Application Report
SLVA702A–May 2015–Revised June 2015

CISPR25 Radiated Emissions Using TPS65320-Q1

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ABSTRACT

This report provides a summary of CISPR25 Radiated Emissions test results using the TPS65320-Q1 (version TPS65320BQPWPRQ1).

Contents

List of Figures

List of Tables

1 Schematics and Printed Circuit Board (PCB) Description

HVAL102 is the subject board designed for EMC required by automotive specification CISPR25. HVAL102 Rev A PCB was used for all testing.

1.1 Schematic and Bill of Materials for HVL102 Rev E

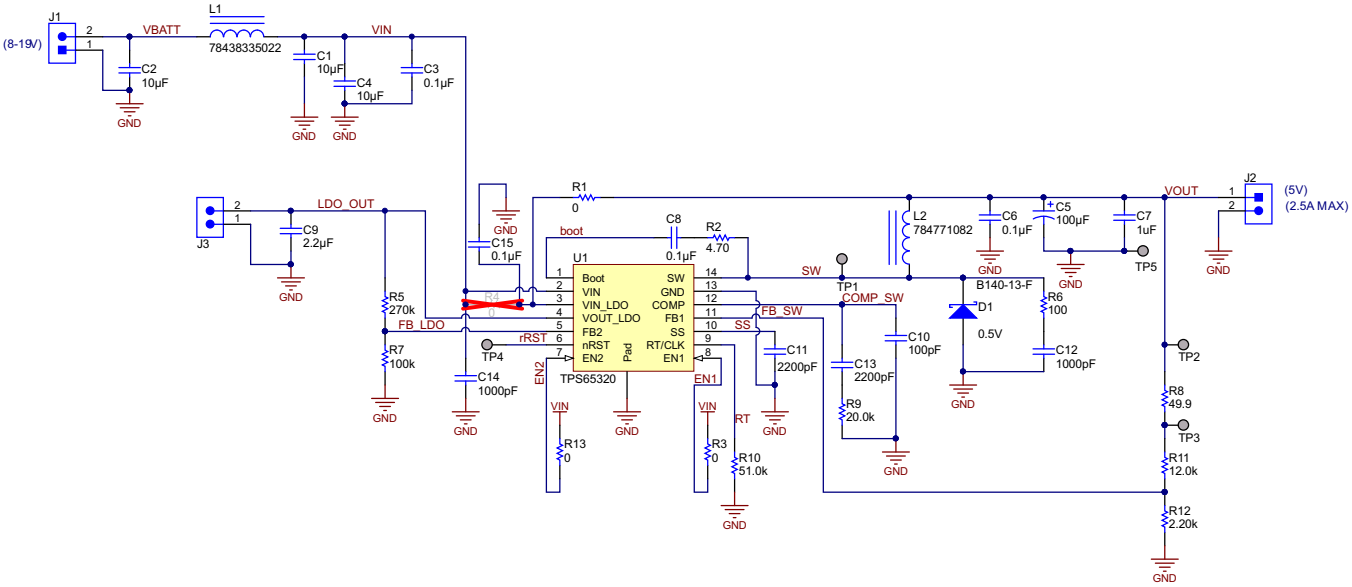

Table 1. Bill of Materials for HVL102

Designator	Qty.	Value	Description	Package	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		HVL102	Any
C1, C2, C4	3	10 µF	CAP, CERM, 10 µF, 35 V, ±10%, X7R, 1210	1210	GRM32ER7YA106KA12L	Murata
C3, C6, C8, C15	4	0.1 µF	CAP, CERM, 0.1 µF, 16 V, ±5%, X7R, 0603	603	0603YC104JAT2A	AVX
C5	1	100 µF	CAP, TANT, 100 µF, 6.3 V, ±10%, 1.7 Ω, 3528-21 SMD	3528-21	293D107X96R3B2TE3	Vishay-Sprague
C7	1	4.7 µF	CAP, CERM, 4.7 µF, 10 V, ±10%, X5R, 0805	805	0805ZD475KAT2A	AVX
C9	1	2.2 µF	CAP, CERM, 2.2 µF, 10 V, ±10%, X5R, 0603	603	GRM188R61A225KE34D	Murata
C10	1	100 pF	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0402	402	CC0402JRNPO9BN101	Yageo America
C11, C13	2	2200 pF	CAP, CERM, 2200 pF, 50 V, ±10%, X7R, 0402	402	GRM155R71H222KA01D	Murata
C12	1	1000 pF	CAP, CERM, 1000 pF, 100 V, ±20%, X7R, 0603	603	06031C102MAT2A	AVX
C14	1	1000 pF	CAP, CERM, 1000 pF, 100 V, ±10%, X7R, 0603	603	06031C102KAT2A	AVX
D1	1	0.5 V	Diode, Schottky, 40 V, 1 A, SMA	SMA	B140-13-F	Diodes Inc.
