Texas Instruments Inc.

TEST REPORT

SCOPE OF WORK
EMC Testing – LM5155EVM-BST, Model(s): BMC028A

REPORT NUMBER
104310663DAL-001

ISSUE DATE
31-July-2020

PAGES
44

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

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 104310663DAL-001
Project Number: G104310663

Report Issue Date: 31-July-2020

Model(s) Tested: BMC028A

Standards: **EN 61326-1**
Issued: 2013 Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements – Part 1: General Requirements

Tested by:
Intertek Testing Services NA, Inc.
1809 10th Street Suite 400
Plano, TX 75074
USA

Client:
Texas Instruments Inc.
15210 S. 50th Street Suite 120
Phoenix, AZ 85044
USA

Report prepared by

Reshar Rouse

Reshar Rouse
Compliance Investigator

Report reviewed by

William B Cullen

William Cullen
Engineering Supervisor

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
3	Client Information	
4	Description of Equipment Under Test and Variant Models	
5	System Setup and Method	
6	Radiated Emissions (CISPR 11:2009, A1:2009)	Pass
7	AC Mains Conducted Emissions (CISPR 11:2009, A1:2009)	Pass
8	Harmonics (IEC 61000-3-2:2005, A1: 2008, A2:2009)	Pass
9	Flicker (IEC 61000-3-3:2008)	Pass
10	Radiated, Radio-Frequency, Electromagnetic Immunity (IEC 61000-4-3:2006, A1: 2007, A2:2010)	Pass
11	Power Frequency Magnetic Field Immunity Test (IEC 61000-4-8:2009)	Pass
12	Revision History	

3 Client Information

This EUT was tested at the request of:

Client: Texas Instruments Inc.
15210 S. 50th Street Suite 120
Phoenix, AZ 85044
USA
Contact: Youhao Xi
Telephone: (480) 629-2487
Email: Youhao.Xi@ti.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Texas Instruments Inc.
15210 S. 50th Street Suite 120
Phoenix, AZ 85044
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
LM5155EVM-BST	Texas Instruments Inc.	BMC028A	Not Available

Receive Date:	07/15/2020
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)

The Texas Instruments Inc. LM5155EVM-BST is The LM5155 Boost Evaluation Module.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
6V to 18V	4A	440kHz	Single Phase

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	The EVM energized and putting out nominal output voltage (24VDC).

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	None

5 System Setup and Method

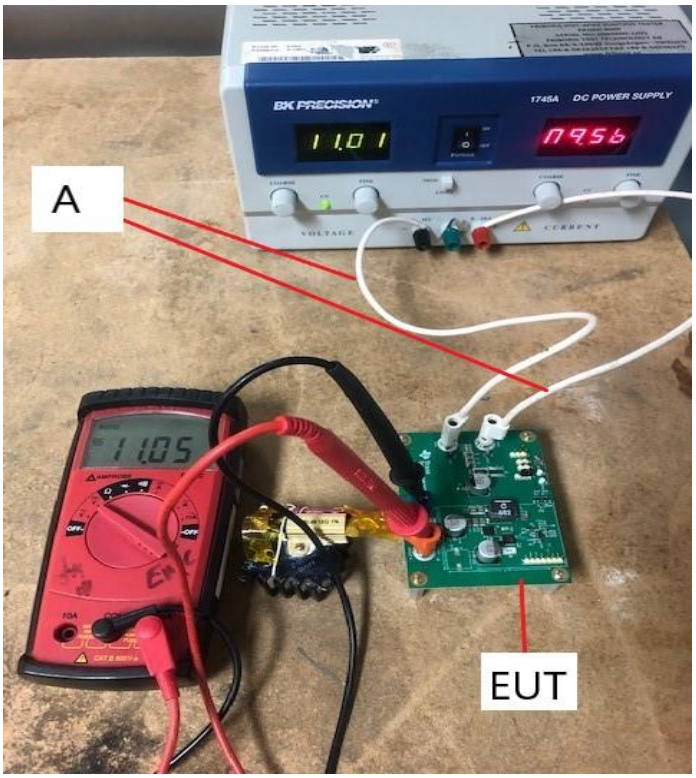
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
A	DC Power Cables	<3	None	None	DC Power Supply

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
DC Power Supply	BK Precision	1745A	N/A
Load Resistor			N/A
Digital Multimeter			

5.1 Method:

Configuration as required by EN 61326-1.

5.2 Block Diagram:



5.3 EUT Performance Criteria and Monitoring:

Performance as required by EN 61326-1.

No.	Description
1	**Performance criterion A:** The apparatus shall continue to operate as intended during the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended.
2	**Performance criterion B:** The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. During the test, degradation of performance is allowed, however. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended.
3	**Performance criterion C:** Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls, or by any operation specified in the instructions for use.

General notes:

Product Specific Performance:

No.	Description
1	The EUT shall continue to hold an output voltage of 24VDC across the load.

Description of how performance was observed during testing:

No.	Description
1	Visually by putting a DMM across the load to monitor the output voltage.

General notes:

6 Radiated Emissions

6.1 Method

Tests are performed in accordance with CISPR 11.

TEST SITE: 3m SAC

Site Designation: The Panashield 3 meter Semi Anechoic Chamber has a bore sight antenna and a 2 meter turntable with a 4400lbs capability.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 3m	10kHz-30 MHz	4.2 dB	N/A dB
Radiated Emissions, 3m	30-1000 MHz	3.5 dB	6.3 dB
Radiated Emissions, 1m	1-18 GHz	3.9 dB	5.5 dB
Radiated Emissions, 3m	1-18 GHz	3.5 dB	5.5 dB
Radiated Emissions, 1m	18-26 GHz	3.9 dB	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, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample 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

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
1324	Antenna Bilog	Sunol Sciences Corp.	JB6	A101612	1/6/2020	1/6/2021
1179	Preamplifier	Com-Power	PAM-103	441028	12/19/2019	12/18/2020
4134	RF Cable N to N 18GHz	MegaPhase	F520-N1N1-118	17174601003	10/29/2019	10/28/2020
4284	78 Low Loss RF Cable N Type	Maury Microwave	UC-N-MM-78	1728113	4/14/2020	4/14/2021
4138	RF Cable N to N 18GHz	MegaPhase	F520-N1N1-276	17174602001	10/29/2019	10/28/2020
3005	EMI Receiver- Freq Range 20Hz to 40GHz	Rhode & Schwarz	ESU 40	100136	3/24/2020	3/24/2021
4333	Ambient Data Logger	Extech Instruments	SD700	A.086409	4/24/2020	4/24/2021

Software Utilized:

Name	Manufacturer	Asset #	Version
Total Integrated Laboratory Environment	ETS-Lindgren	1330	6.0

Profile

Name	Manufacturer	Asset #	Version/Rev
Master Radiated Emissions	ETS-Lindgren	1330-004	11/11

6.3 Results:

The sample tested was found to Comply.

