector
RF Exposure Classification:	Mobile
Dimensions:	20cm L x 11.5cm W x 3.5cm H
Enclosure Material:	Plastic
Power Supply:	Manufacturer: Xing Yuan Electronics Co. Ltd.
	Model: XY-1204000UA
	Input: 100-240VAC, 50/60Hz, 1.5A
	Output: 12VDC, 4.0A
Ports:	1x DC power input
	1x BNC antenna

MODE OF OPERATION: Device was transmitting continuously with modulation on its single channel at its maximum output power.

SUPPORT EQUIPMENT: None

DEVIATIONS FROM TEST PROCEDURES: None

MODIFICATIONS TO THE PRODUCT: None

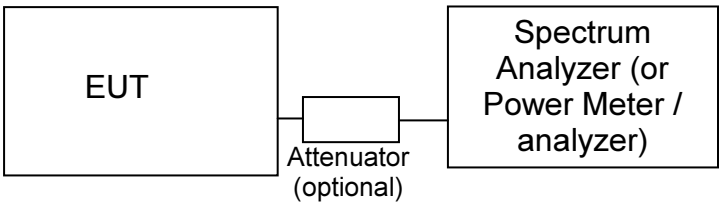
TEST SITE

GENERAL INFORMATION

Antenna port measurements were taken at NTS Plano facility located at 1701 E Plano Pkwy #150 Plano, TX 75074.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's RF input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the RF port of the EUT and the measurement equipment.



Test Configuration for Antenna Port Measurements

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

CONDUCTED SPURIOUS EMISSIONS

Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode measurements). Where the limits are expressed as an average power the spectrum analyzer is tunes to that frequency with a narrow span (wide enough to capture the emission and its sidebands) and the resolution and video bandwidths are adjusted as required by the reference measurement standards. For transmitter measurements the

appropriate detector (average, peak, normal ,sample, quasi-peak) is used when making measurements for licensed devices. For receiver conducted spurious measurements the detector is set to peak.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

FREQUENCY STABILITY

The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The temperature is varied across the specified frequency range in 10 degree increments with frequency measurements made at each temperature step. The EUT is allowed enough time to stabilize at each temperature variation.

The spectrum analyzer is configured to give a 5- or 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature. Where possible the device is set to transmit an unmodulated signal. Where this is not possible the frequency drift is determined by finding a stable point on the signal (e.g. the null at the centre of an OFDM signal) or by calculating a centre frequency based on the upper and lower XdB points (where X is typically 6dB or 10dB) on the signal’s skirts.

INSTRUMENTATION

For all conducted measurements a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis.

Measurement bandwidths for the test instruments are set in accordance with the requirements of the standards referenced in this document.

Software control is used to correct the measurements for transducer factors (e.g. antenna) and the insertion loss of cables, attenuators and other series elements to obtain the final measurement value. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are exported in a graphic and/or tabular format, as appropriate.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the EUT antenna port or receiving antenna and the test receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

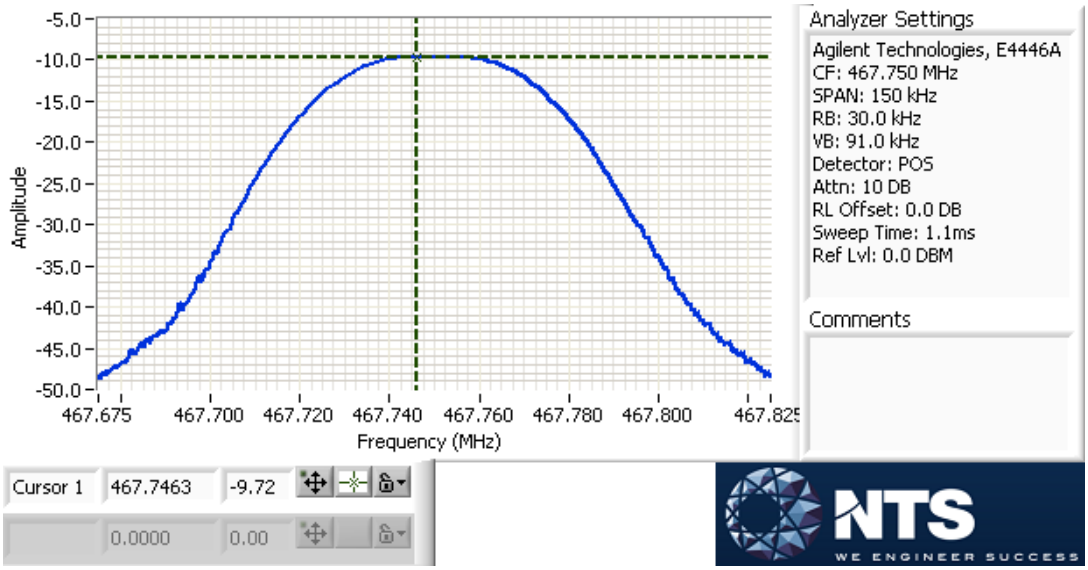
Appendix A Test Data

RF Power Output (CFR 47 §90.217, CFR 47 §2.1046)

Date: Apr 1, 2014

Spectrum Analyzer (dBm)	External Attenuator and Cable Loss (dB)	Corrected (dBm)	Corrected (mW)	Limit (mW)	Verdict
-9.72	30.4	20.68	117.0	120.0	Pass

Note: 60s max hold, auto-sweep, 8000 data points across span

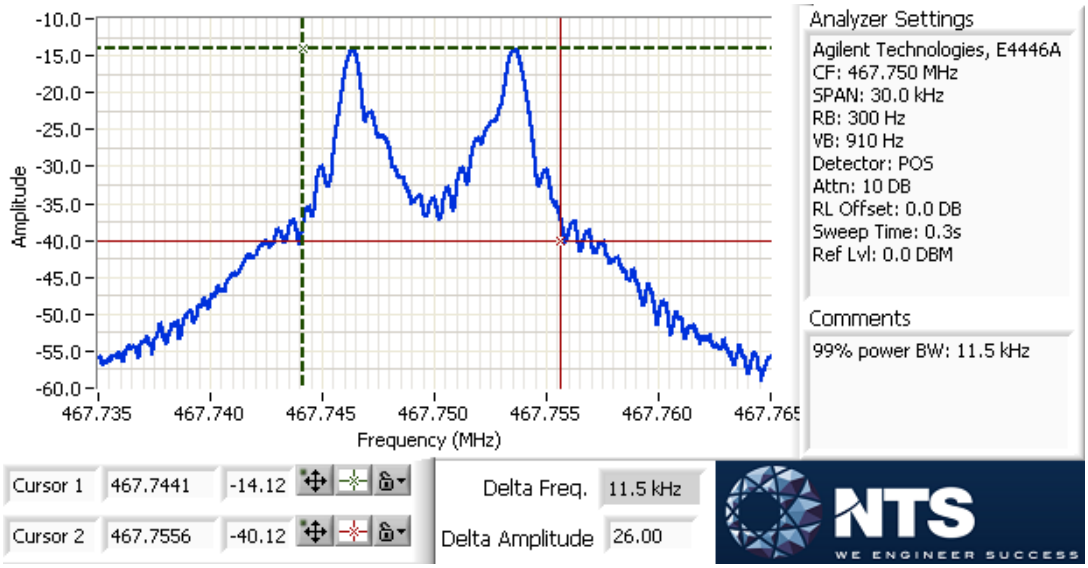


99% Occupied Bandwidth (CFR 47 §2.1049)

