Washington Laboratories, Ltd.

FCC Certification Test Report
For the
Mars Electronics (MEI)
easitrax™

FCC ID: QP8EASITRAX

WLL JOB# **9554**
April 19, 2007

Prepared for:

Mars Electronics (MEI)
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West Chester, PA 19380

Prepared By:

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Abstract

This report has been prepared on behalf of Mars Electronics (MEI) to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.225 of the FCC Rules and Regulations. This Certification Test Report documents the test configuration and test results for a Mars Electronics (MEI) easitrax™.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Mars Electronics (MEI) easitrax™ complies with the limits for an Intentional Radiator device under FCC Part 15.225.

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1 Introduction

1.1 Compliance Statement

The Mars Electronics (MEI) easitrax™ complies with the limits for an Intentional Radiator device under FCC Part 15.225.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2003 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Mars Electronics (MEI) 1301 Wilson Drive West Chester, PA 19380
Purchase Order Number:	4500043252
Quotation Number:	63378

1.4 Test Dates

Testing was performed on the following date(s):	January 23 and February 15, 2007

1.5 Test and Support Personnel

Washington Laboratories, LTD	John Repella
Client Representative	Bob Carney

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**eres
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The Mars Electronics (MEI) easitrax™ is comprised of the Cashflow SC66 Series Bill Validator. It is a digital signal processor based currency recognition acceptor used primarily in the Gaming or Retail industry to validate and store legitimate currency and issue credit to its host machine. The validator consist of a chassis, removable bill cassette (with RF tag installed), acceptor module (with control PCB, LED PCB, sensor PCBs, and transport motors) , an interface PCB, antenna PCB, and interface cable. The antenna PCB couples to the I/F PCB and is downward looking in order to communicate with the RF tag. Power is supplied to the acceptor module via the interface cable which provides 24Vdc, normally supplied from the 120Vac host machine.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mars Electronics (MEI)
FCC ID:	QP8EASITRAX
Model:	easitrax™
FCC Rule Parts:	§15.225
Frequency Range:	13.56MHz
Maximum Output Power:	109.2 µV/m at 10 meters
Modulation:	None
Occupied Bandwidth:	2.23 kHz
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Internal PCB
Frequency Tolerance:	>±0.01% (±100 ppm)
Interface Cables:	Power
Power Source & Voltage:	24Vdc from 120Vac

2.2 Test Configuration

The easitrax™ was configured for testing as indicated in the figure below.

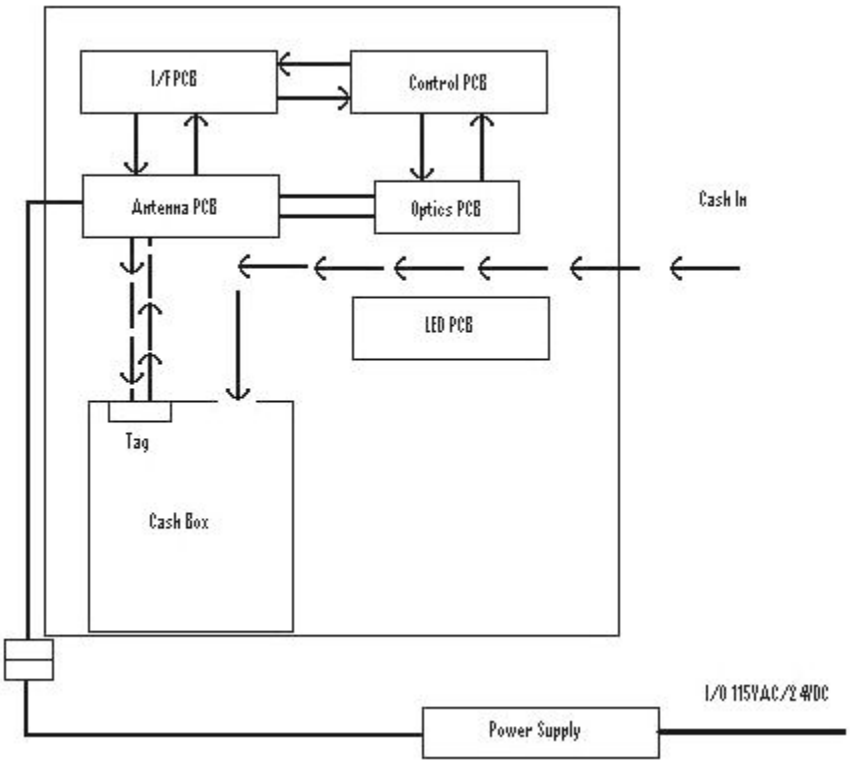

Figure 1: Test Configuration

2.3 Testing Algorithm

The Reader operates at 13.56MHz.