6.4 Setup Photographs:

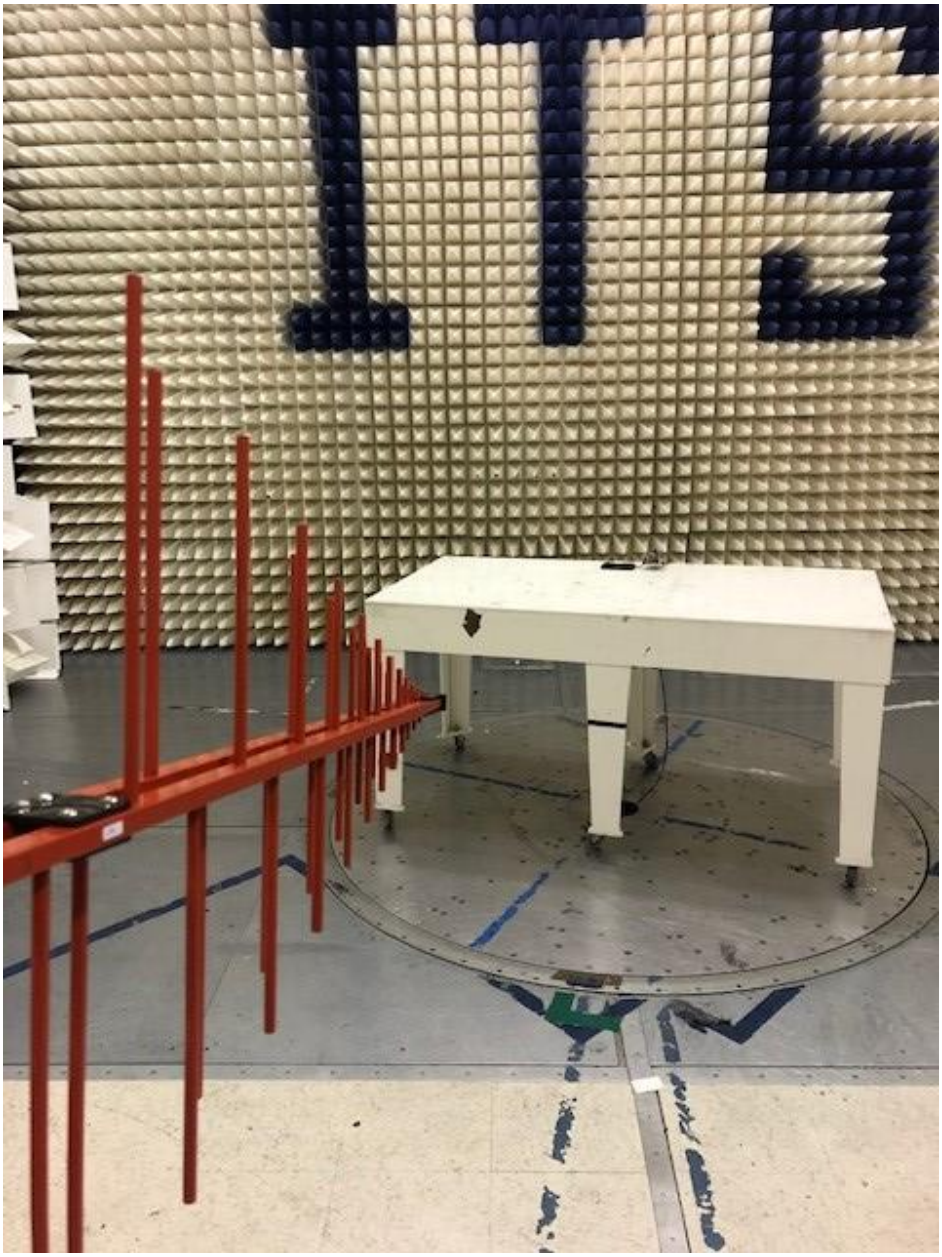


Figure 6-1 A Radiated Emissions Test Setup Front Heat Sink up, PCB Flat on Table

Figure 6-2 A Radiated Emissions Test Setup Front

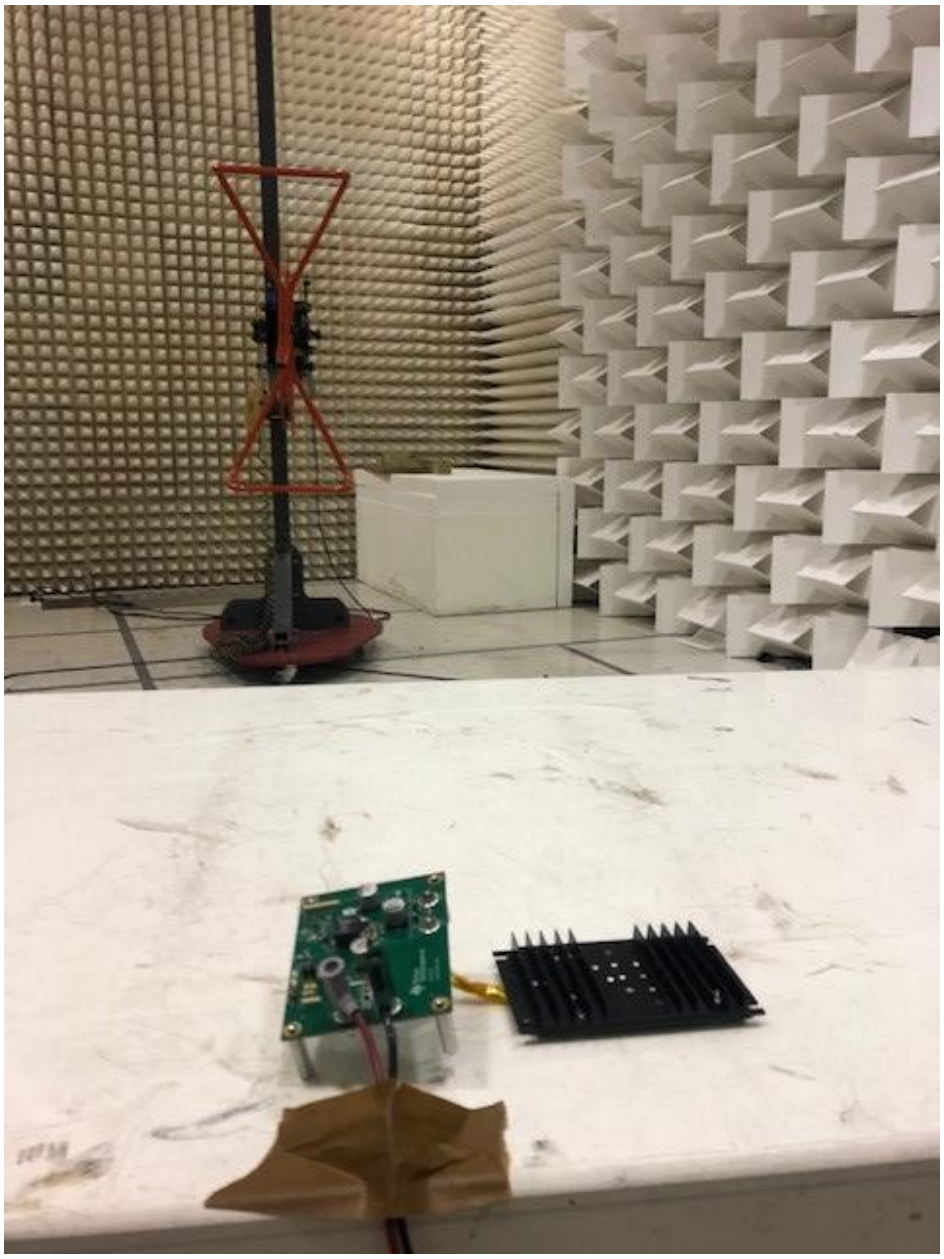


Figure 6-3 B Radiated Emissions Test Setup Back Heat Sink up, PCB Flat on Table

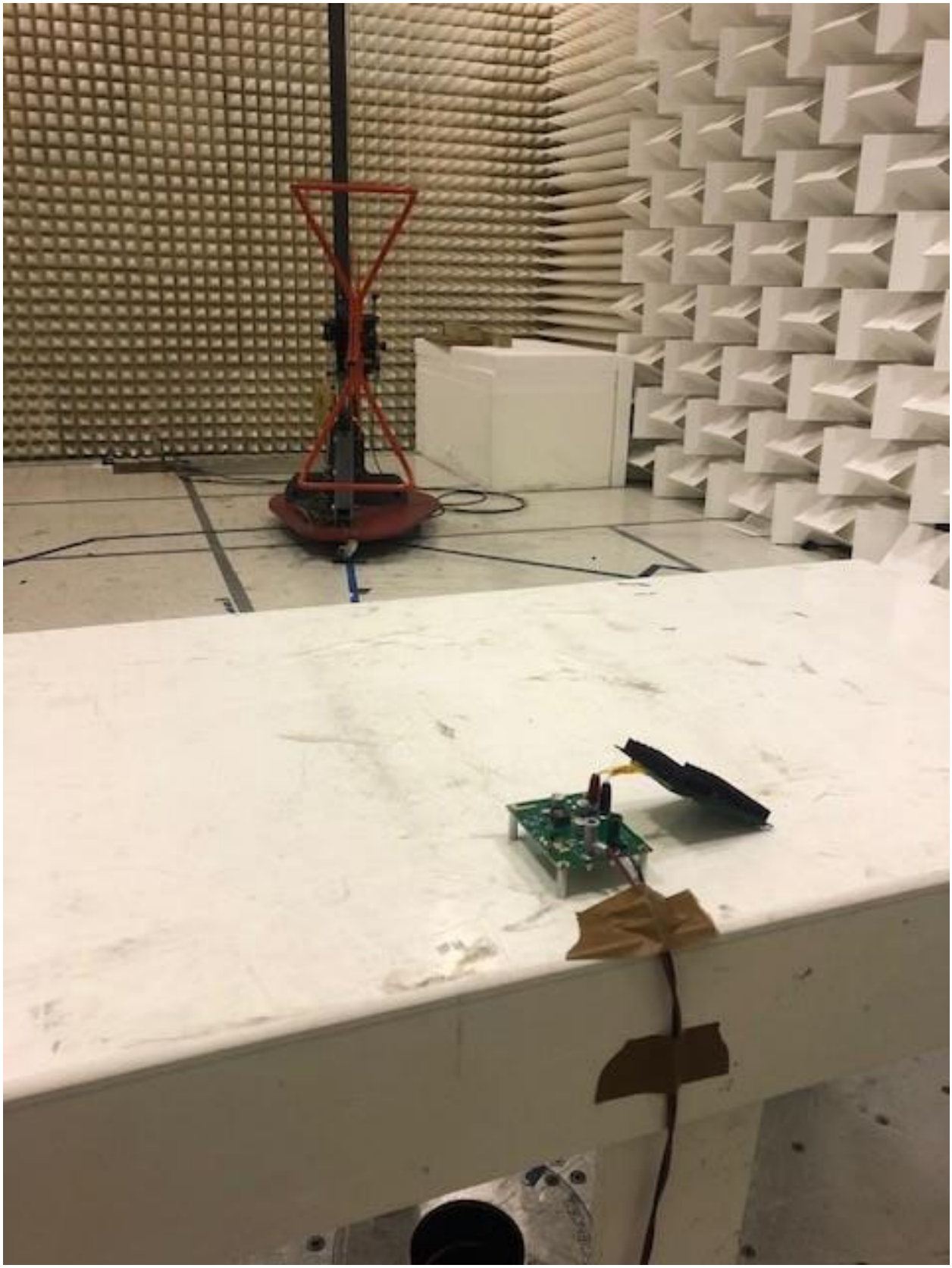


Figure 6-4 B Radiated Emissions Test Setup Back

6.5 Plots/Data:

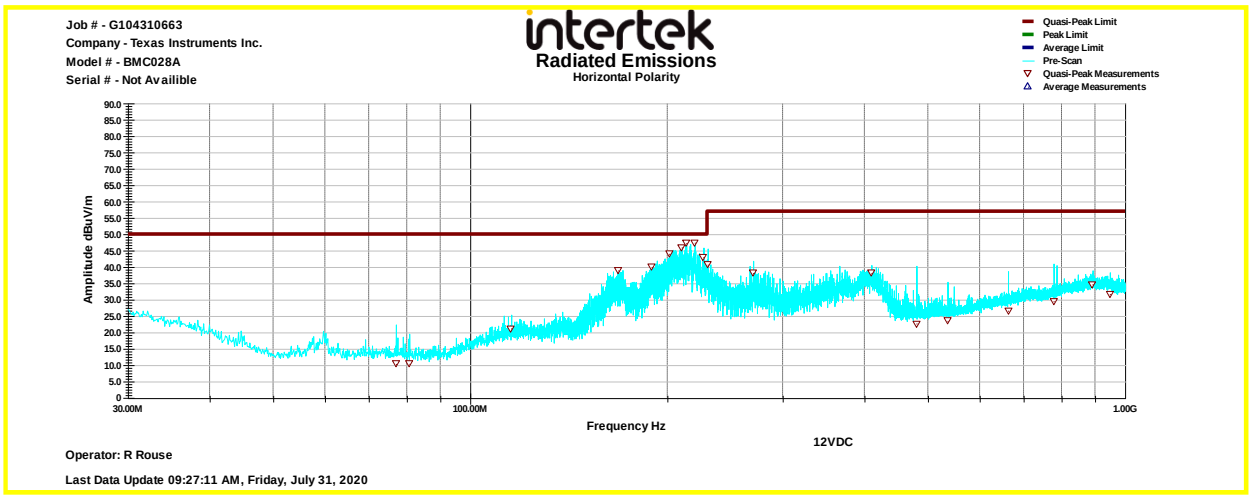


Figure 6-5 Horizonal Polarity

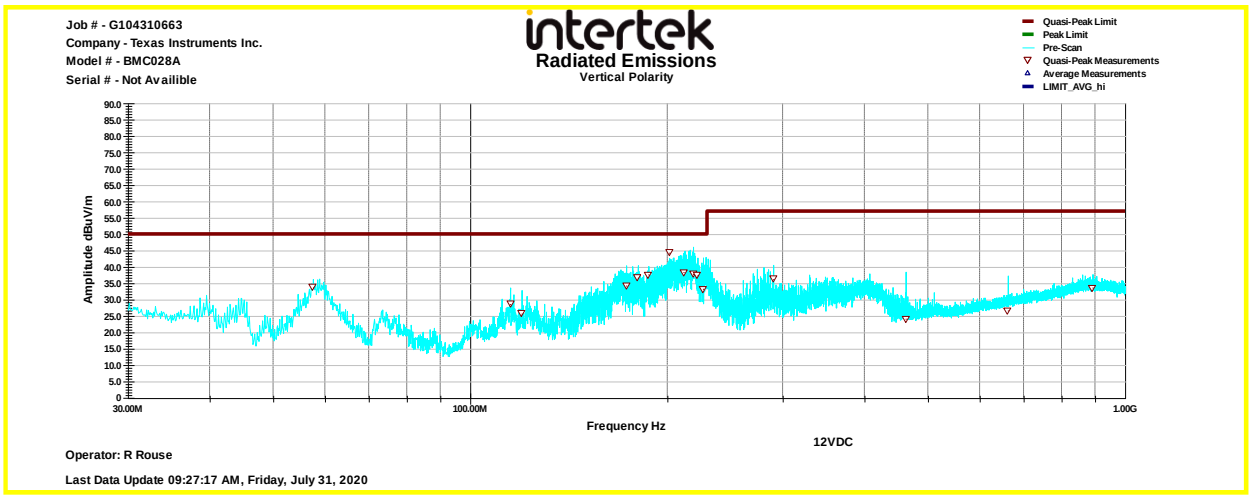


Figure 6-6 Vertical Polarity

Table 6-1 Horizontal Test Data

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
77.05	199	21	30.5	14.1	35.5	1.2	10.3	50	-39.7
80.75	163	252	30.7	13.9	35.5	1.3	10.4	50	-39.6