Date: Apr 1, 2014

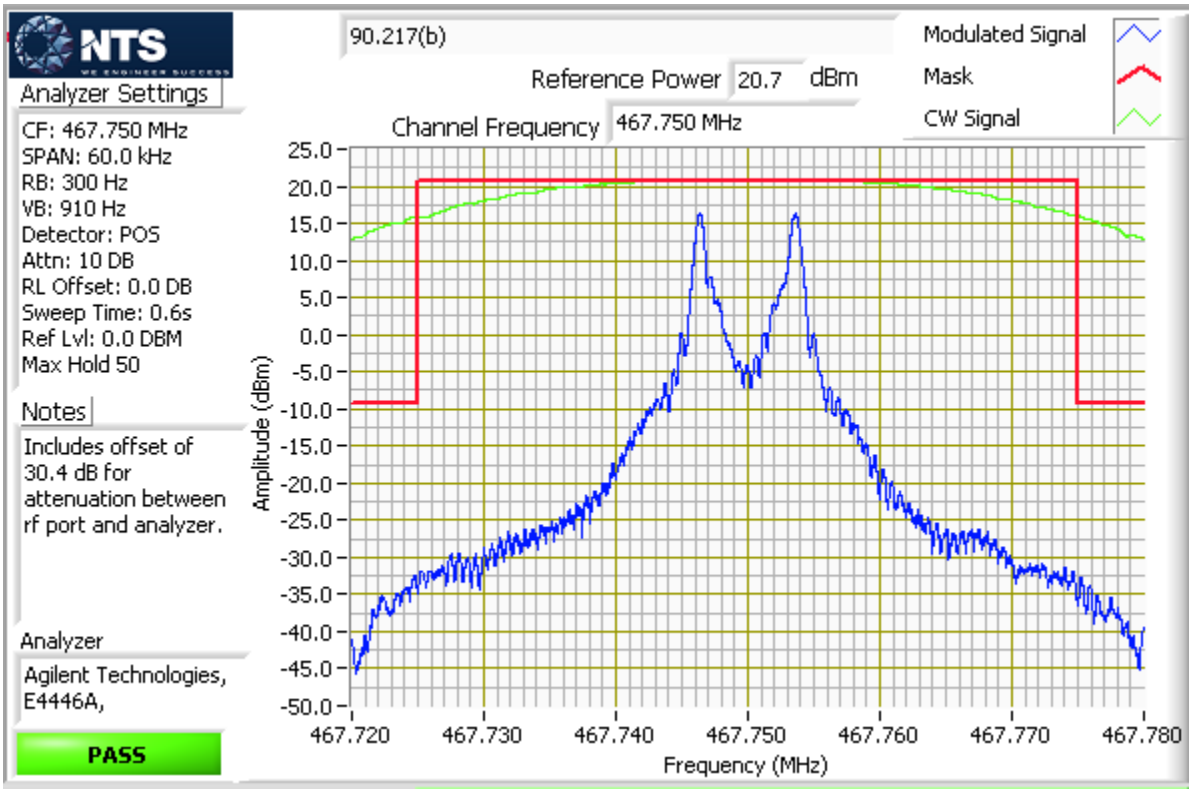
99% Occupied Bandwidth (kHz)	Limit (kHz)	Verdict
11.5	12.5	Pass

Note: 60s max hold, auto-sweep, 8000 data points across span



Emission Mask (CFR 47 §90.217(b))

Date: Apr 1, 2014
Auto-sweep, 8000 data points across span

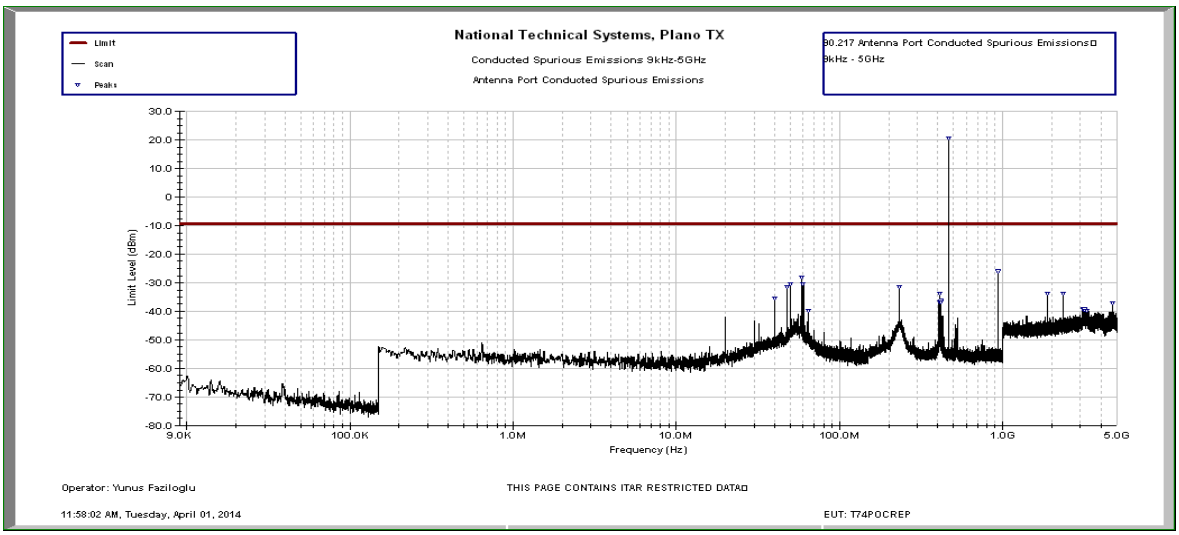


Spurious Emissions at the Antenna Terminal (CFR 47 §90.217(b), CFR 47 §2.1051)

Date: Apr 1, 2014
Frequency Range: 9kHz-5GHz
Instrumentation settings in accordance with CFR 47 §90.210(o).

Frequency Range	RBW	VBW	Number of data points	Divided into	Detector	Sweep Time	Max hold over
9kHz-150kHz	1kHz	3kHz	8000	2 segments	Peak	Auto	50 sweeps
150kHz-1GHz	100kHz	300kHz	8000	2 segments	Peak	Auto	50 sweeps
1GHz-5GHz	1MHz	3MHz	8000	2 segments	Peak	Auto	50 sweeps

Frequency	Reading (dBm)	Limit (dBm)	Margin (dB)	Verdict
39.992 MHz	-35.35	-9.38	-25.97	Pass
48.008 MHz	-31.19	-9.38	-21.81	Pass
49.999 MHz	-30.51	-9.38	-21.13	Pass
58.47 MHz	-27.99	-9.38	-18.61	Pass
60.006 MHz	-30.45	-9.38	-21.07	Pass
64.022 MHz	-39.58	-9.38	-30.2	Pass
233.83 MHz	-31.26	-9.38	-21.88	Pass
407.76 MHz	-36.63	-9.38	-27.25	Pass
409.25 MHz	-33.81	-9.38	-24.43	Pass
417.75 MHz	-36.28	-9.38	-26.9	Pass
419.77 MHz	-36.8	-9.38	-27.42	Pass
467.79 MHz	20.62	Reference	N/A	N/A
935.51 MHz	-25.98	-9.38	-16.6	Pass
1.8709 GHz	-33.68	-9.38	-24.3	Pass
2.3387 GHz	-33.52	-9.38	-24.14	Pass
3.0988 GHz	-39.38	-9.38	-30	Pass
3.1144 GHz	-39.45	-9.38	-30.07	Pass
3.149 GHz	-39.37	-9.38	-29.99	Pass
3.2741 GHz	-39.53	-9.38	-30.15	Pass
4.6775 GHz	-36.98	-9.38	-27.6	Pass



Radiated Spurious Emissions (CFR 47 §90.217(b), CFR 47 §2.1053)

Date: Aug 28, 2014
Frequency Range: 30MHz-5GHz
Instrumentation settings: In accordance with CFR 47 §90.210(o) for both pre-scan and final field strength measurements.
30MHz -1GHz RBW=100kHz, VBW=300kHz, Peak, max-hold
1GHz-5GHz RBW=1MHz, VBW=3MHz, Peak, max-hold

Limit: -30dBc from calculated EIRP
Calculated EIRP (dBm) = Peak Conducted Output Power (dBm) + Declared Antenna Gain (dBi)
Calculated EIRP = 20.68 + 2.0 = 22.68dBm
Limit = 22.68 – 30 = -7.32dBm EIRP

This limit can be expressed in terms of field strength via EIRP (W) = (E * D) ^ 2 / 30 equation, where:
E = Electric field strength in V/m
D = Measurement distance in meters
Therefore -7.32dBm EIRP limit can be expressed as 87.9dBuV/m electric field strength limit at 3m.