FID1–FID6	6		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
J1, J2	2		Terminal Block, 6 A, 3.5-mm Pitch, 2-Pos, TH	7×8.2×6.5 mm	ED555/2DS	On-Shore Technology
J3	1		Header, TH, 100 mil, 2×1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	TSW-102-07-G-S	Samtec, Inc.
L1	1	2.2 µH	Inductor, 2.2 µH, 1.8 A, 0.094 Ω, SMD	SMD, 2-Leads, Body 3×3 mm	78438335022	Wurth Elektronik eiSos
L2	1	8.2 µH	Inductor, Shielded, Metal Composite, 8.2 µH, 5.05 A, 0.02 Ω, SMD	SMD, 2-Leads, Body 12×12 mm	784771082	Wurth Elektronik eiSos
LBL1	1		Thermal Transfer Printable Labels, 0.650" W × 0.200" H - 10,000 per roll	PCB Label 0.650"H × 0.200"W	THT-14-423-10	Brady
R1, R3, R13	3	0 Ω	RES, 0 Ω, 5%, 0.1 W, 0603	603	CRCW06030000Z0EA	Vishay-Dale
R2	1	4.7 Ω	RES, 4.7 Ω, 0.5%, 0.1 W, 0603	603	RT0603DRE074R7L	Yageo America
R5	1	270 kΩ	RES, 316 kΩ, 1%, 0.063W, 0402	402	CRCW0402316KFKED	Vishay-Dale
R6	1	100 Ω	RES, 100 Ω, 1%, 0.1 W, 0603	603	CRCW0603100RFKEA	Vishay-Dale
R7	1	100 kΩ	RES, 100 kΩ, 1%,	402	CRCW0402100KFKED	Vishay-Dale
R8	1	49.9 Ω	RES, 49.9 Ω, 1%, 0.1 W, 0603	603	CRCW060349R9FKEA	Vishay-Dale
R9	1	20 kΩ	RES, 20 kΩ, 1%, 0.063W, 0402	402	CRCW040220K0FKED	Vishay-Dale
R10	1	51 kΩ	RES, 51 kΩ, 1%, 0.1 W, 0603	603	RC0603FR-0751KL	Yageo America
R11	1	12 kΩ	RES, 12 kΩ, 1%, 0.1 W, 0603	603	RC0603FR-0712KL	Yageo America
R12	1	2.2 kΩ	RES, 2.2 kΩ, 1%, 0.1 W, 0603	603	RC0603FR-072K2L	Yageo America

Table 1. Bill of Materials for HVL102 (continued)

Designator	Qty.	Value	Description	Package	Part Number	Manufacturer
TP5	1		PCB Pin, TH	PCB Pin (3125-2)	3125-2-00-34-00-00-08-0	Mill-Max
U1	1		TPS65320		TPS65320-Q1	TI
R4	0	0 Ω	RES, 0 Ω, 5%, 0.1 W, 0603	603	CRCW06030000Z0EA	Vishay-Dale

