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BI Inc.
TEST REPORT

SCOPE OF WORK
EMC TESTING – BI LOC8 LTE

REPORT NUMBER
103443796LEX-001

ISSUE DATE	**[REVISED DATE]**
5/30/2018	5/30/2018

PAGES
19

DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 103443796LEX-001
Project Number: G103443796

Report Issue Date: 5/30/2018

Model(s) Tested: LC-880

FCC Standards: Title 47 CFR Part 22, 24, and 27

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
BI Inc.
6265 Gunbarrel Ave, Suite B
Boulder, CO 80301
USA

Report prepared by

Brian Daffin,
Engineer

Report reviewed by

Bryan Taylor,
Team Leader

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Radiated Spurious Emissions (ANSI C63.26: 2014)	Compliant

Results for the remainder of the tests can be found in the module certification reports for the SARA-R410M.

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	BI Inc.
Address:	6265 Gunbarrel Ave, Suite B Boulder, CO 80301 USA
Contact:	Lemu Admike
Telephone:	303 218 1032
Email:	Lemu.admike@bi.com
Manufacturer Information	
Manufacturer Name:	BI Inc.
Manufacturer Address:	6265 Gunbarrel Ave, Suite B Boulder, CO 80301 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	BI LOC8 LTE
Model Number	LC-880
Serial Number	Test Sample 1
Receive Date	5/10/2018
Test Start Date	5/10/2018
Test End Date	5/18/2018
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	3.6 VDC battery
Rated Current	<1A
Frequency Bands	1850 – 1910MHz (Band 2) 1710 – 1755MHz (Band 4) 824 – 849MHz (Band 5) 698 – 716MHz (Band 12) 777 – 787MHz (Band 13)
Modulation	QPSK and 16-QAM
Description of Equipment Under Test (provided by client)	
The LOC8 is an ankle worn tracking device.	

4.1 Variant Models:

There were no variant models covered by this evaluation.

4.2 EUT Photo (Front):

4.3 EUT Photo (Back):

5 Radiated Spurious Emissions

5.1 Method

Tests are performed in accordance with ANSI C63.26: 2015

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

5.2 Limit Line Calculation

As described in FCC parts 22.359, 24.238, and 27.53, the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

Since the FCC defines P as the total power in watts, the limit can be defined by the following

Unwanted Emissions Power (dBW) < 10 log(P) – [43 + 10 log(P)]

The first 10 log(P) expression is the fundamental power in dBW, and the second is from the FCC reference. The limit then simplifies to the following

Unwanted Emissions Power (dBW) < 10 log(P) – 43 – 10 log(P)

After cancelling the 10 log(P) factors, the limit is just -43dBW, or -13dBm.

From there, ANSI C63.26 Clause 5 describes a method for converting field strength to field power based on the test distance. The formula they use is to add 20 log(D) – 104.8, where D is the distance between the device and the measurement antenna. So, converting the -13dBm limit to dBµV/m for a 3 meter test distance is as follows

-13 – [20 log(3) – 104.8] = 82.25 dBµV/m

5.3 Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG
Where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 52.0 dBµV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBµV/m

To convert from dBµV to µV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in µV
NF = Net Reading in dBµV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 µV/m

5.4 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde&Schwarz	ESU40	9/20/2017	9/20/2018
Base Station Simulator	3961	Rohde&Schwarz	CMW500	11/22/2017	11/22/2018
Bilog Antenna	3133	ETS Lindgren	3142C	4/6/2017	10/6/2018
Horn Antenna	3780	ETS Lindgren	3117	6/1/2017	6/1/2018
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/29/2017	11/29/2018
3m Cable Preamplifier	3918	TS-PR18	122005	11/29/2017	11/29/2018
3m Cable Preamp→Chamber	2588			11/29/2017	11/29/2018
3m Cable Chamber→Control Room	2593			11/29/2017	11/29/2018
3m Cable Control Room→Receiver	2592			11/29/2017	11/29/2018
10m Cable Antenna→Preamp	3339			11/29/2017	11/29/2018
10m Cable Preamplifier	7019	ZX60-3018G-S+	SUU63801252	11/29/2017	11/29/2018
10m Cable Preamp→Chamber	3172			11/29/2017	11/29/2018
10m Cable Chamber→Control Room	2590			11/29/2017	11/29/2018
10m Cable Control Room→Receiver	2589			11/29/2017	11/29/2018