Any spurious emission with final peak field strength reading within 20dB of the limit (emissions that exceed 87.9 – 20 = 67.9dBuV/m at 3m) were substituted in accordance with TIA-603-C substitution method.

Peak pre-scans were performed from 30MHz-5GHz and plots included below. The limit line shows 67.9dBuV/m at 3m substitution threshold. Based on the pre-scans, the 2nd harmonic at 935.5MHz and the 4th harmonic at 1871MHz exceeded the 67.9dBuV/m at 3m. Therefore final maximized peak field strength measurements were performed at those frequencies and results included below. This was followed by substitution measurements to determine the EIRP at those frequencies.

Final Peak Field Strength Measurements

Polarity H/V	Freq. MHz	Raw dBuV	PreAmp dB	Antenna dB/m	Cable dB	Corrected dBuV/m	Limit dBuV/m	Margin dB
H	935.5	87	-35.4	24.6	1.7	77.9	87.9	-10.0
V	935.5	80.5	-35.4	24.6	1.7	71.4	87.9	-16.5
H	1871	82.2	-39.0	27.2	2.4	72.8	87.9	-15.1
V	1871	73.6	-39.0	27.2	2.4	64.2	87.9	-23.7

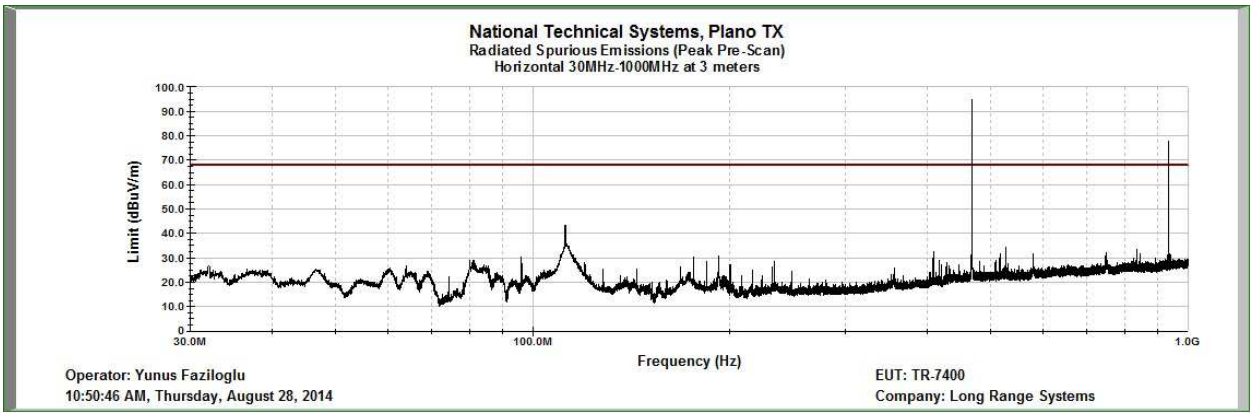
Measurement distance is 3m
Corrected = Raw + PreAmp + Antenna + Cable
Margin = Corrected - Limit
Negative margin indicates a passing result

Substitution Measurements

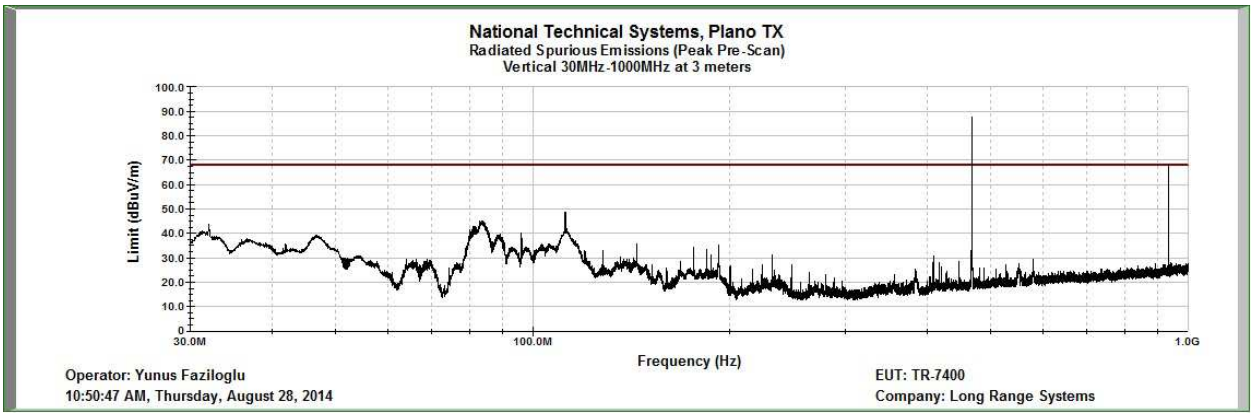
Polarity H/V	Freq. MHz	Sig. Gen. Output dBm	Cable Loss dB	Substitution Antenna Gain dBi	EIRP dBm	Limit dBm	Margin dB
H	935.5	-32.1	0.5	8.0	-24.6	-7.32	-17.28
V	935.5	-39.3	0.5	8.0	-31.8	-7.32	-24.48
H	1871	-36.5	0.6	10.5	-26.6	-7.32	-19.28
V	1871	-45.0	0.6	10.5	-35.1	-7.32	-27.78

EIRP = Sig. Gen. Output – Cable Loss + Substitution Antenna Gain
Margin = EIRP – Limit
Negative margin indicates a passing result