1.2 PCB Layout

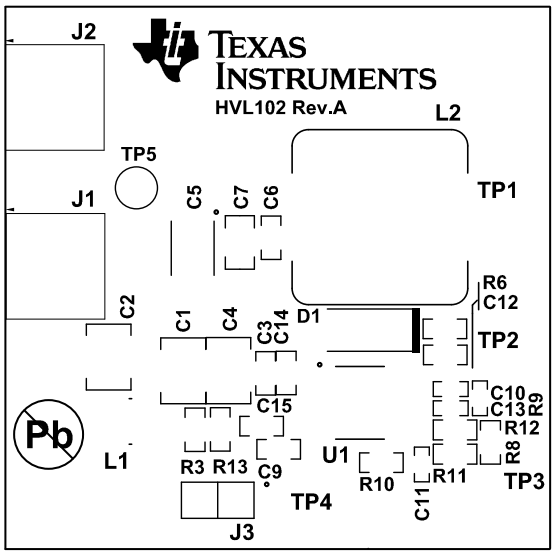

Figure 1. Top Silkscreen

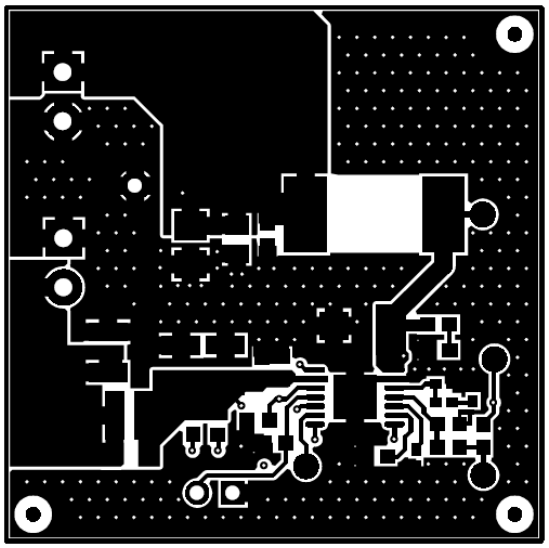

Figure 2. Top Layer Routing

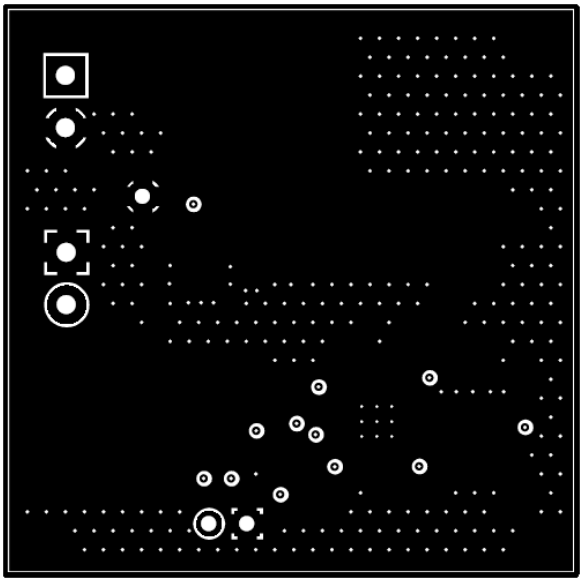

Figure 3. Layer 2, Ground Plane

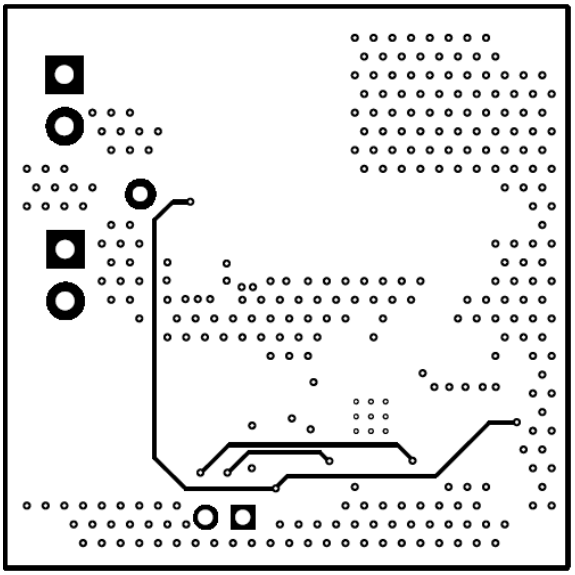

Figure 4. Layer 3 Routing

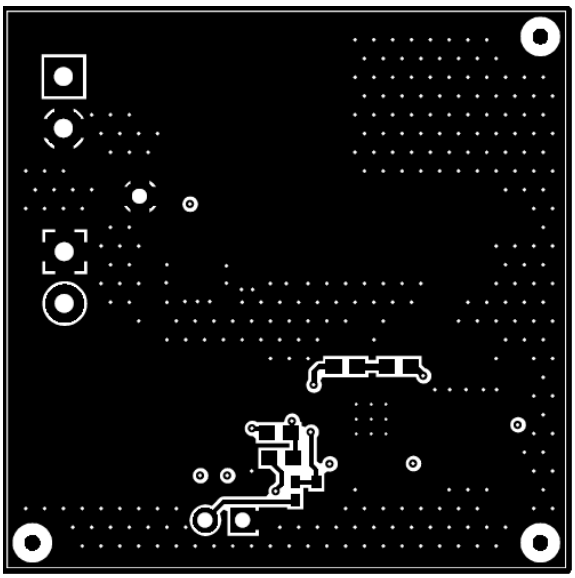

Figure 5. Bottom Layer

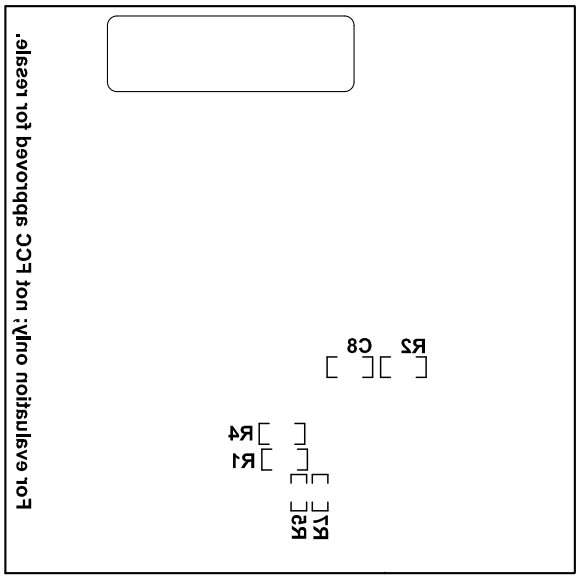

Figure 6. Bottom Layer Silkscreen

2 Description and Setup for Radiated Emissions Measurements

HVL102 revision A was used for all radiated emissions testing.

Setup conditions and test results are described in Section 2.1 and Section 2.2.

2.1 Setup Conditions

- Device under test (DUT): HVL102 revision A, using TPS65320BQPWPRQ1
- Input voltage: Car battery, (BAT+) = 12 V, (BAT–) = GND
- Switching frequency: Fsw = 2 MHz
- Output voltage: VOUT = 5 V
- Load current: IOUT = 2 A
- CISPR25 LISNs placed between BAT+/BAT– and wire harness
- Length of wire harness (BAT+/BAT–) = 1.7 m
- Wire harness and DUT placed on 50 mm of insulation with respect to test table

