





Curtis-Straus LLC, a wholly owned subsidiary of BV CPS

# Test Report

Report No	EM2102-15
Client	Balluff, Inc. Jim Ramler
Address	8125 Holton Drive Florence, KY 41042
Phone	(859) 727 - 2200
Items tested	BIS L-40X SERIES 2
Standards	47 CFR FCC Part 15.207, 47 CFR FCC Part 15.209, RSS-Gen Issue 4
Test Dates	July 11, August 2 and September 18, 2013
Results	As detailed within this report
Prepared by	 Tuyen Truong A. – Test Engineer
Authorized by	 Arik Zwirner – EMC Senior Engineer
Issue Date	<u>Dec. 9, 2015</u>
Conditions of Issue	This Test Report is issued subject to the conditions stated in the 'Conditions of Testing' section on page 21 of this report.

Curtis-Straus LLC is accredited by the American Association for Laboratory Accreditation for the specific scope of accreditation under Certificate Number 1627-01. This report may contain data which is not covered by the A2LA accreditation.



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REV 14-AUG-13 (SC)



**Regulatory Information**

FRN number	0006334478
FCC ID	HLH-BISL40002
IC	12121A-BISL40002

Issue No.	Reason for change	Date Issued
1	Original Release	December 9, 2015

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## Summary

On July 11, August 2 and September 18, 2013 we tested the BIS L-40X SERIES 2 for compliance with the following requirements:

### EMC Emissions:

- CFR 47 FCC Part 15.207 – Conducted limits
- CFR 47 FCC Part 15.209 - Radiated emission limits; general requirements
- RSS-Gen Issue 4 - General Requirements and Information for the Certification of Radio Apparatus

Product is an RFID system which operates at 125 KHz. EUT emissions were maximized by rotating product around its axis and around 3 orthogonal axes. EUT antenna could not be maximized separately. AC Mains conducted emissions was performed on AC side of AC/DC power supply (support equipment) power supply using a  $50\Omega/50\mu\text{H}$  LISN. Spectrum analyzer settings for conducted and radiated emissions tests were 120kHz RBW & 1MHz VBW for 30-1000MHz, 9kHz RBW & 30kHz VBW for 150kHz-30MHz, and 1kHz RBW (in lieu of 200Hz RBW) & 3kHz RBW below 150kHz. Test methods are compliant with ANSI C63.10-2009 and ANSI C63.10-2013.

We found that the product met the above requirements without modification. The test sample was received in good condition. The sample was received on July 11, 2013.

Issue No.	Reason for change	Date Issued
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**Product Tested****Configuration Documentation**

EUT Configuration										
Work Order: M2102 Company: Balluff, Inc. Company Address: 8125 Holton Drive Florence, KY 41042 Contact: Jim Ramler										
<b>MN</b>						<b>SN</b>				
EUT: BIS L-400-035-001-02-S115 EUT Description: Non-Contact Read/Write System EUT Max Frequency: 125KHz EUT TX Frequency: 125KHz						Sample 1				
<b>Support Equipment:</b>						<b>SN</b>				
Variable Power Supply set to 24VDC						E3612A		KP61304227		
Tag						BIS C-150-32/A		--		
<b>EUT Ports:</b>										
<b>Port Label</b>	<b>Port Type</b>	<b>No. of ports</b>	<b>No. Populated</b>	<b>Cable Type</b>	<b>Shielded</b>	<b>Ferrites</b>	<b>Length</b>	<b>Max Length</b>	<b>In/Out NEBS Type</b>	<b>Unpopulated Reason</b>
Power/COM	8-pin Power/COM	1	1	8-wires	yes	None	1m	na	indoor	
<b>Software / Operating Mode Description:</b> Powered on at 24VDC and transmits in 100-150kHz range										

**Compliance Statement**

TEST	RESULT	STANDARD	TEST LEVEL	MARGIN	COMMENTS
<b>Radiated Emissions</b>	PASS	47 CFR FCC Part 15.209, RSS-GEN ISSUE 4	FCC 15.209	-26.3dB @ 0.125MHz	
<b>AC Mains Conducted Emissions</b>	PASS	47 CFR FCC Part 15.207, RSS-GEN ISSUE 4	FCC 15.207	-14.1dB @ 14.5MHz	AC side of support DC Power Supply tested
<b>Occupied Bandwidth</b>	DONE	Industry Canada	RSS 210		

**Modifications Required for Compliance**

There were no modifications required for compliance.

**RADIATED EMISSIONS****Test Method:**

In accordance with the following:

- CFR 47 FCC Part 15.209
- RSS-GEN ISSUE 4

**Results:**

TEST	RESULT	TEST LEVEL	MARGIN	COMMENTS
<b><i>Radiated Emissions</i></b>	PASS	FCC 15.209	-26.3dB @ 0.125MHz	

## Radiated Emissions Data Table(s):

Radiated Emissions Table												
Date: 02-Aug-13			Company: Balluff, Inc.							Work Order: M2102		
Engineer: Arik Zwimer			EUT Desc: BIS L-400-035-001-02-S115							EUT Operating Voltage/Frequency: 24VDC		
Temp: 24°C			Humidity: 42%				Pressure: 1010mBar					
Frequency Range: 125kHz							Measurement Distance: 1 m					
Notes: resolution bandwidth 200Hz												
Antenna Polarization (0° - 90°)	Frequency (MHz)	Reading (dBμV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBμV/m)	---			FCC 15.209		
							Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)
0	0.125	48.3	0.0	50.0	0.1	98.4	---	---	---	124.7	-26.3	Pass
90	0.125	44.6	0.0	50.0	0.1	94.7	---	---	---	124.7	-30.0	Pass
Table Result: Pass by -26.3 dB Worst Freq: 0.125 MHz												
Test Site: 1DCC-OATS-3M-II				Cable 1: EMIR-13				Cable 2: ---			Cable 3: ---	
Analyzer: Gold				Preamp: none				Antenna: Lq Loop			Preselector: ---	