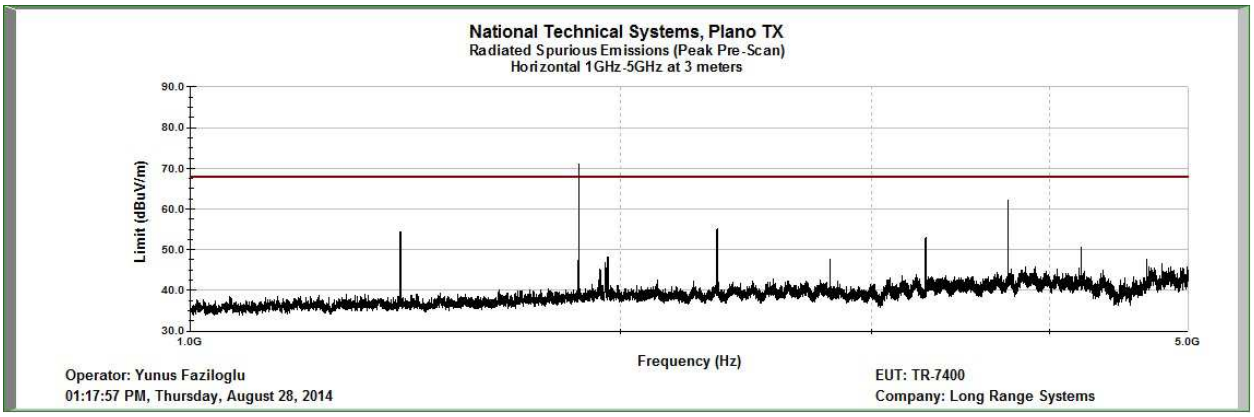
Peak Pre-Scan 30MHz-1GHz Horizontal



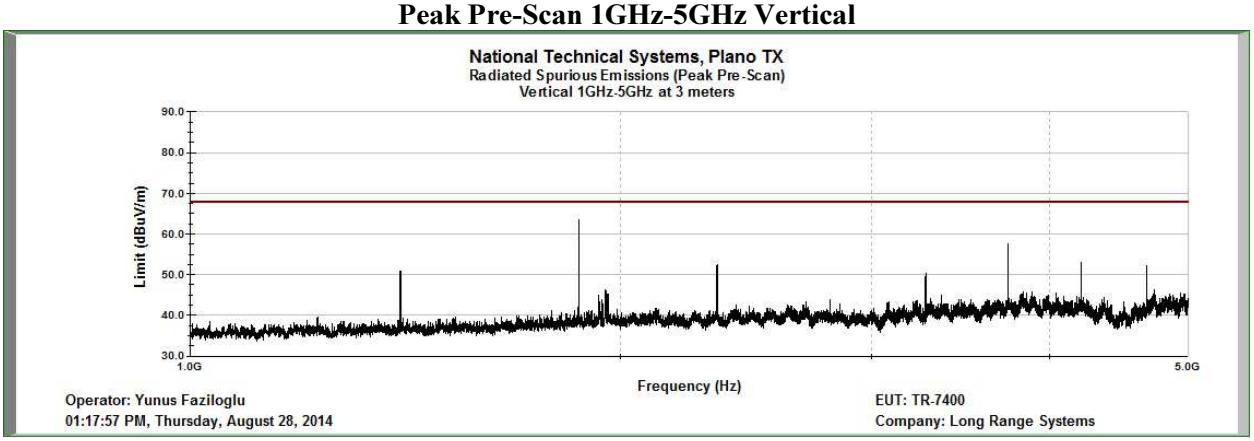
Peak Pre-Scan 30MHz-1GHz Vertical



Peak Pre-Scan 1GHz-5GHz Horizontal



Peak Pre-Scan 1GHz-5GHz Vertical

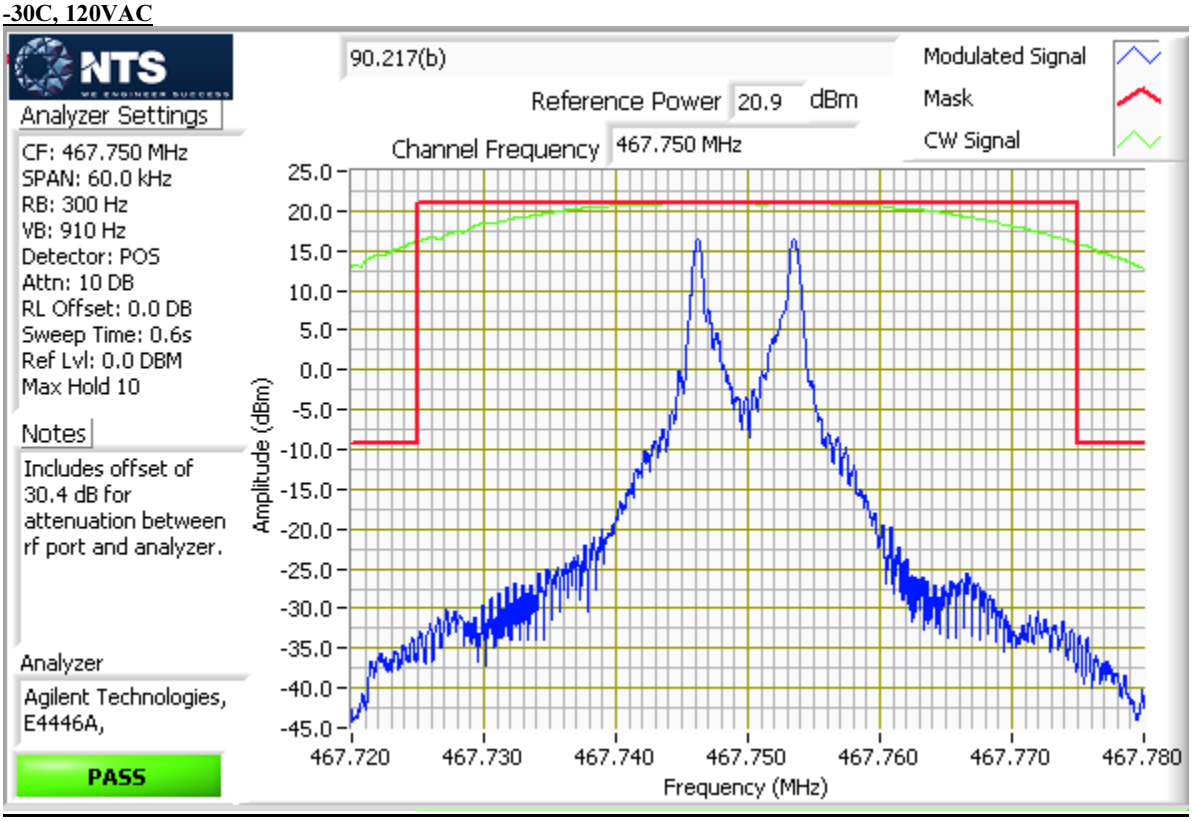


Frequency Stability (CFR 47 §90.217(b), CFR 47 §2.1055)

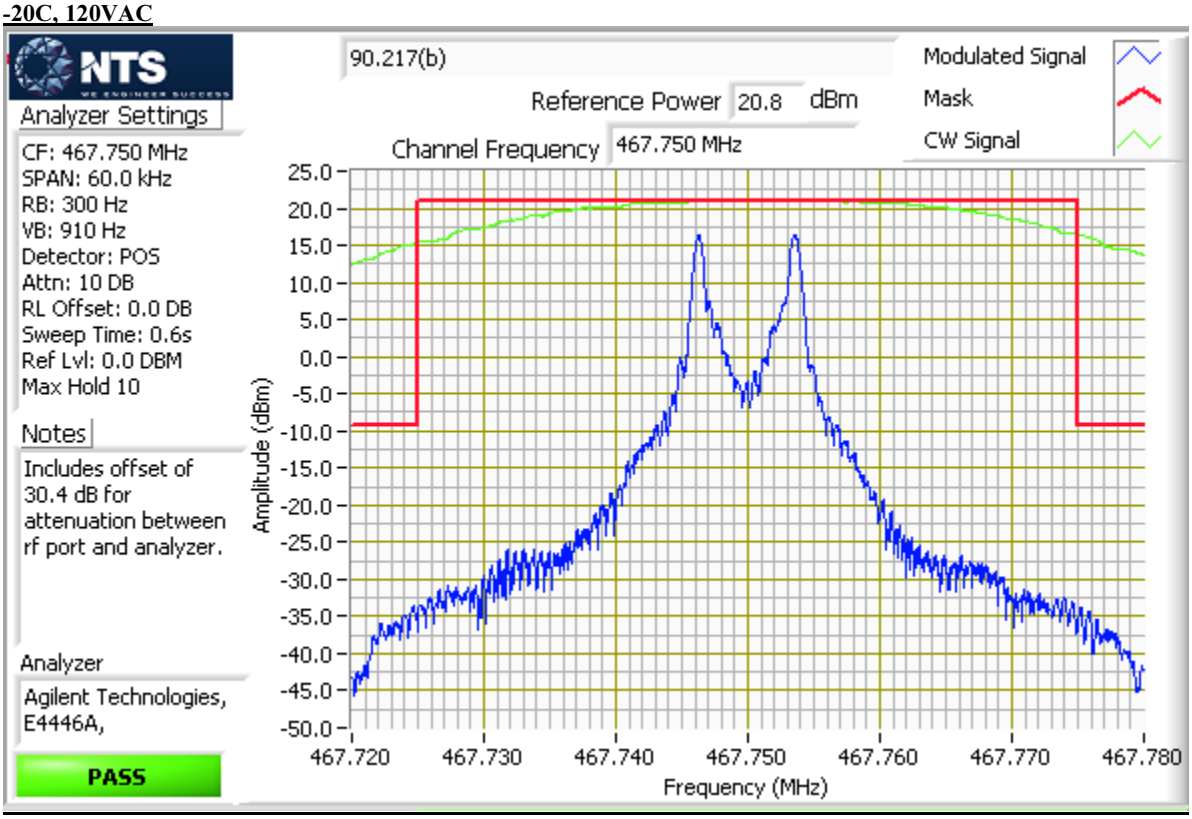
Date: Apr 28, 2014
90.217(b) requires the emission to stay within the defined mask over extreme temperatures and voltages. Emission mask measurements were repeated under the following voltages and temperatures and plots presented below.