The Reader talks to the RF Tag on the lower side at 156KHz modulation. This is Miller Encoded.

The RF tag responds to the Reader using the Manchester Protocol. The Tag does not emit; rather it shorts the Reader's field in a binary response.

Functionality:

The Reader checks for the presence of an RF tag in its field twice a second. This check takes about 20ms.

After a Cash Box is installed the system reads and writes the 16 Char Asset number. This process takes about 4 seconds. There are several 20ms reads and writes during this time.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Asset #	Manufacturer/Model	Description	Cal. Due
0069	HP, 85650A	ADAPTER, QP	6/26/2007
0117	RACAL DANA	FREQUENCY COUNTER	5/4/2007
0473	FLUKE, 111	MULTIMETER, W/CURRENT CLAMP	6/27/2007
0168	BIRD, 8401	RF DUMMY LOAD	CNR
0125	SOLAR 8028-50-TS-BNC	LISN	2/01/2008
0126	SOLAR 8028-50-TS-BNC	LISN	2/01/2008
0070	HP, 85685A	PRESELECTOR, RF W/OPT 8ZE	7/3/2007
0071	HP, 85685A	PRESELECTOR, RF	6/26/2007
0031	EMCO 6502	ACTIVE LOOP	2/12/2008
0034	EMCO, BIA-30	ANTENNA, BICONICAL	2/28/2008
0029	EMCO, 3146A	ANTENNA, LOG PERIODIC	7/19/2008

4 Test Results

4.1 Occupied Bandwidth

Occupied bandwidth measurement was performed by coupling the output of the EUT to the input of a spectrum analyzer.

The occupied bandwidth was measured as shown:

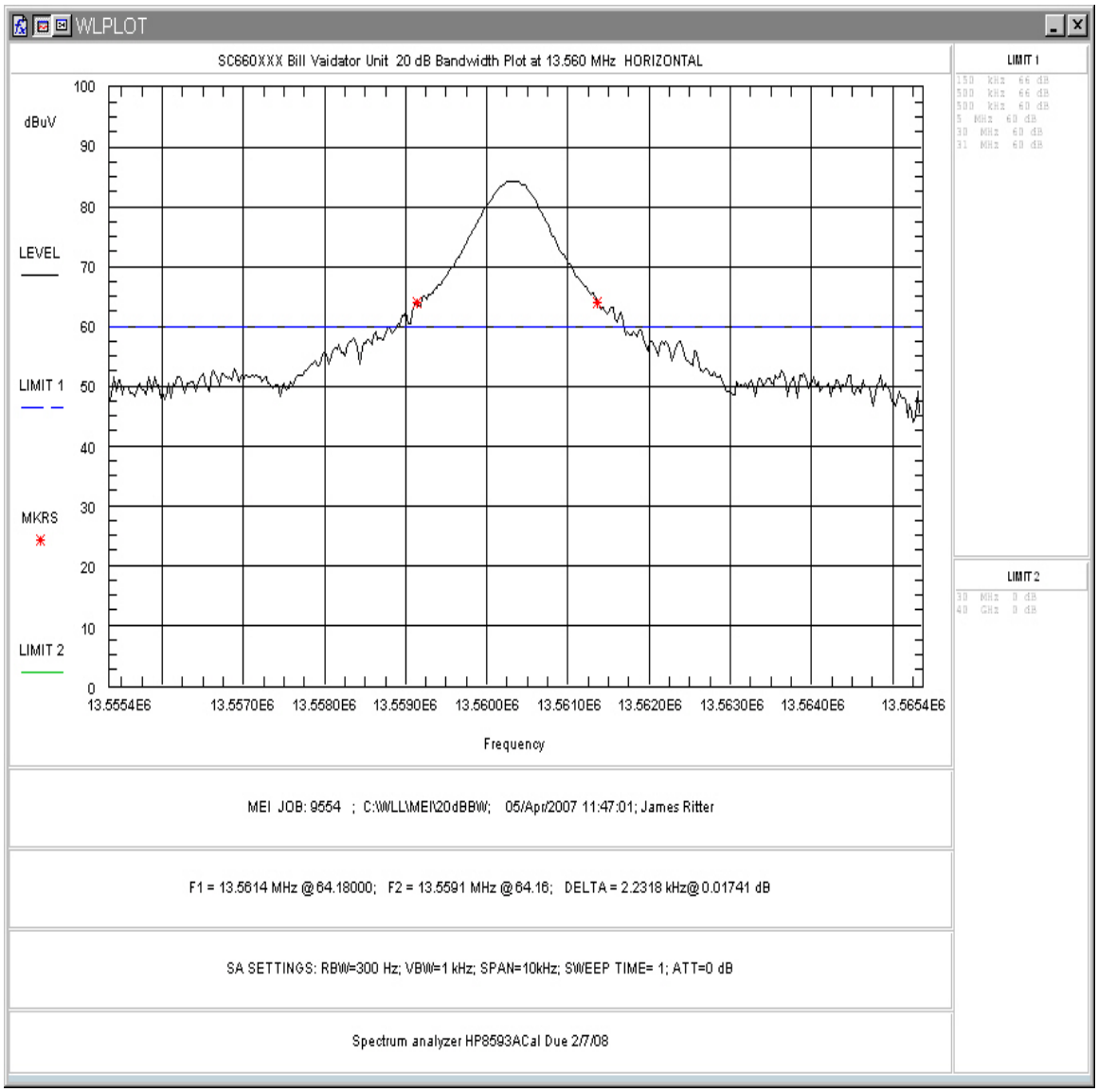

Figure 2. Occupied Bandwidth

Table 3 provides a summary of the Occupied Bandwidth Results.

Table 3: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
13.560MHz	2.23 kHz	N/A	Pass

4.2 Radiated Spurious Emissions: §15.225, §15.209

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225 and 15.209. The limits for the radiated emissions are as shown in the following table.

Table 4: Radiated Spurious Emissions Limits

Frequency (MHz)	Limit (µV/m)	Rule Part Reference
13.553 - 13.567	15,848 (@ 30m)	§15.225(a)
13.410 – 13.553	334 (@ 30m)	§15.225(b)
13.567 – 13.710	334 (@ 30m)	§15.225(b)
13.110 – 13.410	106 (@ 30m)	§15.225(c)
13.710 – 14.010	106 (@ 30m)	§15.225(c)
1.705 – 13.110 14.010 – 30.0	30 (@ 30m)	§15.225(d), §15.209
30.00 – 88.00	100 (@ 3m)	§15.225(d), §15.209
88.00 – 216.00	150 (@ 3m)	§15.225(d), §15.209
216.00 – 960.00	200 (@ 3m)	§15.225(d), §15.209
Above 960	500 (@ 3m)	§15.225(d), §15.209

4.2.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on an Open Area Test Site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured

Testing at frequencies below 30 MHz was performed at ten meters with a loop antenna. The 30 meter limits were used, and because the unit has power so low, the limit was not changes. The unit complies with the 30 meter limit at 10 meters. Three orientations of the loop antenna were tested.

Emissions were scanned up to 1 GHz. Only the fundamental frequency was detected. No other emissions were detected that were related to the RFID Transmitter. All other emissions detected were related to digital emissions of the IUS electronics. Since the EUT is used in a commercial application, these digital emissions were compared to the Class A limit of §15.109(b). For emissions up to 30 MHz peak levels were recorded. Emissions from 30 MHz to 1000 MHz were measured using a Quasi-peak detector. Worst-case emissions are reported in the data table.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level): VdBµV

Antenna Factor (Ant Corr): AFdB/m

Cable Loss Correction (Cable Corr): CCdB

Amplifier Gain: GdB (if applicable)

Electric Field (Corr Level): EdBµV/m = VdBµV + AFdB/m + CCdB - GdB

To convert to linear units: EµV/m = antilog (EdBµV/m/20)

4.2.2 Test Results

The EUT complies with the radiated emission requirements of §15.225.

Table 5: Radiated Emission Test Data, Fundamental Frequency

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Height (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
13.559	X	270.0	1.0	26.00	10.9	1.1	37.9	78.8	15848.0	-46.1
13.559	Y	270.0	1.0	22.44	10.9	1.1	34.4	52.3	15848.0	-49.6
13.559	Z	270.0	1.0	19.76	10.9	1.1	31.7	38.4	15848.0	-52.3

Notes:

0 degree azimuth; antenna height = one (1) meter

Table 6: Radiated Emission Test Data

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
81.350	V	138.0	1.0	13.70	7.8	2.5	24.0	15.8	90.0	-15.1
135.590	V	180.0	1.0	19.80	13.3	3.2	36.3	65.5	150.0	-7.2
162.750	V	45.0	1.0	14.70	12.1	3.5	30.3	32.7	150.0	-13.2
176.270	V	0.0	1.0	24.20	11.3	3.7	39.2	91.2	150.0	-4.3
189.840	V	270.0	1.0	22.00	11.0	3.8	36.8	69.3	150.0	-6.7
203.403	V	314.0	1.0	15.70	12.0	3.9	31.7	38.3	150.0	-11.8
216.653	V	270.0	1.0	10.80	11.4	4.1	26.3	20.7	210.0	-20.1
257.674	V	270.0	1.0	10.50	12.1	4.6	27.2	22.8	210.0	-19.3
284.797	V	270.0	1.0	9.50	13.3	4.9	27.7	24.2	210.0	-18.8
311.869	V	265.0	1.0	4.70	13.6	5.1	23.4	14.8	210.0	-23.0
81.350	H			0.00	7.8	2.5	10.3	3.3	90.0	-28.8
135.590	H	270.0	3.5	7.80	13.3	3.2	24.3	16.5	150.0	-19.2
162.750	H	225.0	3.5	10.60	12.1	3.5	26.2	20.4	150.0	-17.3
176.270	H	45.0	3.5	20.20	11.3	3.7	35.2	57.6	150.0	-8.3
189.840	H	316.0	3.5	15.50	11.2	3.8	30.5	33.5	150.0	-13.0
203.403	H	106.0	3.5	15.70	12.0	3.9	31.7	38.3	150.0	-11.8
216.998	H	115.0	3.5	13.40	11.4	4.1	28.9	27.8	210.0	-17.6
230.561	H	90.0	3.5	14.80	11.1	4.3	30.2	32.4	210.0	-16.2
257.630	H	132.0	3.5	11.00	12.1	4.6	27.7	24.2	210.0	-18.8
284.804	H	127.0	3.5	12.50	13.3	4.9	30.7	34.2	210.0	-15.8
311.869	H	162.0	3.5	8.10	13.6	5.1	26.8	21.9	210.0	-19.6

Notes:

Clocks: 40 MHz, 11.06MHz, 72-84kHz, 32.786kHz, 120MHZ, 20MHz

4.3 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances. Per §15.225(e) the frequency tolerance shall be maintained within ±0.01% of the reference frequency.

4.3.1 Test Procedure

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The frequency stabilities can be maintained to a lesser temperature range provided that the transmitter is automatically inhibited from operating outside the lesser temperature range.

The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20ºC and rated supply voltage) in excess of +/-1356 Hz.

The EUT is powered by 6Vdc voltage supplied via an external DC power supply.

4.3.2 Test Results

The EUT complies with the temperature stability requirements of FCC §15.225(e). Test results are given in Table 7.

Table 7: Frequency Stability Test Data

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)
Ambient	13.560350	0.0	0
-20	13.560480	130.0	0.000959
-10	13.560500	150.0	0.001106
0	13.560450	100.0	0.000737
10	13.560400	50.0	0.000369
20	13.560430	80.0	0.000590
30	13.560350	0.0	0.000000
40	13.560330	-20.0	0.000147
50	13.560400	50.0	0.000369

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Voltage (Volts)
At rated	13.560330	0	0.0	120VAC
At 85%	13.560330	0	0.000000	102VAC
At 115%	13.560350	-20	0.000147	138VAC

4.4 Conducted Emissions (AC Power Line)

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 x 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

The unit was tested with the antenna terminated.

AC Power Line conducted emissions test data are included in Table 8.

Table 8: AC Power Conducted Emissions Test Data

LINE 1 - NEUTRAL

Frequency (MHz)	Level QP (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Limit QP (dBµV)	Level Corr (dBµV)	Margin QP (dB)	Level AVG (dBµV)	Cable Loss (dB)	Level Corr (dBµV)	Limit AVG (dBµV)	Margin AVG (dB)
0.157	43.4	10.1	0.7	65.62	54.3	-11.3	5.4	10.1	16.3	55.6	-39.4
0.161	43.2	10.1	0.7	65.44	54.0	-11.4	8.1	10.1	19.0	55.4	-36.5
0.266	37.5	10.2	0.4	61.24	48.1	-13.1	3.0	10.2	13.6	51.2	-37.6
13.560	11.3	11.9	2.0	60.00	25.2	-34.8	11.3	11.9	25.2	50.0	-24.8
14.196	3.1	12.0	2.1	60.00	17.2	-42.8	0.4	12.0	14.5	50.0	-35.5
27.121	24.4	12.7	4.8	60.00	41.9	-18.1	19.5	12.7	36.9	50.0	-13.1

LINE 2 - PHASE

Frequency (MHz)	Level QP (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Limit QP (dBµV)	Level Corr (dBµV)	Margin QP (dB)	Level AVG (dBµV)	Cable Loss (dB)	Level Corr (dBµV)	Limit AVG (dBµV)	Margin AVG (dB)
0.157	43.1	10.1	0.4	65.62	53.6	-12.0	6.3	10.1	16.8	55.6	-38.8
0.266	37.0	10.2	0.2	61.24	47.4	-13.8	2.9	10.2	13.3	51.2	-37.9
13.560	11.1	11.9	2.7	60.00	25.7	-34.3	11.1	11.9	25.7	50.0	-24.3
14.196	16.9	12.0	2.8	60.00	31.7	-28.3	0.5	12.0	15.3	50.0	-34.7
27.121	24.8	12.7	5.8	60.00	43.2	-16.8	19.8	12.7	38.2	50.0	-11.8