Rev.7/25/2013

## Spectrum Analyzers / Receivers / Preselectors

Gold

Range  
100Hz-26.5 GHzMN  
E4407BMfr  
AgilentSN  
MY45113816Asset  
1284Cat  
ICalibration Due  
3/18/2014

## Radiated Emissions Sites

1DCC-OATS-3M-II

FCC Code  
719150IC Code  
2762A-10VCCI Code  
A-0015Range  
30-1000MHzCat  
IICalibration Due  
5/11/2015

## Antennas

Large Loop

Range  
20Hz-5MHzMN  
6511Mfr  
EMCOSN  
9704-1154Asset  
67Cat  
ICalibration Due  
4/27/2014

## Cables

REMI-13

Range  
9kHz - 2GHzMfr  
C-SCat  
IICalibration Due  
10/15/2013

## Meteorological Meters

Temp./Humidity/Atm. Pressure Gauge

MN  
7400 Perception IIMfr  
DavisSN  
N/AAsset  
965Cat  
ICalibration Due  
5/29/2014

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

## Radiated Emissions Table

Date: 11-Jul-13			Company: Balluff Inc.			Work Order: M2102						
Engineer: Nirak So			EUT Desc: BIS L-400-035-001-02-S115			EUT Operating Voltage/Frequency: 24VDC						
Temp: 24°C			Humidity: 33%			Pressure: 1005mBar						
Frequency Range: 9KHz to 1 MHz						Measurement Distance: 3 m						
Notes:						EUT Max Freq: <108MHz						
Antenna Polarization (0° - 90°)	Frequency (MHz)	Reading (dBμV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBμV/m)	---			FCC 15.209		
							Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)
0	0.065	39.3	21.9	52.7	0.0	70.1				111.3	-41.2	Pass
90	0.06598	39.0	22.0	52.6	0.0	69.6				111.3	-41.7	Pass
0	0.125	45.4	22.5	50.0	0.1	73.0				105.7	-32.7	Pass
90	0.1254	44.0	22.5	50.0	0.1	71.6				105.7	-34.1	Pass
Table Result: Pass by -32.7 dB Worst Freq: 0.125 MHz												
Test Site: EMI Chamber 2			Cable 1: Asset #1781			Cable 2: Asset #1785			Cable 3: ---			
Analyzer: Asset #1328			Preamp: Blue			Antenna: Lg Loop			Preselector: ---			





Rev.6/16/2013

<b>Spectrum Analyzers / Receivers / Preselectors</b> SA EMI Chamber (1328)	<b>Range</b> 9kHz-13.2 GHz	<b>MN</b> E4405B	<b>Mfr</b> Agilent	<b>SN</b> MY44210241	<b>Asset</b> 1328	<b>Cat</b> I	<b>Calibration Due</b> 12/19/2013
<b>Radiated Emissions Sites</b> EMI Chamber 2	<b>FCC Code</b> 719150	<b>IC Code</b> 2762A-7	<b>VCCI Code</b> A-0015	<b>Range</b> 30-1000MHz		<b>Cat</b> II	<b>Calibration Due</b> 2/15/2014
<b>Preamps / Couplers Attenuators / Filters</b> Blue	<b>Range</b> 0.009-2000MHz	<b>MN</b> ZFL-1000-LN	<b>Mfr</b> CS	<b>SN</b> N/A	<b>Asset</b> 759	<b>Cat</b> II	<b>Calibration Due</b> 5/31/2014
<b>Antennas</b> Large Loop	<b>Range</b> 20Hz-5MHz	<b>MN</b> 6511	<b>Mfr</b> EMCO	<b>SN</b> 9704-1154	<b>Asset</b> 67	<b>Cat</b> I	<b>Calibration Due</b> 4/27/2014
<b>Cables</b> Asset #1781 Asset #1785	<b>Range</b> 9kHz - 18GHz 9kHz - 18GHz		<b>Mfr</b> Florida RF Florida RF			<b>Cat</b> II II	<b>Calibration Due</b> 3/6/2014 3/14/2014
<b>Meteorological Meters</b> Weather Clock (Pressure Only) CHAMBER2 Thermohygrometer		<b>MN</b> BA928 35519-044	<b>Mfr</b> Oregon Scientific Control Company	<b>SN</b> C3166-1 72457639	<b>Asset</b> 831 1347	<b>Cat</b> I II	<b>Calibration Due</b> 3/20/2014 8/19/2013

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

**Radiated Emissions Table**

Date: 11-Jul-13		Company: Balluff Inc.		Work Order: M2102								
Engineer: Nirak So		EUT Desc: BIS L-400-035-001-02-S115		EUT Operating Voltage/Frequency: 24VDC								
Temp: 24°C		Humidity: 33%		Pressure: 1005mBar								
Frequency Range: 1 to 30 MHz				Measurement Distance: 3 m								
Notes:				EUT Max Freq: <108MHz								
Antenna Polarization (0° - 90°)	Frequency (MHz)	Reading (dBμV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBμV/m)	---			FCC 15.209		
							Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)
0	27.7	14.6	22.5	37.1	0.4	29.6	---	---	---	69.5	-39.9	Pass
90	27.8	23.0	22.5	37.1	0.4	38.0	---	---	---	69.5	-31.5	Pass
Table Result: Pass				by -31.5 dB		Worst Freq: 27.8 MHz						
Test Site: EMI Chamber 2		Cable 1: Asset #1781		Cable 2: Asset #1785		Cable 3: ---						
Analyzer: Asset #1328		Preamp: Blue		Antenna: Sm Loop (high)		Preselector: ---						