Temperature (C)	AC Voltage (V)	Verdict
-30	120	Pass
-20	120	Pass
-10	120	Pass
0	120	Pass
10	120	Pass
20	102 (85% of 120)	Pass
20	120	Pass
20	138 (115% of 120)	Pass
30	120	Pass
40	120	Pass
50	120	Pass

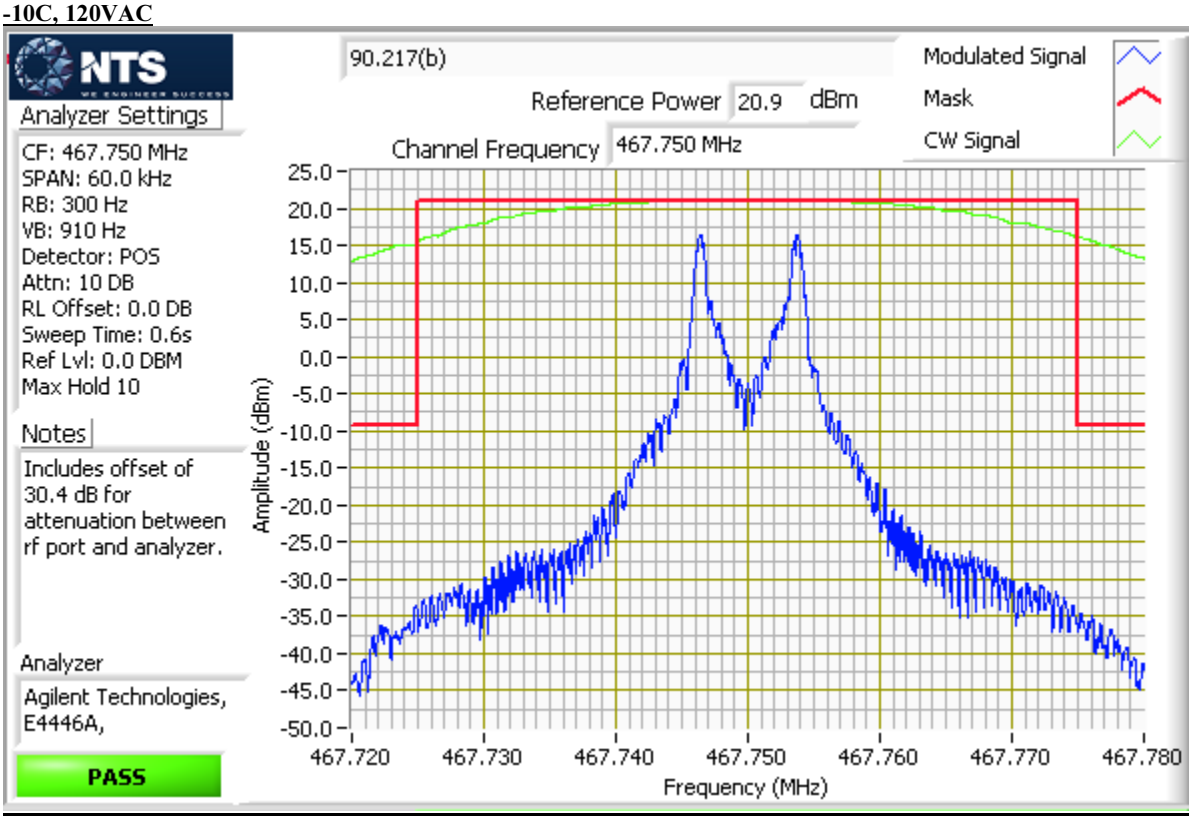
-30C, 120VAC



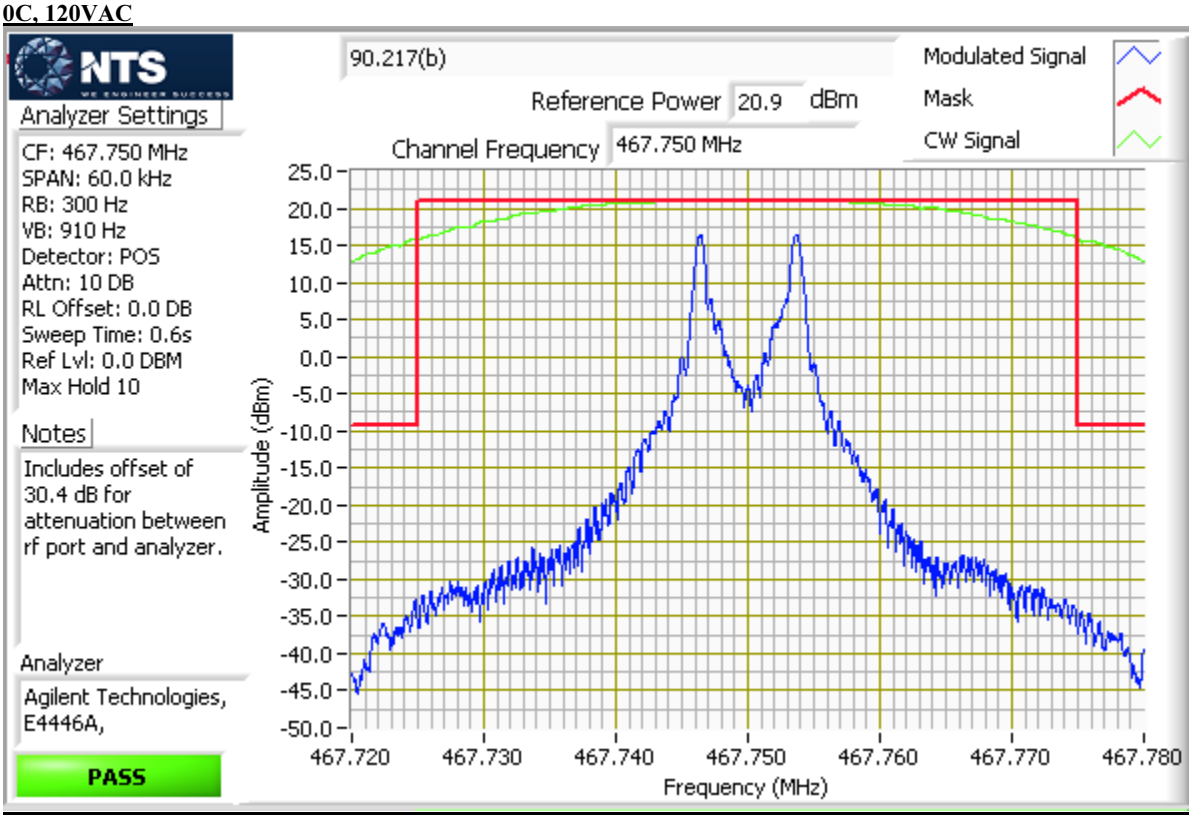
-20C, 120VAC



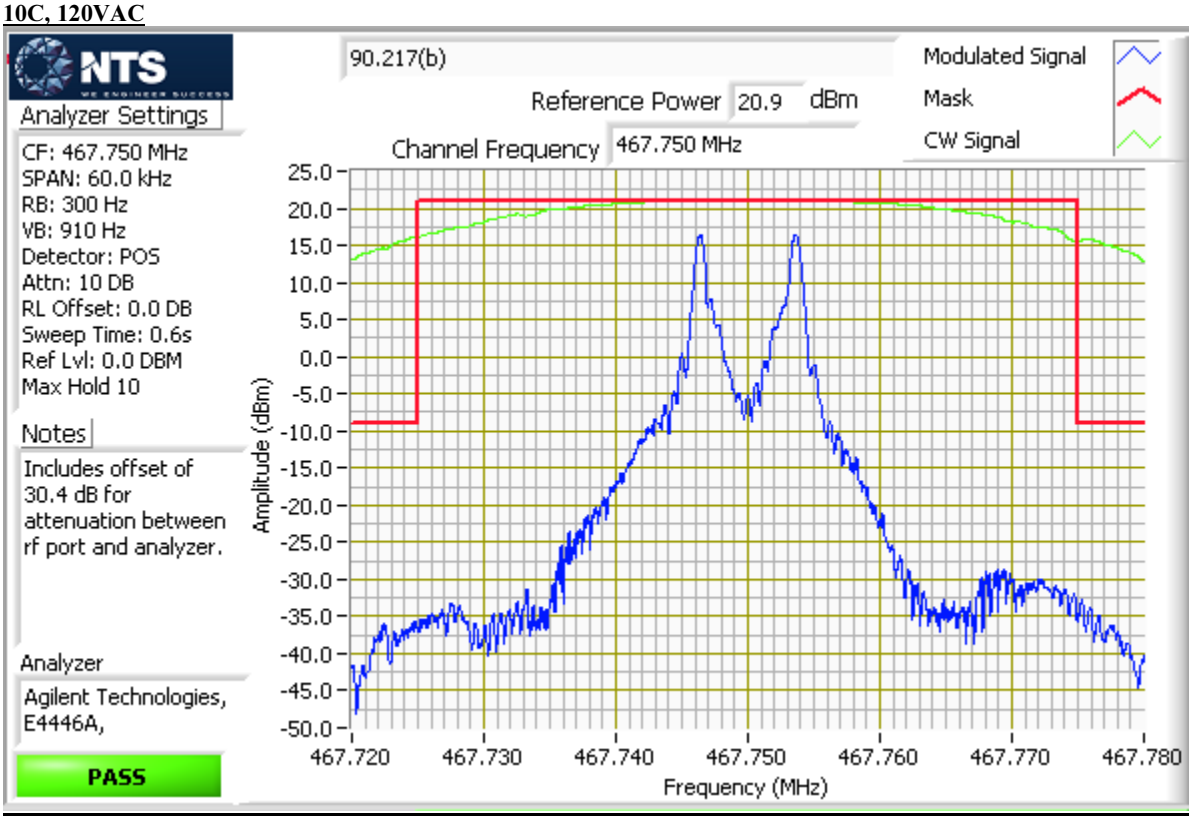
-10C, 120VAC



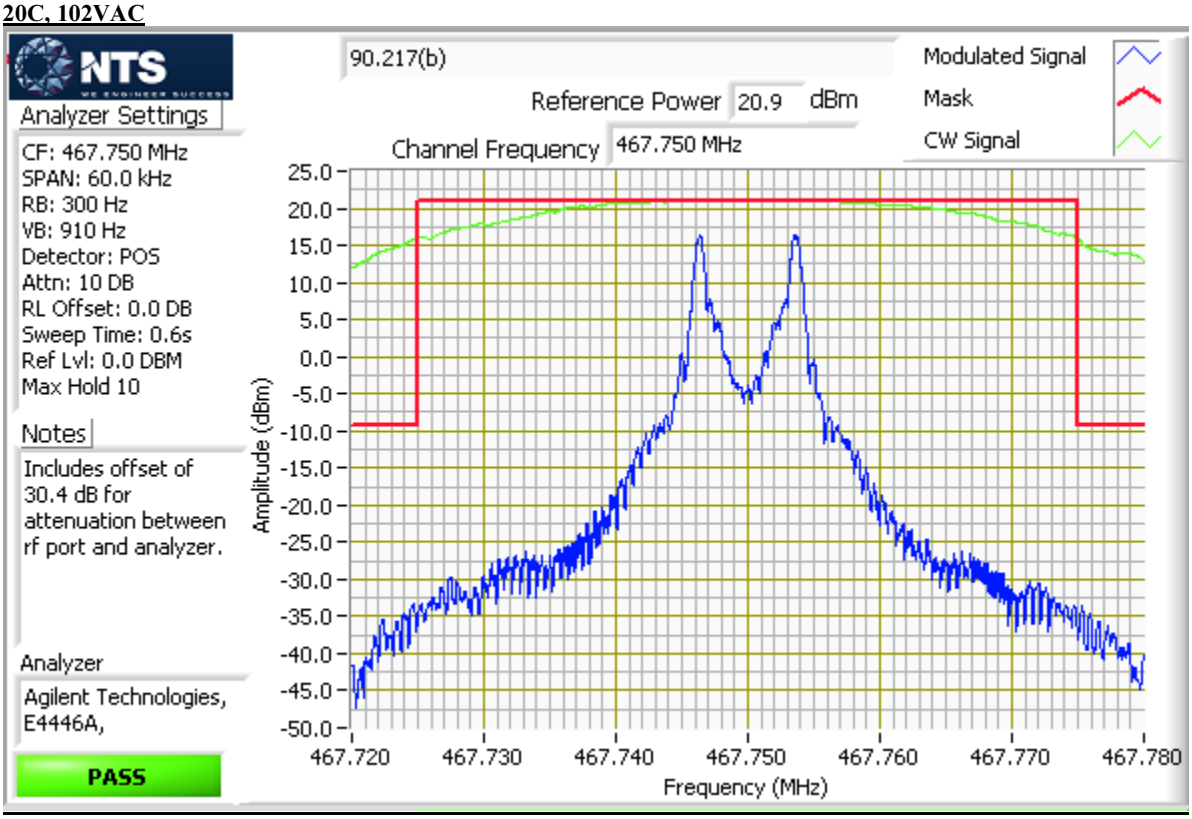