115.45	176	188	35.7	19.4	35.5	1.5	21.2	50	-28.8
168.31	166	205	54.3	18.2	35.4	1.9	38.9	50	-11.1
189.25	114	289	55.6	17.7	35.4	2	39.9	50	-10.1
201.31	100	299	58.3	19	35.4	2.1	44	50	-6
210.35	144	295	62	17.2	35.4	2.1	45.9	50	-4.1
213.75	140	304	63.3	17.2	35.4	2.2	47.2	50	-2.8
220.21	127	325	63	17.5	35.3	2.2	47.4	50	-2.6
227.05	100	322	58.4	17.7	35.4	2.2	43	50	-7
230.51	156	325	55.9	17.9	35.3	2.2	40.7	57	-16.3
270.41	126	154	51.1	19.8	35.3	2.4	38.1	57	-18.9
409.91	289	289	47.4	22.6	34.9	3	38.1	57	-18.9
480.25	216	9	30.1	24.1	34.7	3.3	22.7	57	-34.3
535.71	251	8	29.7	24.8	34.5	3.4	23.5	57	-33.5
662.65	397	9	29.9	26.5	33.5	3.8	26.6	57	-30.4
777.81	300	40	29.3	28	31.9	4.1	29.5	57	-27.5
892.15	386	154	32.3	29.4	31.3	4.4	34.7	57	-22.3
948.05	194	256	29.9	29.8	32.5	4.5	31.7	57	-25.3