Rev.6/16/2013

<b>Spectrum Analyzers / Receivers / Preselectors</b> SA EMI Chamber (1328)	<b>Range</b> 9kHz-13.2 GHz	<b>MN</b> E4405B	<b>Mfr</b> Agilent	<b>SN</b> MY44210241	<b>Asset</b> 1328	<b>Cat</b> I	<b>Calibration Due</b> 12/19/2013
<b>Radiated Emissions Sites</b> EMI Chamber 2	<b>FCC Code</b> 719150	<b>IC Code</b> 2762A-7	<b>VCCI Code</b> A-0015	<b>Range</b> 30-1000MHz		<b>Cat</b> II	<b>Calibration Due</b> 2/15/2014
<b>Preamps / Couplers Attenuators / Filters</b> Blue	<b>Range</b> 0.009-2000MHz	<b>MN</b> ZFL-1000-LN	<b>Mfr</b> CS	<b>SN</b> N/A	<b>Asset</b> 759	<b>Cat</b> II	<b>Calibration Due</b> 5/31/2014
<b>Antennas</b> Small Loop	<b>Range</b> 10kHz-30MHz	<b>MN</b> PLA-130/A	<b>Mfr</b> ARA	<b>SN</b> 1024	<b>Asset</b> 755	<b>Cat</b> I	<b>Calibration Due</b> 4/27/2014
<b>Cables</b> Asset #1781 Asset #1785	<b>Range</b> 9kHz - 18GHz 9kHz - 18GHz		<b>Mfr</b> Florida RF Florida RF			<b>Cat</b> II II	<b>Calibration Due</b> 3/6/2014 3/14/2014
<b>Meteorological Meters</b> Weather Clock (Pressure Only) CHAMBER2 Thermohygrometer		<b>MN</b> BA928 35519-044	<b>Mfr</b> Oregon Scientific Control Company	<b>SN</b> C3166-1 72457639	<b>Asset</b> 831 1347	<b>Cat</b> I II	<b>Calibration Due</b> 3/20/2014 8/19/2013

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

**Radiated Emissions Modifications:**

None



## Radiated Emissions Testing Overview

REV 10-APR-09

Digital and microprocessor based devices use radio frequency (RF) digital signals for timing purposes. An unintentional consequence of this signal usage is that a certain amount of RF energy is radiated from the device into the local environment. This radiated RF energy has the potential to interfere with constructive uses of the RF spectrum such as television broadcasting, police and fire radio, and the like. In order to reduce the likelihood that a device will interfere with these services, it is required that the amplitudes of radiated RF signals from the device are kept below an allowable level.

These RF signals decrease in strength as the distance from the source increases. Thus if the potential victim of interference, e.g. a TV receiver, is far enough from the radiator, e.g. a computer, then no interference will occur. For certain environments it is appropriate to expect that potential interference victims will be located at least a minimum distance from the radiator. For the residential environment this distance is generally accepted to be 10 meters while in the commercial environment the accepted distance is 30 meters. The allowable emissions levels are therefore specified to protect equipment which is located further than that distance from the radiator. In general, radiation from the Equipment Under Test (EUT) is measured at 3 or 10 meters to insure that it is at or below allowable levels.

Measurements of the radiated energy are made by recording the field strength indicated by an antenna placed at a specific distance from the device. Most devices do not radiate the RF energy in a predictable manner. The emitted energy may vary with changes in operating mode, physical configuration, or orientation. During the measurement process these parameters are varied to confirm that the emissions will remain below the allowable levels in the range of typical installations.

The extent of annoyance experienced by a person who is being affected by interference is related to the persistence of the interfering signal. For example, a low level steady whine from a receiver is considered to be more annoying than brief, loud, intermittent pops or clicks. This “human factor” is accounted for by the use of a “quasi-peak” detector in the receiver or spectrum analyzer which measures the signal from the measurement antenna. The detector is a weighted averaging filter with a fast charge time and a slow discharge time. Thus steady continuous signals will charge the quasi-peak detector fully while intermittent signals (those with pulse repetition rates less than 1kHz) are reported at a level which can be significantly below their peak level. It should be noted that most RF signals produced by digital devices are continuous in nature and thus the quasi-peak reading will be identical to the peak signal reading. To reduce the test time, the peak emission level is recorded for continuous wave signals as it is the same as the quasi-peak signal level.

Testing is performed according to test methods from ANSI C63.4 and CISPR 22.

The test site used for measuring radiated emissions follows the format developed internationally for a weather protected Open Area Test Site (OATS). The test site used for measuring radiated emissions above 1GHz for CISPR limits is a Free Space Open Area Test Site (FSOATS). An antenna mast is installed at the specified distance from a rotating table and



is used to raise and lower the measuring antenna. The reference site is clear of reflecting objects, such as metal fences and buildings for an ellipse of twice the measurement test distance. Measuring equipment and personnel are present within the ellipse to facilitate cable manipulation, but measures are taken to minimize the effects. Often preliminary radiated emissions measurements are made at alternate test sites which do not meet the clear space reference criteria. The data collected at alternate test sites is not considered conclusive unless the alternate site also complies with a volumetric site attenuation survey performed over the area that the EUT occupies. The EUT and measuring antenna mark the two foci of the ellipse. The ground plane is made of a combination of galvanized steel sheets and tight wire mesh electrically connected along the seams. This metal ground plane extends 1 meter beyond the furthest extent of the EUT and the measuring antenna. It also covers the area between the EUT and the measuring antenna. The hardware cloth is connected to the utility ground or to stakes driven into the earth for safety. The site configuration for CISPR testing above 1GHz is a semi-anechoic chamber. The ground plane in the test volume is covered by an absorbing material between the antenna and the EUT. In the case of table top equipment, the absorbing material is also placed under the table. In the case of floor-standing equipment the absorbing material extends up from the ground plane 30cm into the test volume, and surrounds the EUT by at most 10cm from the footprint of the equipment.