0C, 120VAC



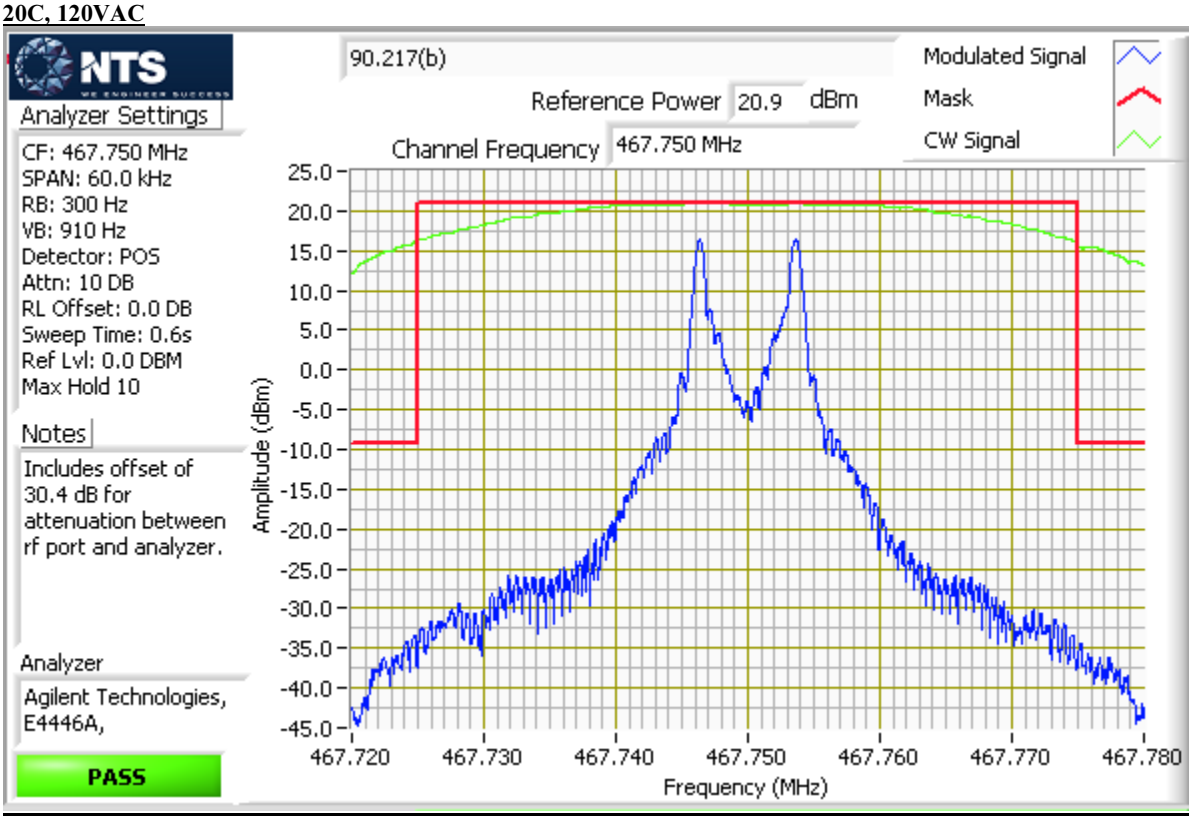
10C, 120VAC



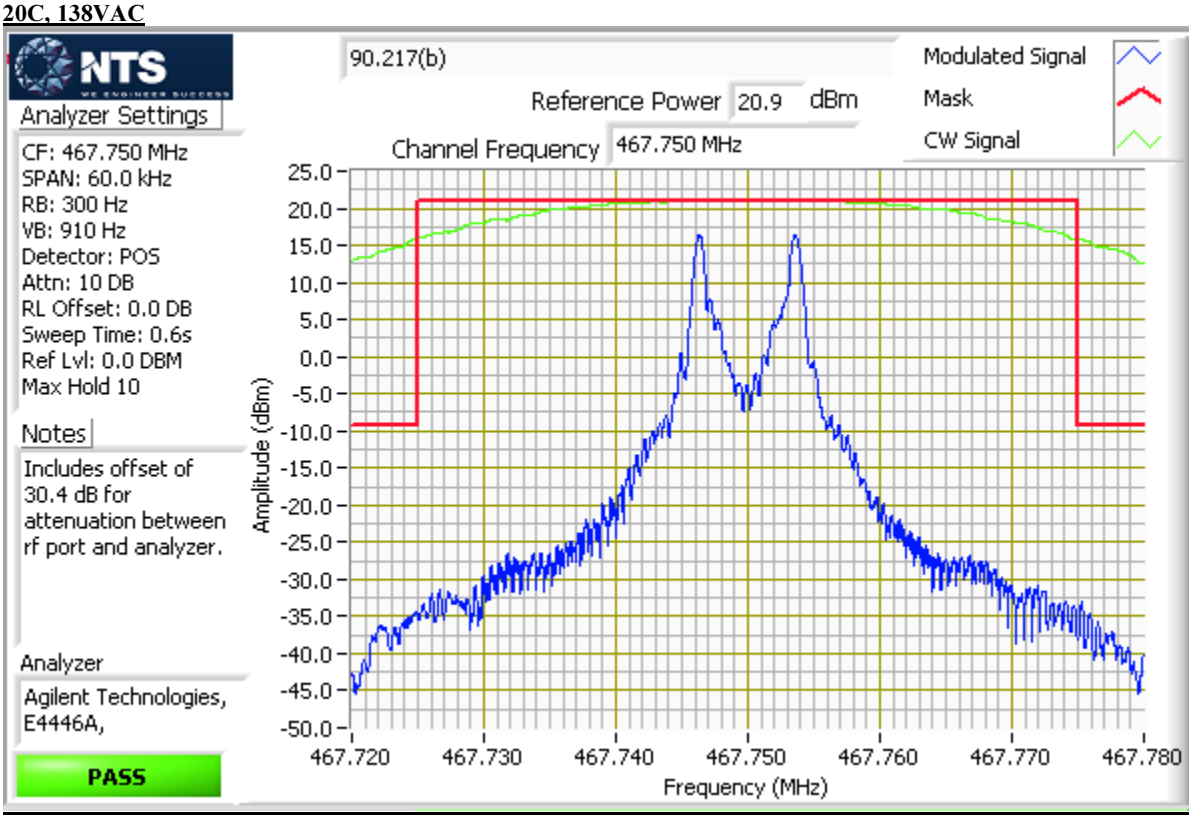
20C, 102VAC



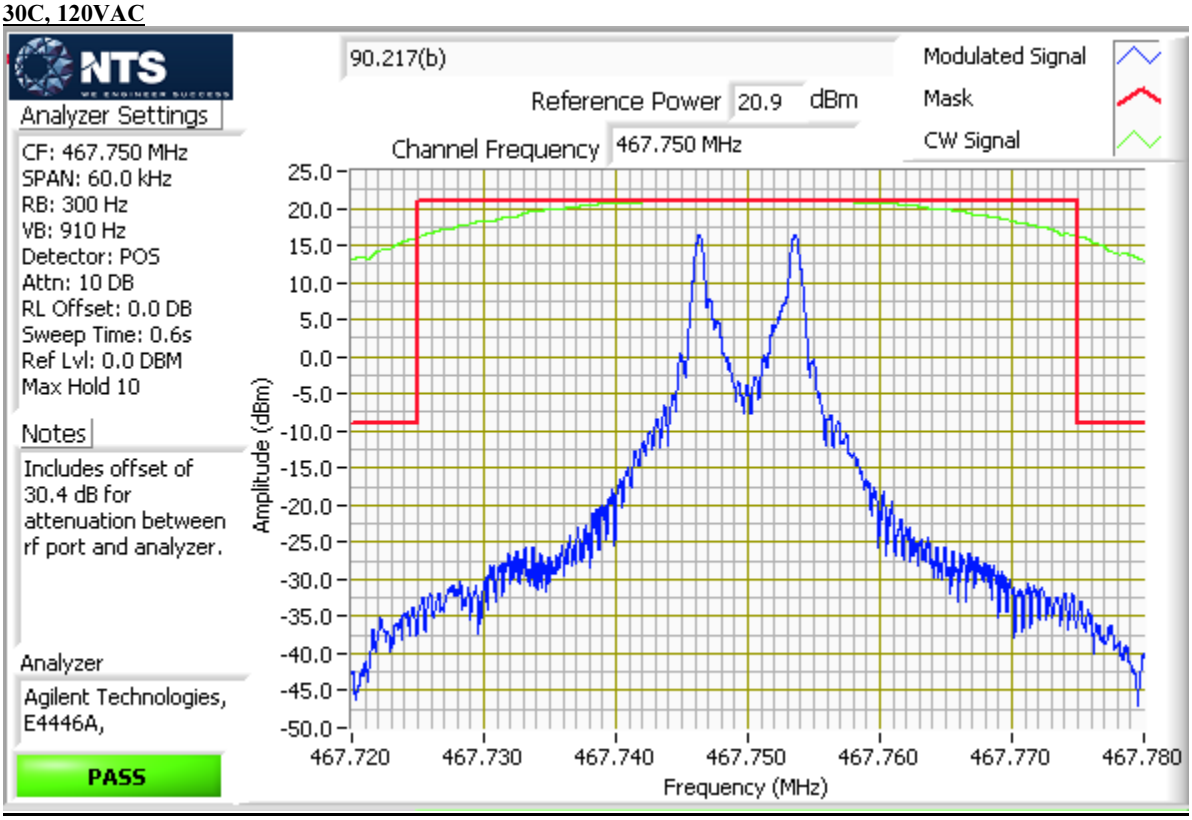
20C, 120VAC



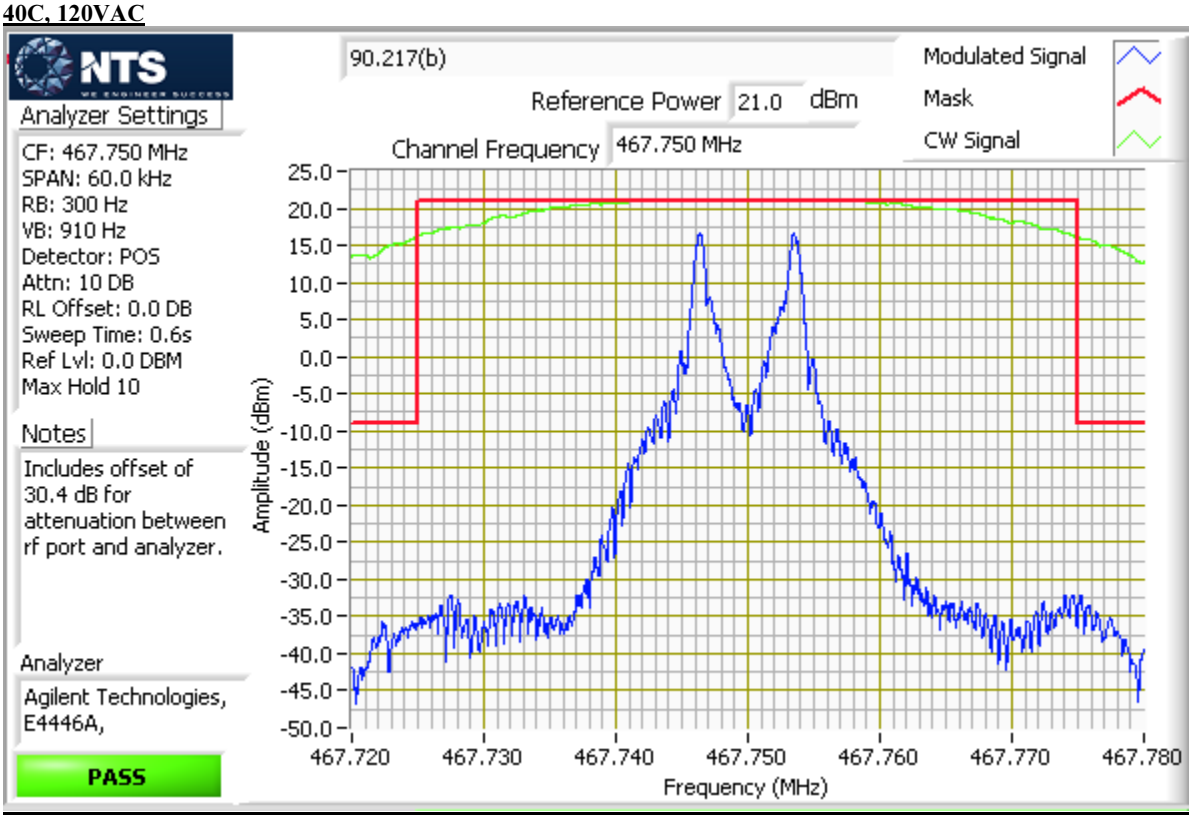
20C, 138VAC



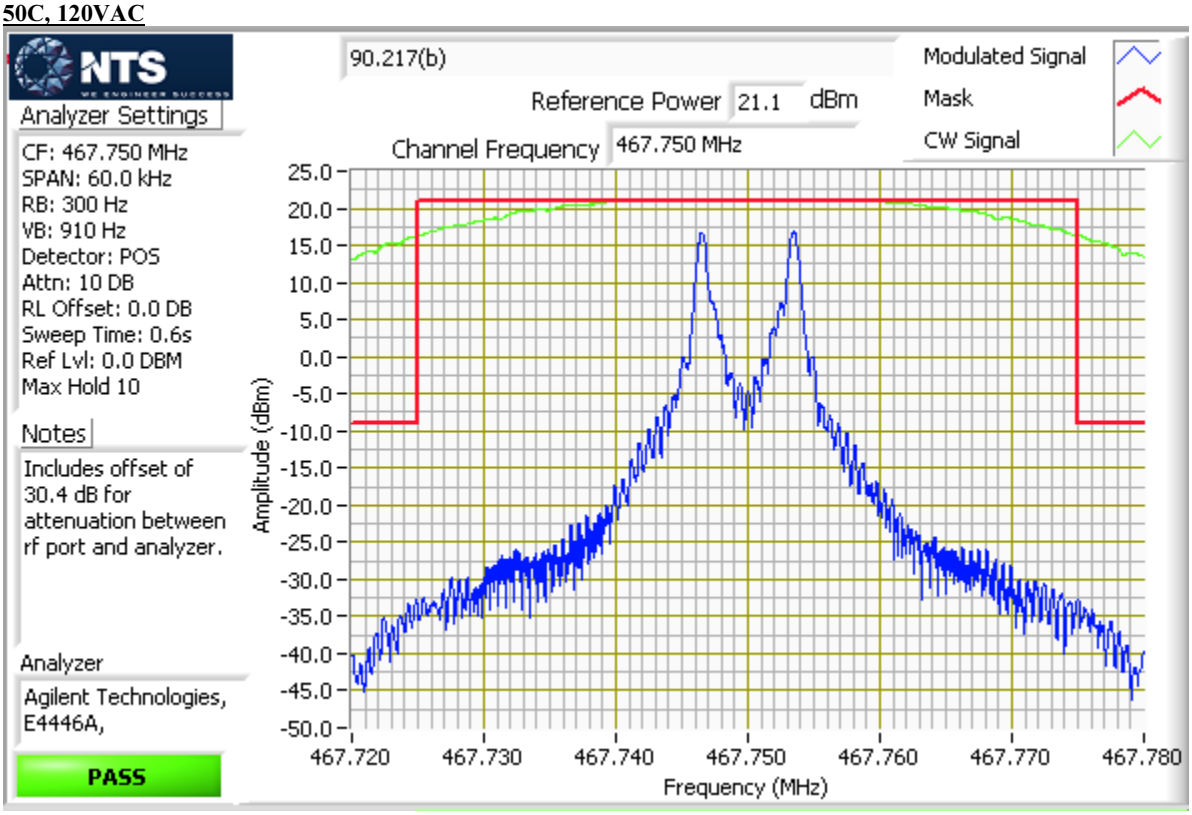
30C, 120VAC



40C, 120VAC



50C, 120VAC



APPENDIX B - TEST EQUIPMENT

NTS ID#	Description	Duration	Calibration Due
E1529P	Spectrum Analyzer Agilent E4446A	12 months	2/14/2015
ENV1195P	Chamber Thermotron	N/A	No Calibration
ENV1384P	Data Acq/Switch Unit Agilent 34970A	12 months	2/24/2015
E1086P	Power Supply Elgar SW1750AE	N/A	No Calibration
E1390P	RMS Voltmeter Fluke 87V	12 months	1/31/2015
E1289P	Biconilog Antenna ETS-Lindgren 3142C	12 months	12/09/2014
E1524P	Biconilog Antenna ETS-Lindgren 3142D	12 months	3/19/2015
E1019P	Horn Antenna Emco 3115	12 months	10/16/2014
E1149P	Horn Antenna Emco 3115	12 months	11/25/2014
E1364P	Pre-amp Miteq AM-1431-N-1197SC	12 months	2/1/2015
E1260P	Pre-amp Miteq AFS44-01001800-45-10P-44	12 months	5/27/2015
E1440P	Signal Generator R&S SMY 01	12 months	11/6/2014
E1013P	Signal Generator HP 83732B	12 months	5/19/2015

End of Report

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