Table 6-2 Vertical Test Data

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
57.54	160	106	54.3	13.9	35.5	1.1	33.7	50	-16.3
115.06	170	35	43.1	19.5	35.5	1.5	28.6	50	-21.4
119.81	150	112	39.9	19.7	35.5	1.6	25.7	50	-24.3
173	150	120	49.7	18.1	35.4	1.9	34.3	50	-15.7
180.25	157	118	52.8	17.3	35.4	2	36.6	50	-13.4
187.1	157	111	53.9	17.2	35.4	2	37.7	50	-12.3
201.32	157	106	58.9	18.8	35.4	2.1	44.3	50	-5.7
211.63	158	326	54.5	17.2	35.4	2.1	38.4	50	-11.6
218.91	250	281	53.5	17.5	35.3	2.2	37.8	50	-12.2
222.35	237	335	53	17.5	35.3	2.2	37.4	50	-12.6
226.65	232	329	48.7	17.7	35.4	2.2	33.3	50	-16.7
290.22	157	127	48.9	20	35.2	2.5	36.2	57	-20.8
462.26	174	139	32.2	23.5	34.8	3.2	24.1	57	-32.9
662.23	250	331	30	26.4	33.5	3.8	26.7	57	-30.3
891.75	151	178	32	28.6	31.3	4.4	33.6	57	-23.4

Test Personnel:	Reshar Rouse RJR	Test Date:	July 30, 2020
Supervising/Reviewing Engineer: (Where Applicable)		Limit Applied:	Group 1, Class A
Product Standard:	EN 61326-1	Ambient Temperature:	26.7ºC
Input Voltage:	230V 50Hz	Relative Humidity:	40.7%
Pretest Verification w/ Artifact:	N/A	Atmospheric Pressure:	933.0mbars

7 AC Mains Conducted Emissions

7.1 Method

Tests are performed in accordance with CISPR 11..

TEST SITE: Vertical Ground Reference Plane, 3m SAC

Site Designation: The Vertical Ground Reference Plane is Intertek built Vertical and Horizontal Planes greater than 2m X 2m.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	9 kHz - 150 kHz	3.43 dB	3.8dB
AC Line Conducted Emissions	150 kHz - 30 MHz	2.85 dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	1.92 dB	5.0dB
AC Line Conducted Emissions with a Current Probe	150 kHz - 30 MHz	1.8	2.9

As shown in the table above our conducted 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, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculations

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

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:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
4333	Ambient Data Logger	Extech Instruments	SD700	A.086409	4/24/2020	4/24/2021
3729	EMI Receiver Old Den-073 20 Hz 26 GHz	Rohde & Schwarz	ESU 26	100265	11/29/2020	11/29/2021
4240	LISN-LISN 9 kHz to 30 MHz 250 & 50 µH Inductors	Com Power	LI-220A	192056	2/14/2020	2/14/2021
3611	Transient Limiter	Hewlett-Packard	11947A	3107A01975	6/25/2020	6/25/2021
4427	Tape measure	Stanley	Power Lock 8m/26'	-	CNR	CNR
980	Generator/Site Source	Com-Power Corp	CGC-255	311172	CNR	CNR
4283	256 Low Loss RF Cable N Type	Maury Microwave	UC-N-MM-256	1741480	4/10/2020	4/10/2021

Software Utilized:

Conducted Emissions

Name	Manufacturer	Asset #	Version
Total Integrated Laboratory Environment	ETS-Lindgren	1330	6.0

Profile

Name	Manufacturer	Asset #	Version/Rev
Master Conducted Emissions	ETS-Lindgren	1330-001	Ver11 Rev12

7.2 Results:

The sample tested was found to Comply.

7.3 Setup Photographs:

Figure 7-1 Conducted Emissions Test Setup

7.1 Plots/Data:

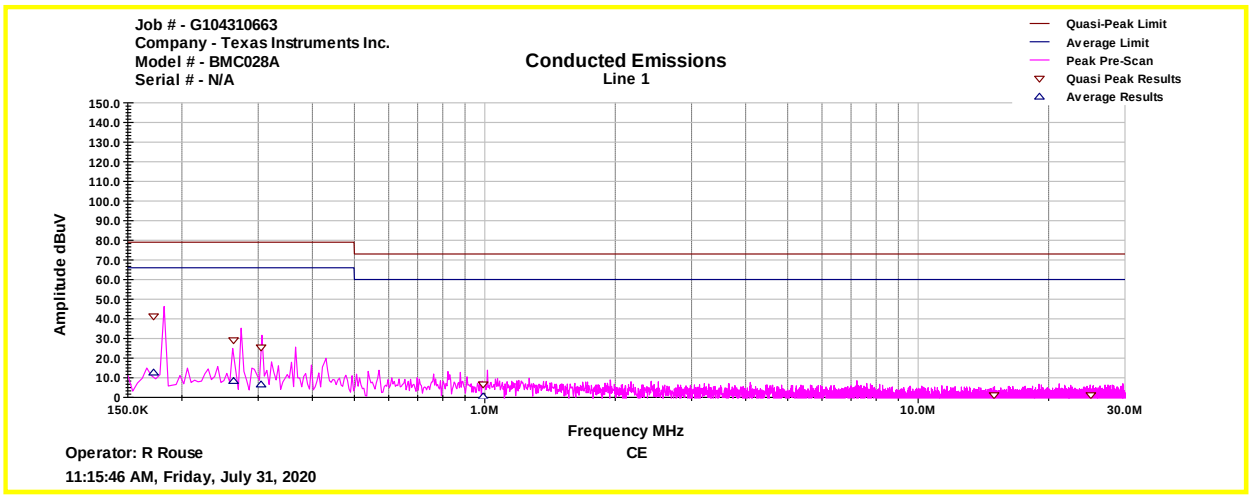


Figure 7-2 Conducted Emissions Line 1

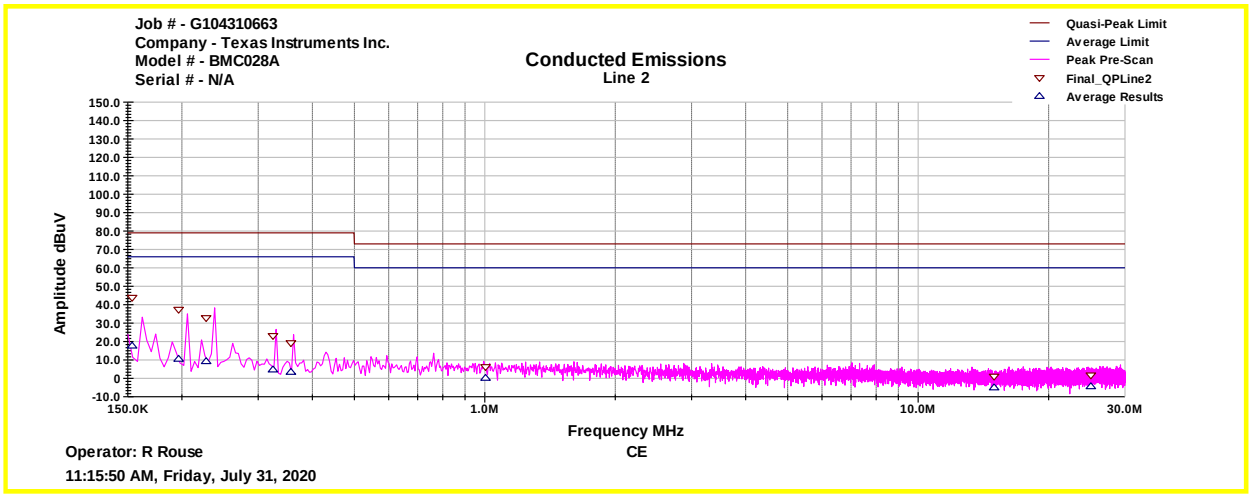


Figure 7-3 Conducted Emissions Line 2

Table 7-1 Conducted Emissions Line 1

Freq. MHz	QP Reading dBuV	Avg Reading dBuV	Cable Factor dB	Limiter Factor dB	Lisn Factor dB	Final QP Reading dBuV	Limit QP dBuV	Margin QP dB	Final Avg dBuV	Limit Avg dBuV	Margin Avg dB
0.17	30.294	2.028	0.208	9.950	0.695	41.147	79	-37.853	12.881	66	-53.119
0.26	18.281	-2.208	0.217	9.950	0.546	28.994	79	-50.006	8.505	66	-57.495
0.30	14.640	-4.050	0.221	9.950	0.513	25.324	79	-53.676	6.634	66	-59.366
0.99	-4.031	-10.042	0.248	9.960	0.360	6.536	73	-66.464	0.525	60	-59.475
15.00	-9.893	-15.462	0.310	10.010	0.440	0.867	73	-72.133	-4.702	60	-64.702
25.00	-9.822	-15.347	0.406	10.040	0.540	1.164	73	-71.836	-4.361	60	-64.361