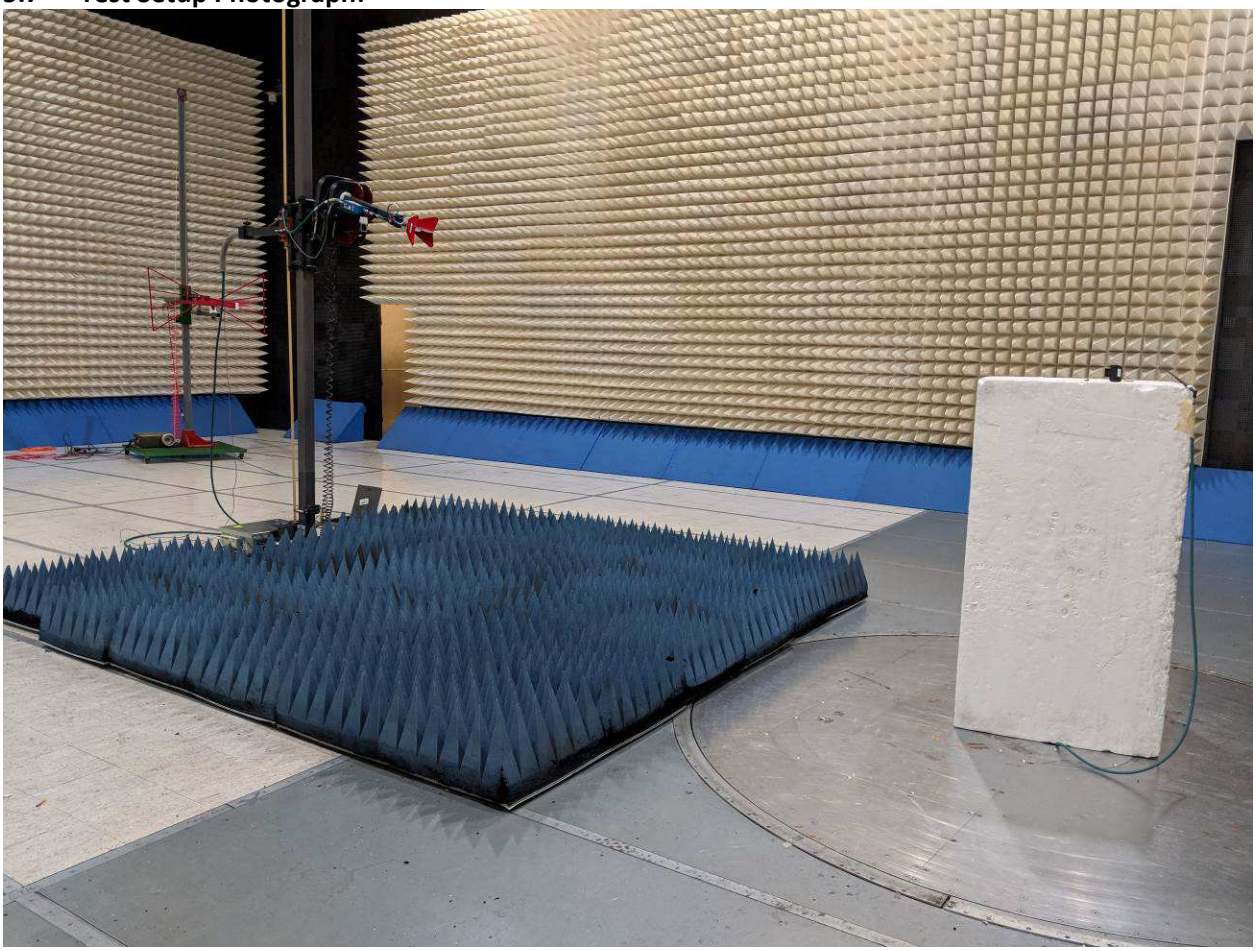
5.5 Software Utilized:

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

5.6 Results:

The sample tested was found to Comply.