In order for accurate emissions measurements to be made the test site must possess propagation characteristics which fall within accepted norms. The site has been checked for suitability using techniques specified in American National Standards Institute (ANSI) document C63.4. This document details a procedure which measures the attenuation of the site which is the chief indicator of site acceptability. The theory behind site attenuation is quite simple. A transmitting antenna is set up at a fixed location at one end of the site with a receiving antenna at the other end. If a signal of some arbitrary amplitude is fed into the transmitting antenna, a lesser amount of signal ought to be measured at the receiving antenna. This difference in signal amplitude is known as the site attenuation, which should follow a predicted curve. Data that does not correspond to the predicted site attenuation curve points to a problem with either the equipment being used or the physical characteristics of the site.

Actual emissions measurements are taken with broadband biconical-log-periodic hybrid antennas calibrated in accordance with the standard site method detailed in ANSI C63.5. Emissions are measured with the receiving antenna oriented in horizontal and vertical polarization with respect to the ground plane. If measurements are made at other than the limit distance, then the readings obtained are scaled to the limit distance using an inverse relationship. The actual test distance used is noted in the report.

The antenna mast is capable of a varying the antenna height between 1 and 4 meters above the ground plane. The receiving antenna is moved over this range at each emission frequency in order to record the maximum observed signal. The mast is non-conductive and remotely controllable. The test distance is measured from the antenna center (marked during calibration) and the periphery of the EUT.

The Equipment Under Test (EUT) is rotated in order to maximize emissions during the test. For equipment intended to operate on a tabletop or desk radiated tests are conducted on a 0.8 meter high, non-conductive platform. Larger floor standing equipment is tested on a floor



mounted rotatable platform. In some cases, large equipment on its own casters may be tested without a platform.

Since radiated emissions are a function of cable placement, the cable placement is varied to encompass typical configurations that an end user might encounter to determine the configuration resulting in maximum emissions. At least one cable for each I/O port type is attached to the EUT. If peripherals or modules are available, at least one of each available type is installed and noted in the report. Excess cable length beyond one meter is bundled in the center into a 30 to 40 cm bundle. Cables requiring non-standard lead dress are recorded in the report.

Network connections are simulated if necessary. Any simulator used matches the expected real network connection in terms of both functionality and impedance. For distributed systems, the support equipment may be placed at such a distance that it does not influence the measured emissions. If this option is used, such placement is noted in the test report.

The possible operating modes of the EUT are explored to determine the configuration which maximizes emissions. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then noise floor measurements at six representative frequencies are recorded. The test report will document if noise floor readings are reported.

FCC and European Norms Radiated Emissions Limits at 10 meters					
Frequency (MHz)	FCC Class A	FCC Class B	CISPR Class A	CISPR Class B	Frequency (MHz)
30-88	39.1	29.5	40	30	30-88
88-216	43.5	33.1	40	30	88-216
216-230	46.4	35.6	40	30	216-230
230-960	46.4	35.6	47	37	230-960
960-1000	49.5	43.5	47	37	960-1000
1000-3000	Avg: 49.5 Peak: 69.5	Avg: 43.5 Peak: 63.5	Not defined	Not defined	1000-3000
3000+	Avg: 49.5 Peak: 69.5	Avg: 43.5 Peak: 63.5	Not defined	Not defined	3000+
<p>At the transitions, the lower limit applies. Simple inverse scaling utilized to convert limits where appropriate.</p>					

FCC and European Norms Radiated Emissions Limits at 3 meters					
Frequency (MHz)	FCC Class A	FCC Class B	CISPR Class A	CISPR Class B	Frequency (MHz)
30-88	49.5	40	50.5	40.5	30-88
88-216	54	43.5	50.5	40.5	88-216
216-230	56.9	46	50.5	40.5	216-230

230-960	56.9	46	57.5	47.5	230-960
960-1000	60	54	57.5	47.5	960-1000
1000-3000	Avg: 60 Peak: 80	Avg: 54 Peak: 74	Avg: 56 Peak: 76	Avg: 50 Peak: 70	1000-3000
3000+	Avg: 60 Peak: 80	Avg: 54 Peak: 74	Avg: 60 Peak: 80	Avg: 54 Peak: 74	3000+
<p>At the transitions, the lower limit applies. Simple inverse scaling utilized to convert limits where appropriate.</p>					

The measurement range is based on the highest frequency signal present or used in the device. The following table details the frequency range of measurements performed.

Frequency range of radiated emissions measurements		
Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)	
	FCC	EU/CISPR
Below 1.705	30 (No radiated measurements)	1000
1.705-108	1000	1000
108-500	2000	2000
500-1000	5000	5000
Above 1000	5 <sup>th</sup> harmonic of the highest frequency 40 GHz whichever is lower.	5 <sup>th</sup> harmonic of the highest frequency 6 GHz whichever is lower.