Table 7-2 Conducted Emissions Line 2

Freq. MHz	QP Reading dBuV	Avg Reading dBuV	Cable Factor dB	Limiter Factor dB	Lisn Factor dB	Final QP Reading dBuV	Limit QP dBuV	Margin QP dB	Final Avg dBuV	Limit Avg dBuV	Margin Avg dB
0.15	32.599	6.77	0.21	9.950	0.74	43.498	79	-35.5	17.67	66	-48.33
0.20	26.223	0.02	0.21	9.950	0.65	37.032	79	-41.97	10.82	66	-55.18
0.23	21.727	-1.64	0.21	9.950	0.59	32.485	79	-46.52	9.11	66	-56.89
0.32	12.097	-6.07	0.22	9.953	0.50	22.767	79	-56.23	4.6	66	-61.4
0.36	8.126	-7.38	0.22	9.956	0.48	18.783	79	-60.22	3.28	66	-62.72
1.00	-4.736	-10.05	0.25	9.960	0.35	5.822	73	-67.18	0.51	60	-59.49
15.01	-9.736	-15.50	0.31	10.010	0.46	1.044	73	-71.96	-4.72	60	-64.72
25.00	-9.765	-15.23	0.41	10.040	0.63	1.311	73	-71.69	-4.15	60	-64.15

Test Personnel:	David Pflugrad DP	Test Date:	July 17, 2020
Supervising/Reviewing Engineer: (Where Applicable)	Rick Hill	Limit Applied:	Group 1, Class A
Product Standard:	EN 61326-1	Ambient Temperature:	25.9ºC
Input Voltage:	230V 50Hz	Relative Humidity:	42.4%
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	991.3mbars

Deviations, Additions, or Exclusions: None

8 Harmonics

8.1 Method

Tests are performed in accordance with EN 61000-3-3.

TEST SITE: Immunity Room

Measurement Uncertainty

Measurement	Parameter	Expanded Uncertainty (k=2)	Permitted Error
Harmonics	Current	1.0%	±5.0%

As shown in the table above our Expanded Measurement Uncertainty for harmonic current U_{lab} is less than the corresponding measurement error allowed by IEC61000-3-2 and IEC61000-4-7, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required. There are currently no U_{CISPR} reference values in CISPR 16 for Harmonics.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
4333	Ambient Data Logger	Extech Instruments	SD700	A.086409	4/24/2020	4/24/2021
1496	Power Analyzer	Ametek	OMNI 3-37i PACS-3/CTS	1247A02352 1247A02352	CNR	CNR

Software Utilized:

Name	Manufacturer	Version
CTSMXL2	California Instruments Corp.	2.13.1

8.3 Results:

The sample tested was found to Comply.

8.4 Setup Photographs:

Figure 8-1 AC Line Harmonic Current Emissions Test Setup

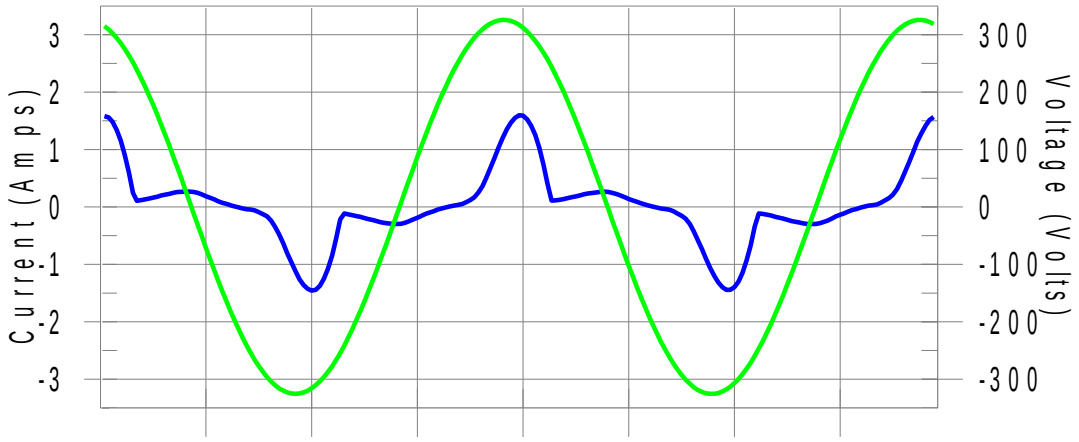
8.5 Plots/Data:

Harmonics – Class-A per Ed. 5.0 (2018)(Run time)

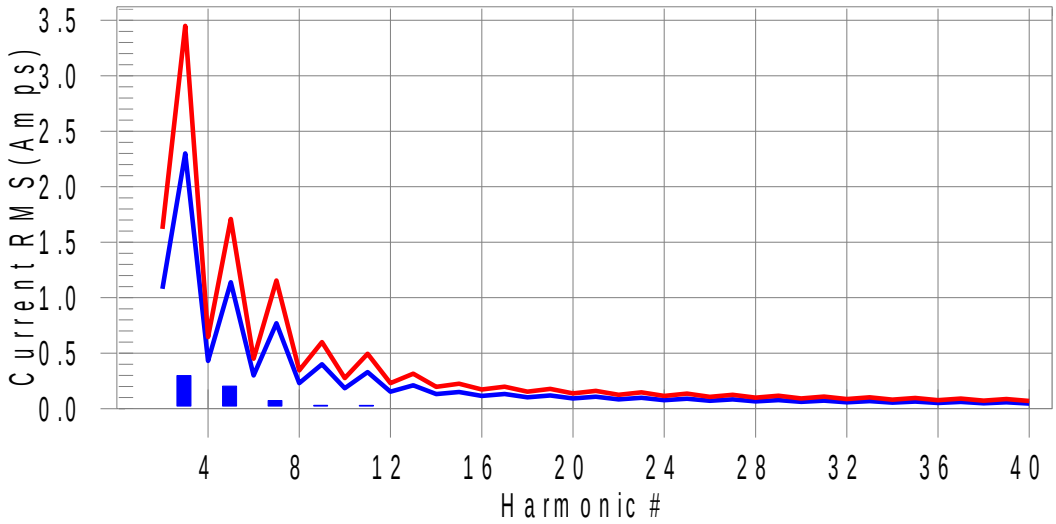
EUT: LM5155EVM-BST **Tested by: R Rouse**
Test category: Class-A per Ed. 5.0 (2018) (European limits) **Test Margin: 100**
Test date: 7/16/2020 **Start time: 11:26:38 PM** **End time: 11:36:51 PM**
Test duration (min): 10 **Data file name: CTSMXL_H-000193.cts_data**
Comment: 230V 50Hz
Customer: Texas Instruments Inc.

Test Result: Pass **Source qualification: Normal**

Current & voltage waveforms



Harmonics and Class A limit line **European Limits**



Test result: Pass Worst harmonics H5-12.2% of 150% limit, H5-17.9% of 100% limit.