5.7 Test Setup Photograph:



5.8 Data: Radiated Spurious Emissions

LTE Band 2

Channel Frequency (MHz)	Modulation	Spurious Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1852	QPSK	3703.67	55.59	82.25	26.66
		5556.22	56.58	82.25	25.67
		7408.27	48.15	82.25	34.10
	16-QAM	3703.06	51.14	82.25	31.11
		5556.72	45.66	82.25	36.59
		7405.96	43.48	82.25	38.77
1880	QPSK	3761.18	58.34	82.25	23.91
		5641.04	56.27	82.25	25.98
		7517.77	45.78	82.25	36.47
	16-QAM	3760.94	58.42	82.25	23.83
		5639.05	52.49	82.25	29.76
		7516.98	44.18	82.25	38.07
1908	QPSK	3817.30	55.55	82.25	26.70
		5724.32	58.94	82.25	23.31
		7632.18	47.75	82.25	34.50
	16-QAM	3816.81	61.34	82.25	20.91
		5724.37	55.06	82.25	27.19
		7629.19	44.05	82.25	38.20

LTE Band 4

Channel Frequency (MHz)	Modulation	Spurious Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1711.5	QPSK	3421.58	61.21	82.25	21.04
		5133.63	61.42	82.25	20.83
		6847.08	54.00	82.25	28.25
		8556.66	50.02	82.25	32.23
	16-QAM	3422.15	69.63	82.25	12.62
		5134.69	59.02	82.25	23.23
		6847.33	57.75	82.25	24.5
		8554.10	44.19	82.25	38.06
1732.5	QPSK	3465.20	71.25	82.25	11.00
		5197.29	67.29	82.25	14.96
		6927.84	53.67	82.25	28.58
	16-QAM	3465.94	72.14	82.25	10.11
		5196.76	60.61	82.25	21.64
		6931.27	62.33	82.25	19.92
		8669.76	44.54	82.25	37.71
1753.5	QPSK	3509.14	50.50	82.25	31.75
		5261.93	63.81	82.25	18.44
		7015.73	60.51	82.25	21.74
	16-QAM	3507.75	61.15	82.25	21.10
		5261.41	58.56	82.25	23.69
		7012.83	52.00	82.25	30.25

LTE Band 5

Channel Frequency (MHz)	Modulation	Spurious Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)
825.3	QPSK	1651.46	64.39	82.25	17.86
		2475.31	70.68	82.25	11.57
		2476.60	66.52	82.25	15.73
		3299.86	53.48	82.25	28.77
		4127.44	50.44	82.25	31.81
	16-QAM	1651.86	62.70	82.25	19.55
		2476.71	61.02	82.25	21.23
		3297.28	39.74	82.25	42.51
		3302.80	54.33	82.25	27.92
836.5	QPSK	1673.76	69.24	82.25	13.01
		2511.63	58.82	82.25	23.43
		4177.94	41.58	82.25	40.67
	16-QAM	1672.92	72.82	82.25	9.43
		2511.67	39.10	82.25	43.15
		2512.93	49.15	82.25	33.10
		3354.78	39.94	82.25	42.31
		4183.03	44.33	82.25	37.92
847.7	QPSK	1695.83	74.43	82.25	7.82
		2539.80	38.89	82.25	43.36
		3392.19	43.88	82.25	38.37
		4236.07	46.58	82.25	35.67
	16-QAM	1696.25	73.61	82.25	8.64
		2543.13	50.42	82.25	31.83
		3393.15	40.99	82.25	41.26
		4238.89	45.60	82.25	36.65