2.2 Photo of Test Setup and Result for Monopole

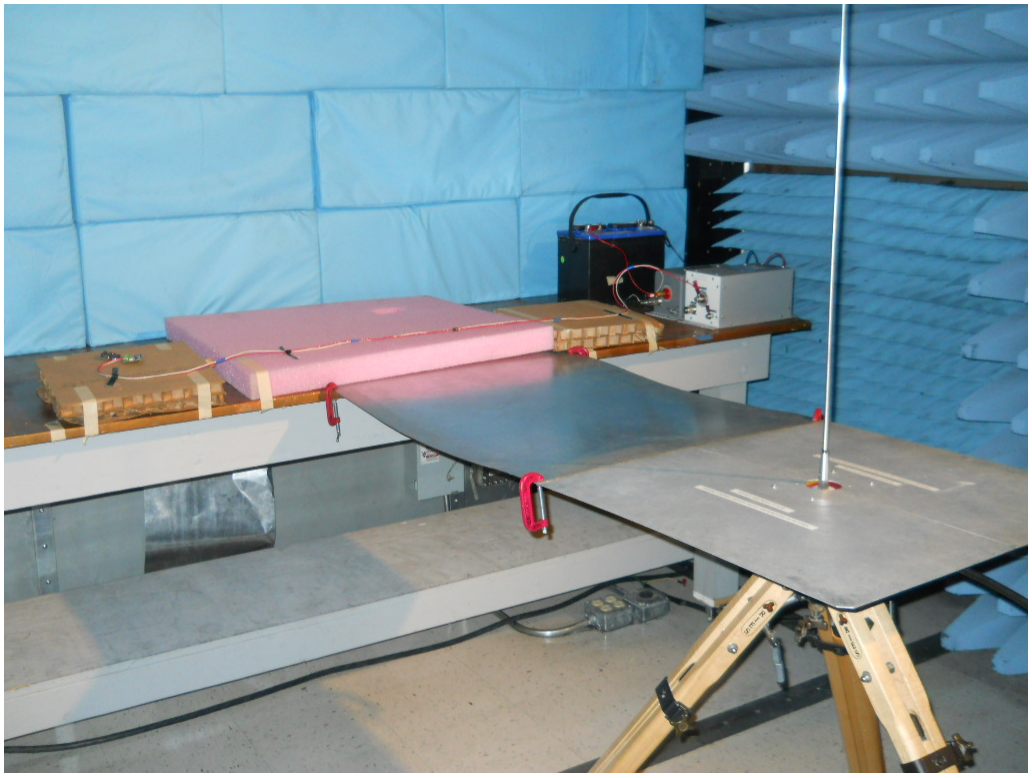

Figure 7. Monopole

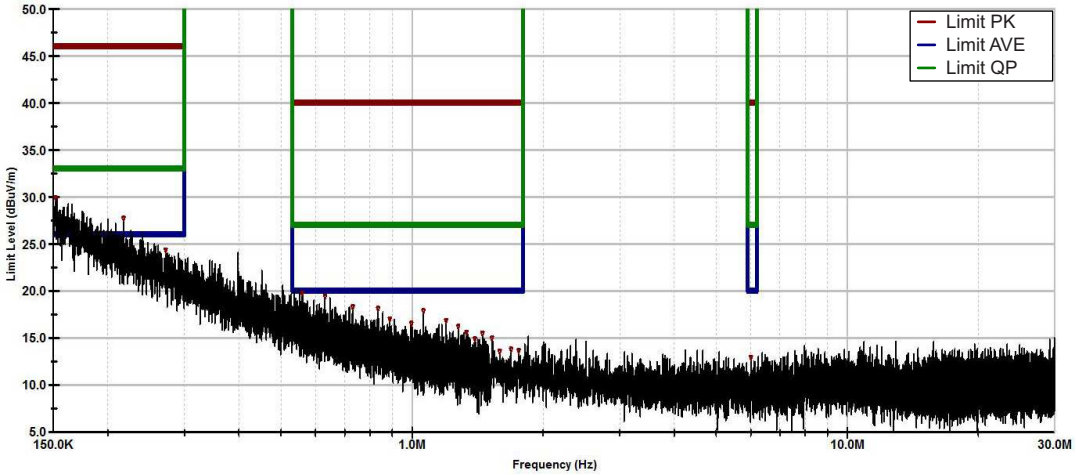

Figure 8. Monopole Ambient

Table 2. Monopole Ambient

Frequency	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency	Limit dBµV/m	Peaks dBµV/m	Margin dB
151.52 KHz	26	29.86	3.86		1.1966 MHz	20	16.83	–3.17
217.16 KHz	26	27.69	1.69		1.2759 MHz	20	16.19	–3.81
271.5 KHz	26	24.31	–1.69		1.3324 MHz	20	15.57	–4.43
559.05 KHz	20	19.75	–0.25		1.3939 MHz	20	14.88	–5.12
630.77 KHz	20	19.4	–0.6		1.4512 MHz	20	15.47	–4.53
730.67 KHz	20	18.27	–1.73		1.5253 MHz	20	14.96	–5.04
834.96 KHz	20	18.11	–1.89		1.5894 MHz	20	13.57	–6.43
888.62 KHz	20	17	–3		1.6873 MHz	20	13.77	–6.23
996.28 KHz	20	16.5	–3.5		1.7582 MHz	20	13.61	–6.39
1.0616 MHz	20	17.86	–2.14		6.0039 MHz	20	12.9	–7.1