Current Test Result Summary (Run time)

EUT: LM5155EVM-BST **Tested by: R Rouse**
Test category: Class-A per Ed. 5.0 (2018) (European limits) **Test Margin: 100**
Test date: 7/16/2020 **Start time: 11:26:38 PM** **End time: 11:36:51 PM**
Test duration (min): 10 **Data file name: CTSMXL_H-000193.cts_data**
Comment: 230V 50Hz
Customer: Texas Instruments Inc.

Test Result: Pass **Source qualification: Normal**
THC(A): 0.373 **I-THD(%): 69.8** **POHC(A): 0.012** **POHC Limit(A): 0.251**

Highest parameter values during test:

V_RMS (Volts):	**230.391**	**Frequency(Hz):**	**50.00**
I_Peak (Amps):	**1.602**	**I_RMS (Amps):**	**0.657**
I_Fund (Amps):	**0.535**	**Crest Factor:**	**2.460**
Power (Watts):	**114.7**	**Power Factor:**	**0.769**

Harm#	Harms(avg)	100%Limit	%of Limit	Harms(max)	150%Limit	%of Limit	Status
2	0.017	1.080	1.6	0.027	1.620	1.7	Pass
3	0.298	2.300	13.0	0.302	3.450	8.7	Pass
4	0.009	0.430	2.1	0.011	0.645	1.6	Pass
5	0.204	1.140	17.9	0.208	1.710	12.2	Pass
6	0.003	0.300	N/A	0.004	0.450	N/A	Pass
7	0.073	0.770	9.5	0.075	1.155	6.5	Pass
8	0.003	0.230	N/A	0.004	0.345	N/A	Pass
9	0.031	0.400	7.7	0.032	0.600	5.3	Pass
10	0.002	0.184	N/A	0.003	0.276	N/A	Pass
11	0.028	0.330	8.6	0.029	0.495	5.9	Pass
12	0.001	0.153	N/A	0.002	0.230	N/A	Pass
13	0.019	0.210	9.1	0.020	0.315	6.4	Pass
14	0.002	0.131	N/A	0.002	0.197	N/A	Pass
15	0.011	0.150	7.5	0.012	0.225	5.4	Pass
16	0.001	0.115	N/A	0.002	0.173	N/A	Pass
17	0.012	0.132	8.8	0.013	0.198	6.4	Pass
18	0.001	0.102	N/A	0.001	0.153	N/A	Pass
19	0.008	0.118	6.9	0.009	0.178	4.9	Pass
20	0.001	0.092	N/A	0.001	0.138	N/A	Pass
21	0.006	0.107	5.6	0.007	0.161	4.1	Pass
22	0.001	0.084	N/A	0.001	0.125	N/A	Pass
23	0.006	0.098	6.5	0.007	0.147	4.5	Pass
24	0.001	0.077	N/A	0.001	0.115	N/A	Pass
25	0.004	0.090	N/A	0.004	0.135	N/A	Pass
26	0.001	0.071	N/A	0.001	0.107	N/A	Pass
27	0.004	0.083	N/A	0.005	0.125	N/A	Pass
28	0.001	0.066	N/A	0.001	0.099	N/A	Pass
29	0.003	0.078	N/A	0.004	0.116	N/A	Pass
30	0.001	0.061	N/A	0.001	0.092	N/A	Pass
31	0.003	0.073	N/A	0.003	0.109	N/A	Pass
32	0.001	0.058	N/A	0.001	0.086	N/A	Pass
33	0.003	0.068	N/A	0.003	0.102	N/A	Pass
34	0.001	0.054	N/A	0.001	0.081	N/A	Pass
35	0.002	0.064	N/A	0.003	0.096	N/A	Pass
36	0.001	0.051	N/A	0.001	0.077	N/A	Pass
37	0.002	0.061	N/A	0.002	0.091	N/A	Pass
38	0.001	0.048	N/A	0.001	0.073	N/A	Pass
39	0.002	0.058	N/A	0.002	0.087	N/A	Pass
40	0.000	0.046	N/A	0.001	0.069	N/A	Pass

Voltage Source Verification Data (Run time)

EUT: LM5155EVM-BST **Tested by: R Rouse**
Test category: Class-A per Ed. 5.0 (2018) (European limits) **Test Margin: 100**
Test date: 7/16/2020 **Start time: 11:26:38 PM** **End time: 11:36:51 PM**
Test duration (min): 10 **Data file name: CTSMXL_H-000193.cts_data**
Comment: 230V 50Hz
Customer: Texas Instruments Inc.

Test Result: Pass **Source qualification: Normal**
Measured source distortion is within the requirements of the standards
Measurements are compliant with IEC/EN61000-3-2 Ed. 5 & IEC/EN61000-4-7 Ed. 2.1

Highest parameter values during test:

Voltage (Vrms):	**230.391**	**Frequency(Hz):**	**50.00**
I_Peak (Amps):	**1.602**	**I_RMS (Amps):**	**0.657**
I_Fund (Amps):	**0.535**	**Crest Factor:**	**2.460**
Power (Watts):	**114.7**	**Power Factor:**	**0.769**

Harm#	Harmonics V-rms	Limit V-rms	% of Limit	Status
2	0.097	0.461	21.07	OK
3	0.049	2.073	2.34	OK
4	0.014	0.461	2.94	OK
5	0.053	0.921	5.72	OK
6	0.029	0.461	6.30	OK
7	0.063	0.691	9.13	OK
8	0.010	0.461	2.15	OK
9	0.018	0.461	3.80	OK
10	0.011	0.461	2.41	OK
11	0.031	0.230	13.61	OK
12	0.011	0.230	4.78	OK
13	0.027	0.230	11.59	OK
14	0.008	0.230	3.62	OK
15	0.025	0.230	10.89	OK
16	0.008	0.230	3.37	OK
17	0.021	0.230	9.04	OK
18	0.012	0.230	5.12	OK
19	0.022	0.230	9.70	OK
20	0.013	0.230	5.75	OK
21	0.018	0.230	8.00	OK
22	0.009	0.230	3.73	OK
23	0.013	0.230	5.85	OK
24	0.009	0.230	4.00	OK
25	0.015	0.230	6.35	OK
26	0.009	0.230	3.82	OK
27	0.015	0.230	6.41	OK
28	0.008	0.230	3.42	OK
29	0.014	0.230	6.02	OK
30	0.011	0.230	4.78	OK
31	0.011	0.230	4.67	OK
32	0.007	0.230	3.21	OK
33	0.009	0.230	3.88	OK
34	0.008	0.230	3.29	OK
35	0.011	0.230	4.92	OK
36	0.008	0.230	3.43	OK
37	0.012	0.230	5.25	OK
38	0.008	0.230	3.28	OK
39	0.013	0.230	5.74	OK
40	0.011	0.230	4.80	OK

Test Personnel:	Reshar Rouse RJR	Test Date:	July 17, 2020
Supervising/Reviewing Engineer: (Where Applicable)		Limit Applied:	Class A
Product Standard:	EN 61000-3-3	Ambient Temperature:	26.7ºC
Input Voltage:	230V 50Hz	Relative Humidity:	40.7%
Pretest Verification w/ Artifact:	N/A	Atmospheric Pressure:	933.0mbars

Deviations, Additions, or Exclusions: None

9 Flicker

9.1 Method

Tests are performed in accordance with EN 61000-3-3.

TEST SITE: Immunity Room

Measurement Uncertainty

Measurement	Parameter	Expanded Uncertainty (k=2)	Permitted Error
Flicker	Pst	0.4 %	±8.0%
Flicker	dc	0.4%	±8.0%

As shown in the table above our Expanded Measurement Uncertainty for Pst and dc U_{lab} is less than the corresponding measurement error allowed by IEC 61000-3-3, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required. There are currently no U_{CISPR} reference values in CISPR 16 for Flicker.

9.2 Test Equipment Used:

Software Utilized:

Name	Manufacturer	Version
CTSMXL2	California Instruments Corp.	2.13.1

9.3 Results:

The sample tested was found to Comply.