LTE Band 12

Channel Frequency (MHz)	Modulation	Spurious Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)
700.5	QPSK	1402.37	57.18	82.25	25.07
		2102.32	51.77	82.25	30.48
		3500.95	44.34	82.25	37.91
		4203.97	46.17	82.25	36.08
	16-QAM	1401.64	58.46	82.25	23.79
		2099.79	54.01	82.25	28.24
		2809.85	39.00	82.25	43.25
		4199.84	43.73	82.25	38.52
707.5	QPSK	1415.81	52.97	82.25	29.28
		2124.16	62.04	82.25	20.21
		2831.59	52.15	82.25	30.10
		3538.21	40.53	82.25	41.72
	16-QAM	1415.17	52.56	82.25	29.69
		2120.60	46.50	82.25	35.75
		2830.17	51.67	82.25	30.58
		3539.80	52.38	82.25	29.87
		4248.34	50.50	82.25	31.75
714.5	QPSK	1427.93	54.11	82.25	28.14
		2147.17	46.66	82.25	35.59
		2858.66	52.17	82.25	30.08
		3570.27	46.22	82.25	36.03
		4284.32	47.08	82.25	35.17
	16-QAM	1431.71	47.85	82.25	34.40
		2143.30	62.14	82.25	20.11
		2857.99	52.80	82.25	29.45
		3570.52	49.65	82.25	32.60
		4296.26	41.93	82.25	40.32

LTE Band 13

Channel Frequency (MHz)	Modulation	Spurious Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)
777	QPSK	1575.09	54.62	82.25	27.63
		2356.74	69.01	82.25	13.24
		3143.94	44.15	82.25	38.10
		3932.77	52.57	82.25	29.68
		4716.95	48.65	82.25	33.60
		5505.06	53.90	82.25	28.35
		6291.40	51.63	82.25	30.62
	16-QAM	1559.85	55.21	82.25	27.04
		2357.94	74.99	82.25	7.26
		3145.72	59.88	82.25	22.37
		3893.48	66.23	82.25	16.02
		4715.97	51.87	82.25	30.38
782	QPSK	1572.77	75.30	82.25	6.95
		2358.85	78.67	82.25	3.58
		3125.17	61.47	82.25	20.78
		3931.34	68.60	82.25	13.65
		4718.66	63.81	82.25	18.44
		5504.77	62.95	82.25	19.30
	16-QAM	1562.07	77.27	82.25	4.98
		2338.66	52.85	82.25	29.40
		3144.60	53.98	82.25	28.27
		3931.44	69.00	82.25	13.25
		4718.72	64.62	82.25	17.63
		5504.03	50.91	82.25	31.34
787	QPSK	1572.00	71.30	82.25	10.95
		2359.19	80.23	82.25	2.02
		3143.35	59.23	82.25	23.02
		3928.86	66.92	82.25	15.33
		4714.77	54.33	82.25	27.92
		5500.75	57.23	82.25	25.02
	16-QAM	1572.48	76.15	82.25	6.10
		2357.77	77.67	82.25	4.58
		3145.98	58.45	82.25	23.80
		3930.16	73.82	82.25	8.43
		4718.74	64.62	82.25	17.63
		5504.63	58.72	82.25	23.53

Test Personnel:	Brian Daffin	Test Date:	5/10/2018 – 5/21/2018
Supervising/Reviewing Engineer: (Where Applicable)	N/A	Limit Applied:	See Tables Above
		Ambient Temperature:	25.7 °C
Input Voltage:	3.6 VDC battery	Relative Humidity:	41.1 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.0 mbar

Deviations, Additions, or Exclusions: The device was tested in three orthogonal positions, with the worst case results reported in the data above

6 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	5/30/2018	103443796LEX-001	BD	BCT	Original Issue