The test data is derived from the voltage on the spectrum analyzer. First the reading is corrected for gain factors associated with the use of preamps and loss in the cable. A factor in dB is subtracted from the reading to account for preamp gain, while a factor in dB is added to the signal to account for cable loss. A conversion is performed from the resulting voltage to field strength by multiplying the voltage by the antenna factor. Since antenna factor is expressed as a logarithm (dB/m), this operation takes the form of an addition (to multiply logarithmic numbers, you add them together). Thus:

$$\text{Field Strength (dBuV/m)} = \text{Voltage Reading (dBuV)} - \text{Preamp Gain (dB)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

When the levels of ambient radio signals such as local television stations are within 6 dB of the appropriate limit, the following steps may be taken to assure compliance:

1. The measurement bandwidth may be reduced. A check is made to see that peak readings are not affected. The use of a narrower bandwidth allows examination of emissions close to local ambient signals.
2. The antenna may be brought closer to the EUT to increase signal-to-ambient signal strength.
3. For horizontally polarized signals the axis of the test site may be rotated to discriminate against local ambients.

**CONDUCTED EMISSIONS****Test Method:**

In accordance with the following:

- CFR 47 FCC Part 15.207
- RSS-GEN ISSUE 4

**Results:**

TEST	RESULT	TEST LEVEL	MARGIN	COMMENTS
<b><i>AC Mains Conducted Emissions</i></b>	PASS	FCC 15.207	-14.1dB @ 14.5MHz	AC side of support DC Power Supply tested
<b><i>DC Mains Conducted Emissions</i></b>	N/A	FCC 15.207	N/A	EUT support Power Supply is AC powered

**Conducted Emissions Data Table(s):****AC side of DC Supply - Conducted Emissions Data Table**

Date: 18-Sep-13 Engineer: Tuyen Truong Temp: 20.5 °C Notes: EUT is powered with HP E3612A Power Supply (120Vac/60Hz). EUT is tied to earth ground.						Company: Balluff, Inc. EUT Desc: BIS L-400-035-001-02-S115 Humidity: 40%						Work Order: M2102 Pressure: 1001mBar					
Frequency Range: 0.15 - 30MHz												EUT Input Voltage/Frequency: 24Vdc					
Frequency (MHz)	Quasi-Peak Readings		Average Readings		LISN Factors		Cable Factor (dB)	ATTN Factor (dB)	FCC 15.207			FCC 15.207					
	QP1 (dBµV)	QP2 (dBµV)	AVG1 (dBµV)	AVG2 (dBµV)	L1 (dB)	L2 (dB)			QP Limit (dBµV)	Margin (dB)	Result (Pass/Fail)	AVG Limit (dBµV)	Margin (dB)	Result (Pass/Fail)			
	10.7	9.1	-1.1	-0.5	0.0	0.0			-0.2	-20.2	60.0	-28.8	Pass	50.0	-30.0	Pass	
	14.50	17.0	17.0	15.3	15.3	-0.1			-0.1	-0.3	-20.2	60.0	-22.4	Pass	50.0	-14.1	Pass
	16.34	9.9	8.1	1.4	0.3	-0.1			-0.1	-0.3	-20.2	60.0	-29.5	Pass	50.0	-28.0	Pass
	20.60	13.0	13.5	9.5	8.1	-0.1			-0.1	-0.3	-20.2	60.0	-25.9	Pass	50.0	-19.9	Pass
	22.39	15.0	14.1	12.7	12.2	-0.1			-0.1	-0.3	-20.2	60.0	-24.4	Pass	50.0	-16.7	Pass
	26.72	12.7	11.4	7.1	6.9	-0.1			-0.1	-0.3	-20.2	60.0	-26.6	Pass	50.0	-22.3	Pass
Result: Pass						Worst Margin: -14.1 dB				Frequency: 14.500 MHz							
Measurement Device: LISN ASSET 1729(Line 1) LISN ASSET 1730(Line 2)						Cable: CEMI-02 Attenuator: 20dB ATTEN-03				Spectrum Analyzer: SA EMI Chamber (1327) Site: CEMI 3							

C-S CEMI Calculator Version 3.0.12

Equipment Factor Sheet rev: 9/11/2013

<b>Spectrum Analyzers / Receivers / Preselectors</b> SA EMI Chamber (1327)	<b>Range</b> 9kHz-13.2 GHz	<b>MN</b> E4405B	<b>Mfr</b> Agilent	<b>SN</b> MY45103416	<b>Asset</b> 1327	<b>Cat</b> I	<b>Calibration Due</b> 5/30/2014
<b>LISNs/Measurement Probes</b> LISN Asset 1729 LISN Asset 1730	<b>Range</b> 150kHz-30MHz 150kHz-30MHz	<b>MN</b> LI-150A LI-150A	<b>Mfr</b> Com-Power Com-Power	<b>SN</b> 201085 201090	<b>Asset</b> 1729 1730	<b>Cat</b> I I	<b>Calibration Due</b> 1/28/2014 2/14/2014
<b>Conducted Test Sites (Mains / Telco)</b> CEMI-03	<b>FCC Code</b> 9kHz - 2GHz		<b>VCCI Code</b> C-S			<b>Cat</b> II	<b>Calibration Due</b> 10/13/2013
<b>Cables</b> CEMI-02	<b>Range</b> 9kHz - 2GHz		<b>Mfr</b> C-S			<b>Cat</b> II	<b>Calibration Due</b> 3/26/2014
<b>Attenuators</b> 20dB ATTEN-03	<b>Range</b> 9kHz-2GHz	<b>MN</b>	<b>Mfr</b>	<b>SN</b> N/A	<b>Asset</b>	<b>Cat</b> II	<b>Calibration Due</b> 12/3/2013
<b>Meteorological Meters</b> Temp./Humidity/Atm. Pressure Gauge		<b>MN</b> 7400 Perception II	<b>Mfr</b> Davis	<b>SN</b> N/A	<b>Asset</b> 965	<b>Cat</b> I	<b>Calibration Due</b> 5/29/2014

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

**Conducted Emissions Modifications:**

None





## Line Conducted Emissions Overview:

REV 9-MAY-06

Digital and microprocessor based devices use radio frequency (RF) digital techniques for timing purposes and in applications such as switching power supplies. An unintentional consequence of this for AC powered devices is that a certain amount of the RF energy is impressed upon the AC power mains in the form of a conducted noise voltage. These conducted emissions have the potential to interfere with constructive uses of the RF spectrum such as AM radio and may also interfere with other devices attached to the same AC mains circuit. In order to reduce the likelihood that a device will interfere it is required that the conducted RF signals from the device are below an allowable level.