9.4 Setup Photographs:

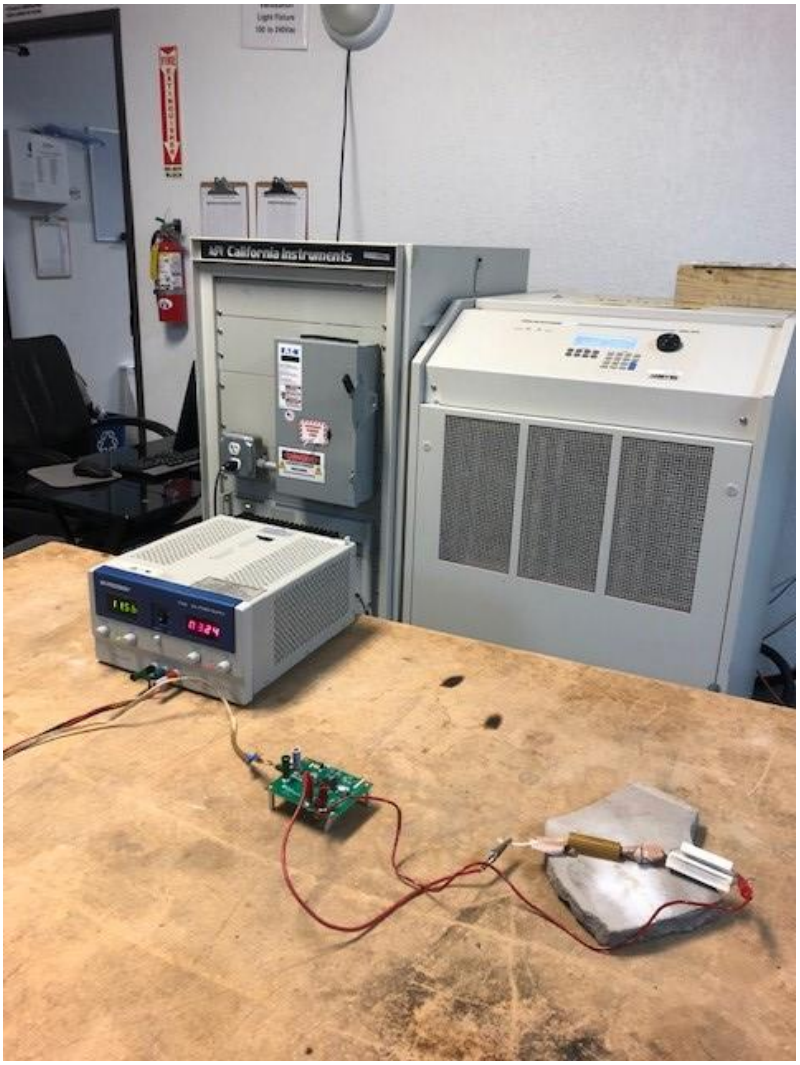


Figure 9-1 AC Line Voltage Flicker and Fluctuations Test Setup

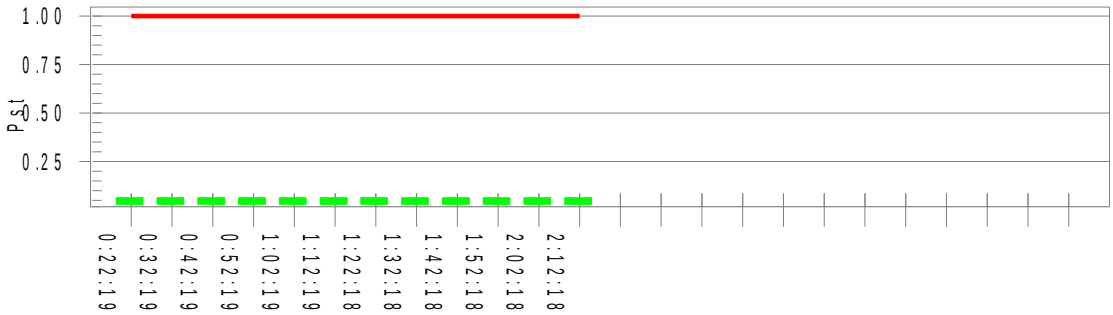
9.5 Plots/Data:

Flicker Test Summary per EN 61000-3-3 Ed. 3.0 (2013) (Run time)

EUT: LM5155EVM-BST **Tested by: R Rouse**
Test category: All parameters (European limits) **Test Margin: 100**
Test date: 7/17/2020 **Start time: 12:11:58 AM** **End time: 2:13:31 AM**
Test duration (min): 120 **Data file name: CTSMXL_F-000195.cts_data**
Comment: 230V 50Hz
Customer: Texas Instruments Inc.

Test Result: Pass **Status: Test Completed**

Pst_i and limit line **European Limits**



Plt and limit line

Parameter values recorded during the test:

Vrms at the end of test (Volt):	**230.13**			
T-max (mS):	**0.0**	**Test limit (mS):**	**500.0**	**Pass**
Highest dc (%):	**0.00**	**Test limit (%):**	**3.30**	**Pass**
Highest dmax (%):	**-0.07**	**Test limit (%):**	**4.00**	**Pass**
Highest Pst (10 min. period):	**0.064**	**Test limit:**	**1.000**	**Pass**
Highest Plt (2 hr. period):	**0.064**	**Test limit:**	**0.650**	**Pass**

Test Personnel:	Reshar Rouse RJR	Test Date:	July 17, 2020
Supervising/Reviewing Engineer: (Where Applicable)		Limit Applied:	European
Product Standard:	EN 61000-3-3		
Input Voltage:	230V 50Hz	Ambient Temperature:	26.4ºC
		Relative Humidity:	40.8%
Pretest Verification w/ Artifact:	Yes	Atmospheric Pressure:	933.0mbars

Deviations, Additions, or Exclusions: None

10 Radiated, radio-frequency, electromagnetic field immunity test

10.1 Method

Tests are performed in accordance with EN 61000-4-3.
TEST SITE: Compact Chamber.

Site Designation: The Compact Chamber is a Braden Shielding Systems 3meter Semi Anechoic Chamber for performing a 16 point calibrated field immunity test.

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
569	Signal Generator	Rohde & Schwarz	SMR20	101111	1/8/2020	1/8/2021
4743	RF Power meter	Boonton	4541	14364	10/14/2019	10/14/2020
4199	RF Cable	Maury Microwave	UC-N-MM-78	1728116	4/14/2020	4/14/2021
4200	RF Cable	Maury Microwave	UC-N-MM-276	1741482	10/14/2019	10/13/2020
3613	Directional Coupler 2	Werlatone	C5982	10385	8/26/2019	8/25/2020
1075	Bi-Directional Coupler	Werlatone	C8000-102	2426	8/25/2019	8/25/2020
207	Antenna	Amplifier Research	AT5080	306847	10/9/2019	10/9/2020
271	Double Ridge Guide	A H Systems	SAS-571	787	CBU	CBU
4286	Power Amplifier	Com Power	ARI-6000-100W	1005	CNR	CNR
3555	RF Amplifier	Amplifier Research	200W1000M7A	16049	CNR	CNR
4333	Ambient Data Logger	Extech Instruments	SD700	A.086409	4/24/2020	4/24/2021

Software Utilized:

Name	Manufacturer	Asset #	Version
Total Integrated Laboratory Environment	ETS-Lindgren	1330	6.0

Profile

Name	Manufacturer	Asset #	Version/Rev
Master Radiated Immunity	ETS-Lindgren	1330-005	11/7

10.1 Results:

The sample tested was found to Comply.