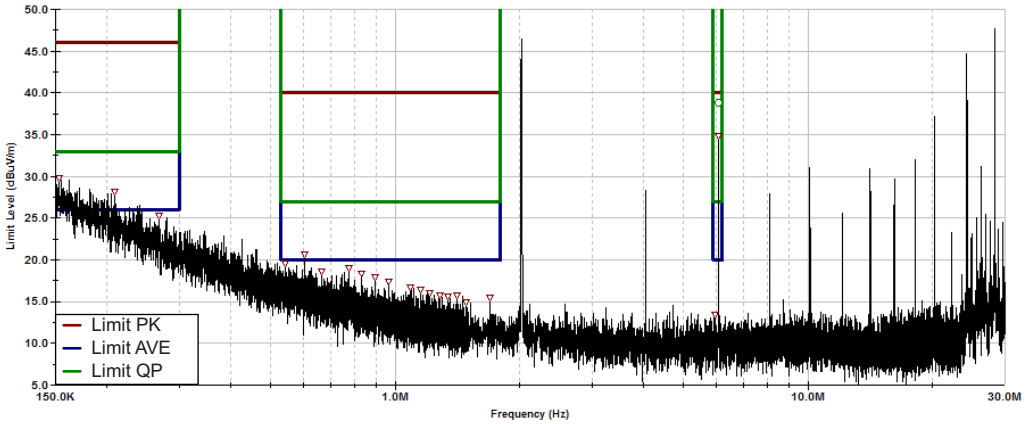

Figure 9. Monopole Test Data

Table 3. Monopole Test Data[1]

Frequency	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency	Limit dBµV/m	Peaks dBµV/m	Margin dB
153.54 KHz	26	29.75	3.75		1.0921 MHz	20	16.75	–3.25
209.74 KHz	26	28.24	2.24		1.1537 MHz	20	16.38	–3.62
268.13 KHz	26	25.32	–0.68		1.2131 MHz	20	16.01	–3.99
540.83 KHz	20	19.61	–0.39		1.2805 MHz	20	15.77	–4.23
604.61 KHz	20	20.68	0.68		1.3397 MHz	20	15.64	–4.36
664.52 KHz	20	18.59	–1.41		1.4143 MHz	20	15.76	–4.24
772.01 KHz	20	19.05	–0.95		1.4814 MHz	20	14.91	–5.09
826.86 KHz	20	18.31	–1.69		1.7008 MHz	20	15.43	–4.57
892.67 KHz	20	18	–2		5.9415 MHz	20	13.49	–6.51
966.75 KHz	20	17.43	–2.57		6.0698 MHz	20	34.88	14.88