Testing is performed according to test methods from ANSI C63.4 and CISPR 22.

Line conducted emissions are measured from the device over the frequency range of 0.15 to 30 MHz. The EUT is powered from a Line Impedance Stabilization Network (LISN). The purpose of the LISN is to provide a calibrated impedance across which to measure the conducted emissions. The RF noise voltage produced by the EUT across the LISN is measured and compared to the limit. In order for the LISN to perform properly it is attached to a ground plane at least 2 meters by 2 meters in size. For tabletop equipment the measurement is performed with the equipment 40 cm from a vertical conducting surface bonded to a ground plane under the product. The ground plane extends 0.5 meters beyond the product and is 2.5mx3.7m in size. The vertical surface is 2.5mx2.5m.

As with radiated emissions, the “human factor” is accounted for by the use of a “quasi-peak” detector in the receiver or spectrum analyzer that measures the signal from the LISN. For certain tests (such as EN55022), both an average and a quasi-peak limit are specified. Emissions from a device must be below both limits when measured with the appropriate detector. If the emission level is below the average limit when measured with the quasi-peak detector, the EUT is presumed to pass both limits.

The possible operating modes of the EUT are explored to determine the configuration that maximizes emissions. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

As of September 9, 2002, the FCC has harmonized its conducted emission limits with CISPR. The following table displays the limits applicable to both FCC and CISPR.



Line Conducted Emissions Limits: Class A (dB $\mu$ V)		
Frequency (MHz)	Quasi-Peak	Average
0.15 - 0.5	79	66
0.5 - 30	73	60
Line Conducted Emissions Limits: Class B (dB $\mu$ V)		
Frequency (MHz)	Quasi-Peak	Average
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5	56	46
5 - 30	60	50
Note 1: The lower limit applies at the transition frequencies		
*Note 2: The limit decreases linearly with the logarithm of the frequency		

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then the noise floor at six representative frequencies is recorded. The test report will document if noise floor readings are reported.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

**OCCUPIED BANDWIDTH****Test Method:**

In accordance with the following:

- RSS 210 – License - exempt Radio Apparatus (All Frequency Bands): Category I Equipment

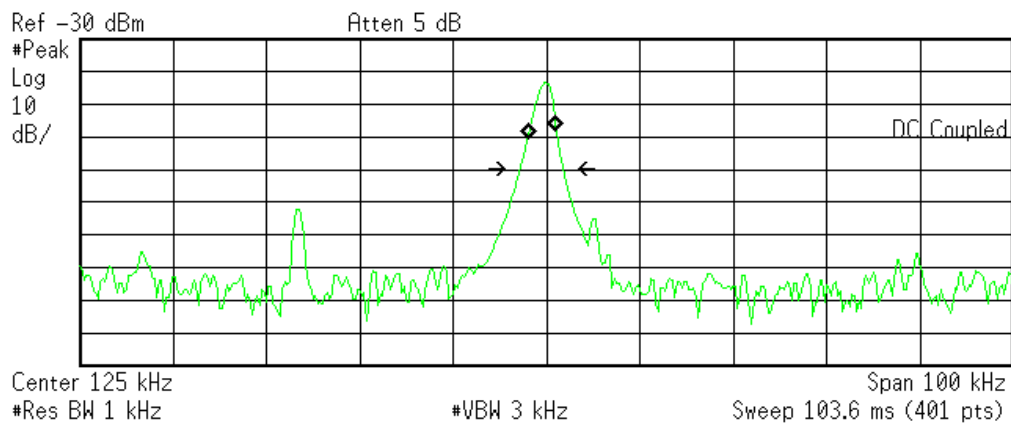
**Results:**

TEST	RESULT	TEST LEVEL	MARGIN	COMMENTS
<i>Occupied Bandwidth</i>	DONE	RSS 210	N/A	

## Occupied Bandwidth Plot(s):

✱ Agilent

R L



Occupied Bandwidth  
3.1821 kHz

Occ BW % Pwr    99.00 %  
x dB            -26.00 dB

Transmit Freq Error    -476.197 Hz  
x dB Bandwidth        4.630 kHz\*

## Measurement Uncertainty

The listed uncertainties are the worst case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