10.2 Setup Photographs:

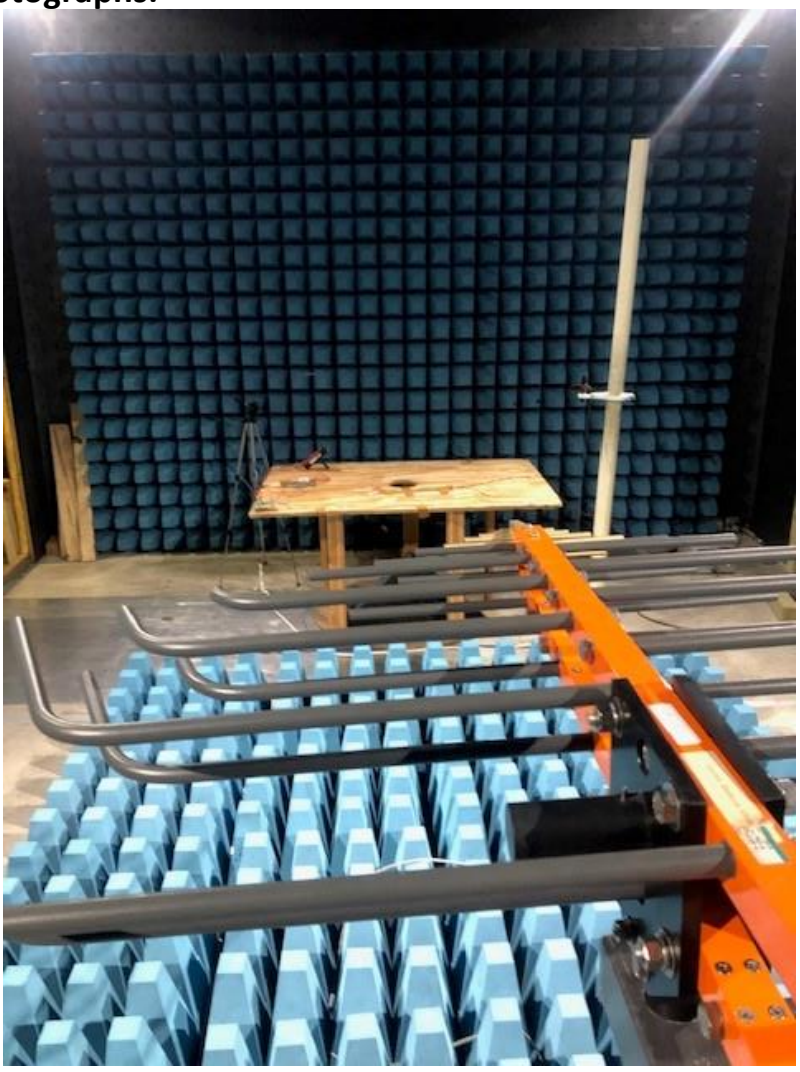


Figure 10-1 Radiated Immunity 80MHz to 1GHz Test Setup

Figure 10-2 Radiated Immunity 1.4GHz to 2.7GHz Test Setup

10.3 Data:

Field Level (V/m)	Frequency Range MHz	Antenna Polarity, Azimuths and Result Classification							
		Vertical				Horizontal			
		0	90	180	270	0	90	180	270
3	80-1000	A	A	A	A	A	A	A	A
3	1400-2000	A	A	A	A	A	A	A	A
1	2000-2700	A	A	A	A	A	A	A	A

Test Personnel:	Reshar Rouse RJR	Test Date:	July 17, 2020
Supervising/Reviewing Engineer: (Where Applicable)		Modulation::	1 kHz
		Required Performance:	A
Product Standard:	EN 61326-1	Test Levels:	See Table Above
		Ambient Temperature:	32.1ºC
Input Voltage:	12VDC	Relative Humidity:	34.6%
Field Level Monitored:	Yes	Atmospheric Pressure:	992.4mbars

Notes:

(A) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

11 Power Frequency Magnetic Field Immunity Test

11.1 Method

Tests are performed in accordance with EN 61000-4-8.

TEST SITE: Vertical Ground Reference Plane

Site Designation: The Vertical Ground Reference Plane is Intertek built Vertical and Horizontal Planes greater than 2m X 2m.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
4333	Ambient Data Logger	Extech Instruments	SD700	A.086409	4/24/2020	4/24/2021
4525	Magnetic Immunity Test System	Com Power	APT-5060	506002	CNR	CNR

Software Utilized:

Name	Manufacturer	Version
None		

11.3 Results:

The sample tested was found to Comply.

11.4 Setup Photographs:

Figure 11-1 Power Frequency Magnetic Field Immunity Test Setup

11.5 Test Data:

Test Location/ Mode/ EUT AC Input	Test Level (A/m)	Frequency (Hz)	Result Classification		
			X – Axis	Y – Axis	Z – Axis
The EVM energized and putting out nominal output voltage (24VDC)./50Hz	3	50	A	A	A
The EVM energized and putting out nominal output voltage (24VDC)./60Hz	3	60	A	A	A

Test Personnel:	Reshar Rouse RJR	Test Date:	July 21, 2020
Supervising/Reviewing Engineer: (Where Applicable)		Required Performance:	A
Product Standard:	EN 61326-1	Test Levels:	See Table Above
Input Voltage:	12DC	Ambient Temperature:	22.6ºC
		Relative Humidity:	45.6%
		Atmospheric Pressure:	989.1mbars

Notes:

(A) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

12 TCF TEST PLAN

G104310663
Written By: Reshar Rouse
Date: 30 July 2020

12.1 CLIENT

Texas Instruments, c/o Youhao Xi
15210 S. 50th Street, Suite 120 Phoenix, AZ 85044
480-629-2487 (o); 480-335-8048 (m)

youhao.xi@ti.com

12.1 EQUIPMENT UNDER TEST

Type Boost DC-DC converter module

BMC028A

Input: 9-18V, Typical 12V; Output: 24V; Load current: 2A; Operating Frequency: 440kHz;

12.2 Configuration of EUT during testing

12.2.1 Composition of EUT

LM5155EVM-BST board, 440kHz

12.2.2 Assembly of EUT

Two ports: Input port and output. Input put sees 12V source, and output goes to 12 Ohm load (2A).

12.2.3 5.2.4 I/O ports

N/A

12.2.4 Auxiliary equipment

N/A.

Bout input and output port returns can be grounded to earth.

12.3 Operation conditions of EUT during testing

12.3.1 Operation modes

Vin=12V,
Load = 12Ohm.

12.3.2 Environmental conditions

Vin range: 9V to 18V, typical 12V.

12.3.3 EUT software during test

N/A

Load=12Ohm or 2A.

MALFUNCTION CRITERIA

A: The EUT shall not have the following malfunctions during the test event: Communication and/or EUT display loss.

Sing of Failures:

- **Output voltage not regulated at 24V +/-**5%.
- **Input current drawn from the 12V source supply is >**5A

B: The EUT has overload protection, and the output voltage may drop to the input voltage level. (normal operation: 12Vin, 24Vout)

C:
Yes

12.3.4 Test description

The following standards, with their relevant amendments, shall be used for guidance:

EN 61326-1:2013 - Radio disturbance characteristics for laboratory test and measurement equipment
- EN 61000-4-2: - Electrostatic Discharge Immunity – not applicable*1
- EN 61000-4-3: - Radiated Electromagnetic Field Immunity
- EN 61000-4-4: - Electrical Fast Transient Immunity – not applicable*2
- EN 61000-4-5: - Surge Immunity– not applicable*2
- EN 61000-4-6: - Conducted Disturbances RF Immunity– not applicable*2
- EN 61000-4-8: - Magnetic Field Immunity
- EN 61000-4-11: - Voltage dips and Interruptions– not applicable*2
- EN 61000-3-2: - Harmonics
- EN 61000-3-3: - Flicker

*Justifications for Basic Tests removed from this evaluation:
Note 1: The EUT is an electrostatically sensitive device and will be marked accordingly by the manufacturer which will require the user to use the proper ESD precautions as stated by the user's manual.
Note 2: The EUT does not connect directly to the public mains as it is a 5 VDC regulated to 2.2V – 3.6 VDC product. The DC power cable is treated as an I/O line which is less than 3m in length.

Basic Standards that apply to this evaluation:
Basic Electromagnetic Environment

Test Standard	Test Level	Performance Criteria
EN 61326-1:2013	**Group 1 Class B**	**Emissions below specified limit**
EN 61000-4-3:	**3V/M, 80 – 1000MHz** **3V/M, 1.4 – 2GHz** **1V/M, 2 – 2.7GHz** **w/1kHz, 80% AM**	**A**
EN 61000-4-8:	**3A/m 50/60Hz**	**A**
EN 61000-3-2:	**Class A Limits**	**Within Specified Limits**
EN 61000-3-3:	**4%**	**Within Specified Limits**

13 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	31-July-2020	104310663DAL-001	RJR	WBC	Original Issue