Measurement	Expanded Uncertainty k=2	Maximum allowable uncertainty
Radiated Emissions (30-1000MHz)		
NIST	5.6dB	N/A
CISPR	4.6dB	5.2dB (Ucisp)
Radiated Emissions (1-26.5GHz)	4.6dB	N/A
Radiated Emissions (above 26.5GHz)	4.9dB	N/A
Magnetic Radiated Emissions	5.6dB	N/A
Conducted Emissions		
NIST	3.9dB	N/A
CISPR	3.6dB	3.6dB (Ucisp)
Telco Conducted Emissions (Current)	2.9dB	N/A
Telco Conducted Emissions (Voltage)	4.4dB	N/A
Electrostatic Discharge	11.5%	N/A
Radiated RF Immunity (Uniform Field)	1.6dB	N/A
Electrical Fast Transients	23.1%	N/A
Surge	23.1%	N/A
Conducted RF Immunity	3dB	N/A
Magnetic Immunity	12.8%	N/A
Dips and Interrupts	2.3V	N/A
Harmonics	3.5%	N/A
Flicker	3.5%	N/A
Radio frequency (@ 2.4GHz)	$3.23 \times 10^{-8}$	$1 \times 10^{-7}$
RF power, conducted	0.40dB	0.75dB
Maximum frequency deviation:		
• Within 300Hz and 6kHz of audio frequency / Within 6kHz and 25kHz of audio frequency	3.4% 0.3dB	5% 3dB
Adjacent channel power	1.9dB	3dB
Conducted spurious emission of transmitter, valid up to 12.75GHz	2.39dB	3dB
Conducted emission of receivers	1.3dB	3dB
Radiated emission of transmitter, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of transmitter, valid up to 80GHz	3.3dB	6dB
Radiated emission of receiver, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of receiver, valid up to 80GHz	3.3dB	6dB
Humidity	2.37%	5%
Temperature	0.7°C	1.0°C
Time	4.1%	10%
RF Power Density, Conducted	0.4dB	3dB
DC and low frequency voltages	1.3%	3%
Voltage (AC, <10kHz)	1.3%	2%
Voltage (DC)	0.62%	1%
The above reflects a 95% confidence level		

## Conditions Of Testing

[Bureau Veritas Consumer Products Services, Inc., a Massachusetts corporation], and/or its affiliates (collectively, the "Company") will conduct, at the request of the Submitter ("Client"), the tests specified on the submitted Test Request Form or equivalent in accordance with, and subject to, the following terms and conditions (collectively, "Conditions"):

1. All orders for tests are subject to acceptance by the Company, and no order will constitute a binding commitment of the Company unless and until such order is accepted by it, as evidenced by the issuance of a written report ("Test Report") by the Company. The Test Report is issued solely by the Company, is intended for the exclusive use of Client and shall not be published, used for advertising purposes, copied or replicated for distribution to any other person or entity or otherwise publicly disclosed without the prior written consent of the Company. By submitting a request for services to the Company, Client consents to the disclosure to accreditation bodies of those records of Client relevant to the accreditation body's assessment of the Company's competence and compliance with relevant accreditation criteria. The Company shall not be liable for any loss or damage whatsoever resulting from the failure of the Company to provide its services within any time period for completion estimated by the Company. If Client anticipates using the Test Report in any legal proceeding, arbitration, dispute resolution forum or other proceeding, it shall so notify the Company prior to submitting the Test Report in such proceeding. The Company has no obligation to provide a fact or expert witness at such proceeding unless the Company agrees in advance to do so for a separate and additional fee.
2. The Test Report will set forth the findings of the Company solely with respect to the test samples identified therein. Unless specifically and expressly indicated in the Test Report, the results set forth in such Test Report are not intended to be indicative or representative of the quality or characteristics of the lot from which a test sample is taken, and Client shall not rely upon the Test Report as being so indicative or representative of the lot or of the tested product in general. The Test Report will reflect the findings of the Company at the time of testing only, and the Company shall have no obligation to update the Test Report after its issuance. The Test Report will set forth the results of the tests performed by the Company based upon the written information provided to the Company. The Test Report will be based solely on the samples and written information submitted to the Company by Client, and the Company shall not be obligated to conduct any independent investigation or inquiry with respect thereto.
3. The Company may, in its sole discretion, destroy samples which have been furnished to the Company for testing and which have not been destroyed in the course of testing. The Company may delegate the performance of all or a portion of the services contemplated hereunder to an affiliate, agent or subcontractor of the Company, and Client consents to such delegation.
4. These Conditions and the Test Report represent the entire understanding of the parties hereto with respect to the subject matter hereof and of the Test Report, and no modification, variance or extrapolation with respect thereto shall be permitted without the prior written consent of the Company.
5. The names, service marks, trademarks and copyrights of the Company and its affiliates, including the names "BUREAU VERITAS," "BUREAU VERITAS CONSUMER PRODUCTS SERVICES," "BVCPS", "MTL", "ACTS", "MTL-ACTS" and CURTIS-STRAUS (collectively, the "Marks") are and shall remain the sole property of the Company or its affiliates and shall not be used by Client except solely to the extent that Client obtains the prior written approval of the Company and then only in the manner prescribed by the Company. Client shall not contest the validity of the Marks or take any action that might impair the value or goodwill associated with the Marks or the image or reputation of the Company or its affiliates.
6. Payment in full shall be due 30 days after the date of invoice. Interest shall be due on overdue amounts from the due date until paid at an interest rate of 1.5% per month or, if less, the maximum rate permitted by law. The Company reserves the right, at any time and from time to time, to revoke any credit extended to Client. Client shall reimburse the Company for any costs it incurs in collecting past due amounts, including court costs and fees and expenses of attorneys and collection agencies. The Test Report may not be used or relied upon by Client if and for so long as Client fails to pay when due any invoice issued by the Company or any affiliate of it to Client or any affiliate or subsidiary of Client together with interest and penalties, if any, accrued thereon.
7. The Company disclaims any and all responsibility or liability arising out of or in connection with e-mail transmissions of such information.
8. Client understands and agrees that the Company is neither an insurer nor a guarantor, that the Company does not take the place of Client or any designer, manufacturer, agent, buyer, distributor or transportation or shipping company, and that the Company disclaims all liability in such capacities. Client further understands that if it seeks assurance against loss or damage, it should obtain appropriate insurance.
9. Client agrees that the Company, by providing the services, does not take the place of Client nor any third party, nor does the Company release them from any of their obligations, nor does the Company otherwise assume, abridge, abrogate or undertake to discharge any duty of any third party to Client or any duty of Client or any third party to any other third party, and Client will not release any third party from its obligations and duties with respect to the tested goods.
10. Client shall, on a timely basis, (a) provide adequate instructions to the Company in order to enable the Company to perform properly its services, (b) provide, or cause Client's suppliers and contractors to provide, the Company with all documents necessary to enable the Company to perform its services, (c) furnish the Company with all relevant information regarding Client's intended use and purposes of the tested goods, (d) advise the Company of essential dates and deadlines relevant to the tested goods and (e) fully exercise all rights and remedies available to Client against third parties in respect of the tested goods.
11. The Company shall undertake due care and ordinary skill in the performance of its services to Client, and the Company shall accept responsibility only where such skill has not been exercised and, even in such event, only to the extent of the limitation of liability set forth herein.
12. If Client desires to assert a claim arising from or relating to (i) the performance, purported performance or non-performance of any services by the Company or (ii) the sale, resale, manufacture, distribution or use of any tested goods, it must

submit that claim to the Company in a writing that sets forth with particularity the basis for such claim within 60 days from discovery of the potential claim and not more than six months after the date of issuance of the Test Report to Client. Client waives any and all such claims including, without limitation, claims that the Test Report is inaccurate, incomplete or misleading or that additional or different testing is required, unless and then only to the extent that Client submits a written claim to the Company within both such time periods.

13. CLIENT SHALL, EXCEPT TO THE EXTENT OF COMPANY'S LIABILITY TO CLIENT HEREUNDER (WHICH IN NO EVENT SHALL EXCEED THE LIMITATION OF LIABILITY HEREIN), HOLD HARMLESS AND INDEMNIFY THE COMPANY, ITS AFFILIATES AND THEIR RESPECTIVE DIRECTORS, OFFICERS, EMPLOYEES, AGENTS AND SUBCONTRACTORS AGAINST ALL ACTUAL OR ALLEGED THIRD PARTY CLAIMS FOR LOSS, DAMAGE OR EXPENSE OF WHATSOEVER NATURE AND HOWSOEVER ARISING FROM OR RELATING TO (i) THE PERFORMANCE, PURPORTED PERFORMANCE OR NON-PERFORMANCE OF ANY SERVICES BY THE COMPANY OR (ii) THE SALE, RESALE, MANUFACTURE, DISTRIBUTION OR USE OF ANY TESTED GOODS.

14. EXCEPT AS MAY OTHERWISE BE EXPRESSLY AGREED TO IN WRITING BY THE COMPANY AND NOTWITHSTANDING ANY PROVISION TO THE CONTRARY CONTAINED HEREIN OR IN ANY TEST REPORT, NO WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, IS MADE.

15. (A) IN NO EVENT WHATSOEVER SHALL THE COMPANY BE LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL, EXEMPLARY OR PUNITIVE DAMAGES IN CONNECTION WITH, RELATING TO OR ARISING OUT OF THE TEST REPORT OR THE SERVICES PROVIDED BY THE COMPANY HEREUNDER, INCLUDING WITHOUT LIMITATION LOSS OF OR DAMAGE TO PROPERTY; LOSS OF INCOME, PROFIT OR USE; OR ANY CLAIMS OR DEMANDS MADE AGAINST CLIENT OR ANY OTHER PERSON BY ANY THIRD PARTY IN CONNECTION WITH, RELATING TO OR ARISING OUT OF THE SERVICES PROVIDED BY THE COMPANY HEREUNDER.

(B) NOTWITHSTANDING ANY PROVISION TO THE CONTRARY CONTAINED HEREIN, AND IN RECOGNITION OF THE RELATIVE RISKS AND BENEFITS TO CLIENT AND THE COMPANY ASSOCIATED WITH THE TESTING SERVICES CONTEMPLATED HEREBY, THE RISKS HAVE BEEN ALLOCATED SUCH THAT UNDER NO CIRCUMSTANCES WHATSOEVER SHALL THE LIABILITY OF THE COMPANY TO CLIENT OR ANY THIRD PARTY IN RESPECT OF ANY CLAIM FOR LOSS, DAMAGE OR EXPENSE, OF WHATSOEVER NATURE OR MAGNITUDE, AND HOWSOEVER ARISING, EXCEED AN AMOUNT EQUAL TO FIVE (5) TIMES THE AMOUNT OF THE FEES PAID TO THE COMPANY FOR THE SPECIFIC SERVICES WHICH GAVE RISE TO SUCH CLAIM OR U.S.\$10,000, WHICHEVER IS THE LESSER AMOUNT.

16. The Company shall not be liable for any loss or damage resulting from any delay or failure in performance of its obligations hereunder resulting directly or indirectly from any event of force majeure or any event outside the control of the Company. If any such event occurs, the Company may immediately cancel or suspend its performance hereunder without incurring any liability whatsoever to Client.

Company's services, including these Conditions, shall be governed by, and construed in accordance with, the local laws of the country where the Company performs the tests or, in the case of tests performed in the United States of America, the laws of Massachusetts without regard to conflicts of laws principles. If any aspect(s) of these Conditions is found to be illegal or unenforceable, the validity, legality and enforceability of all remaining aspects of these Conditions shall not in any way be affected or impaired thereby. Any proceeding related to the subject matter hereof shall be brought, if at all, in the courts of the country where the Company performs the tests or, in the case of tests performed in the United States of America, in the courts of Massachusetts. Client waives the right to interpose any counterclaim or setoffs of any nature in any litigation arising hereunder.

The complete list of the Approved Subcontractors Curtis-Straus may use to delegate the performance of work can be provided upon request.



***Appendix A: Non-Evaluated Data***

This section contains information that Balluff, Inc. has requested accompany report. It has not been evaluated for accuracy by Curtis-Straus.