(1) The peak at around 6 MHz (third harmonic) is 34.88 – 12.9 = 21.98 dBµV/m

2.3 Photo of Test Setup and Result for Bicon Vertical

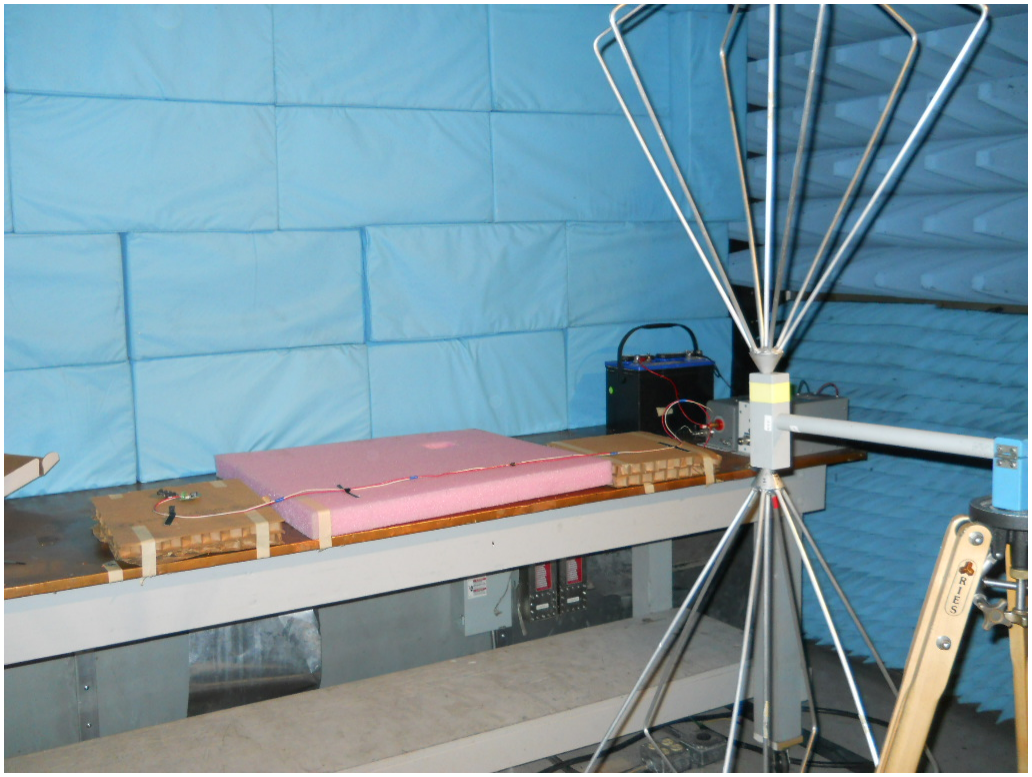

Figure 10. Bicon Vertical

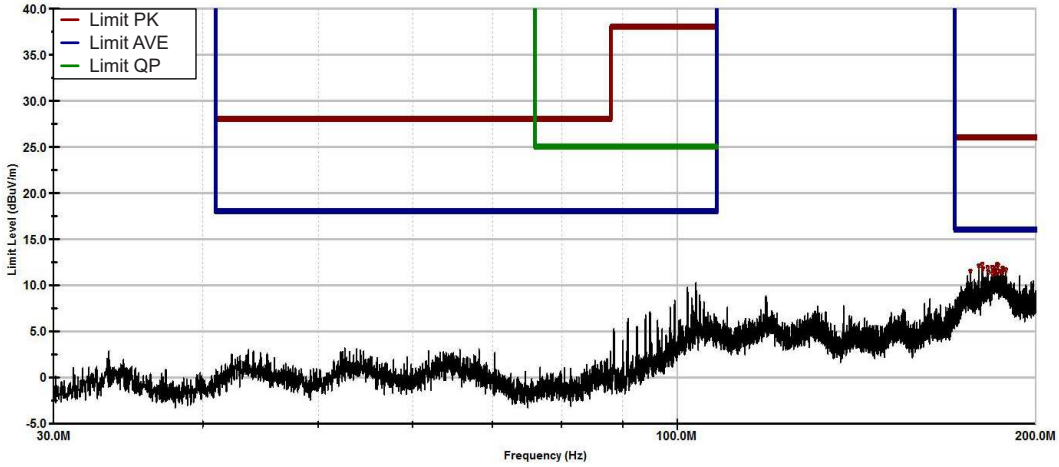

Figure 11. Bicon Vertical Ambient

Table 4. Bicon Vertical Ambient

Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB
176.2	16	11.48	–4.52		184.572	16	11.59	–4.41
179.132	16	12.06	–3.94		185.104	16	11.27	–4.73
180.301	16	12.23	–3.77		185.253	16	11.87	–4.13
180.493	16	11.72	–4.28		185.486	16	12.2	–3.8
182.171	16	11.83	–4.17		185.571	16	11.46	–4.54
182.426	16	11.4	–4.6		185.72	16	11.52	–4.48
183.808	16	11.86	–4.14		185.848	16	12.1	–3.9
183.914	16	11.18	–4.82		186.697	16	11.45	–4.55
184.339	16	11.53	–4.47		—	—	—	—

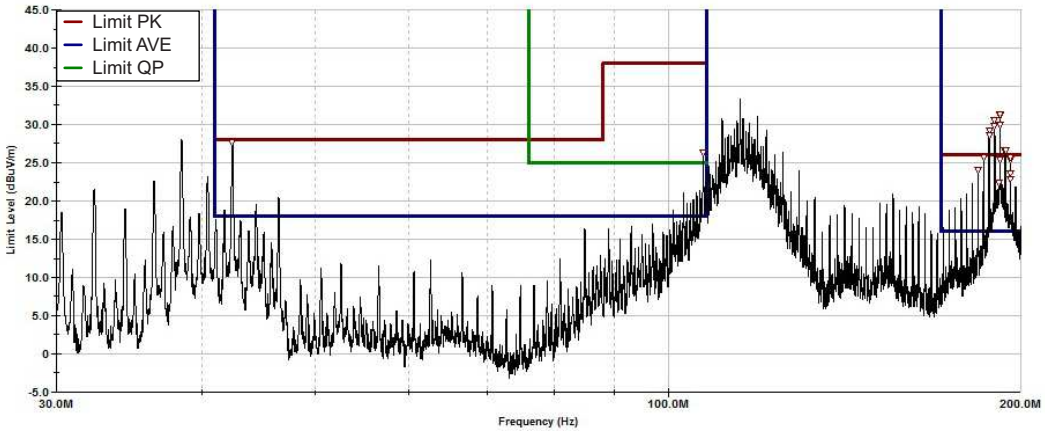

Figure 12. Bicon Vertical Test Data

Table 5. Bicon Vertical Test Data(1)

Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB
42.4525	18	27.73	9.73		191.904	16	25.43	9.43
107.159	18	26.3	8.3		191.968	16	29.95	13.95
183.956	16	24.07	8.07		192.053	16	31.16	15.16
186.018	16	25.81	9.81		192.116	16	31.37	15.37
188.015	16	29.19	13.19		194.05	16	26.68	10.68
188.1	16	28.68	12.68		194.114	16	26.72	10.72
189.97	16	29.81	13.81		195.963	16	22.91	6.91
190.034	16	30.55	14.55		196.026	16	25.51	9.51
190.098	16	30.58	14.58		196.09	16	25.71	9.71
191.84	16	22.43	6.43		196.175	16	23.56	7.56

(1) Between 40 and 45 MHz the reference spike (ambient) is around 2 dBµV/m. By subtracting the ambient from the DUT peak, the equivalent peak for the DUT would be 27.73 – 2 = 25.73 dBµV/m. By subtracting the ambient from the DUT peak, the equivalent peak for the DUT would be 107 MHz, 26.3 – 6 = 20.3 dBµV/m. Above 176 MHz, 30 – 11 = 19 dBµV/m

2.4 Photo of Test Setup and Result for Bicon Horizontal

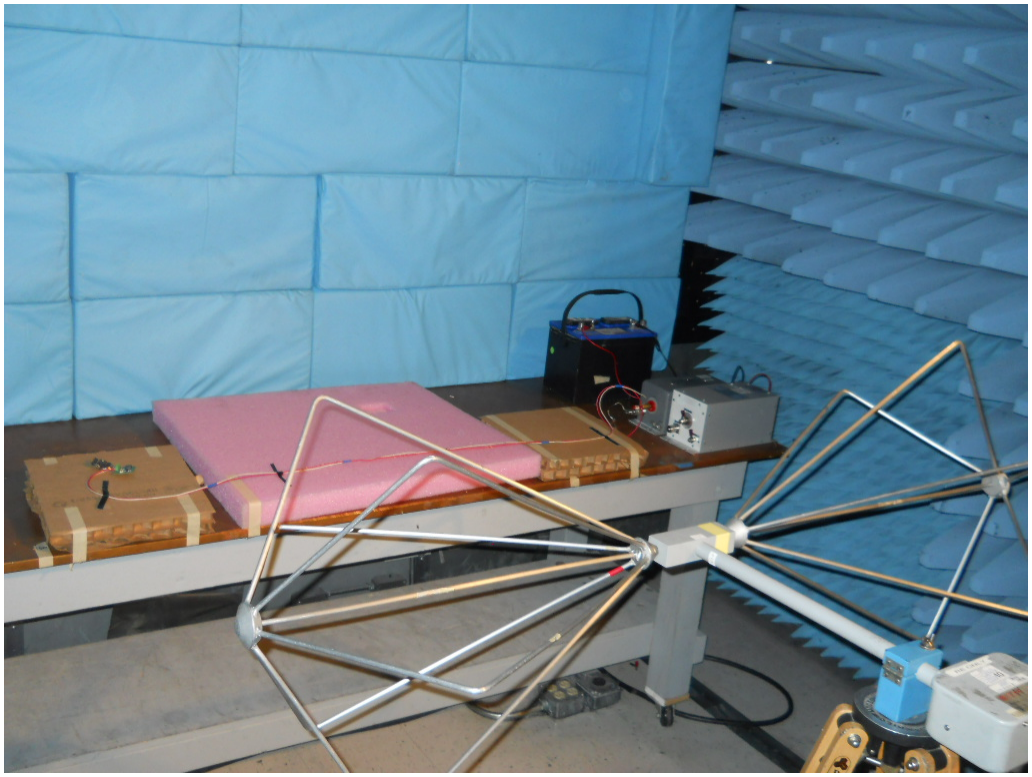

Figure 13. Bicon Horizontal

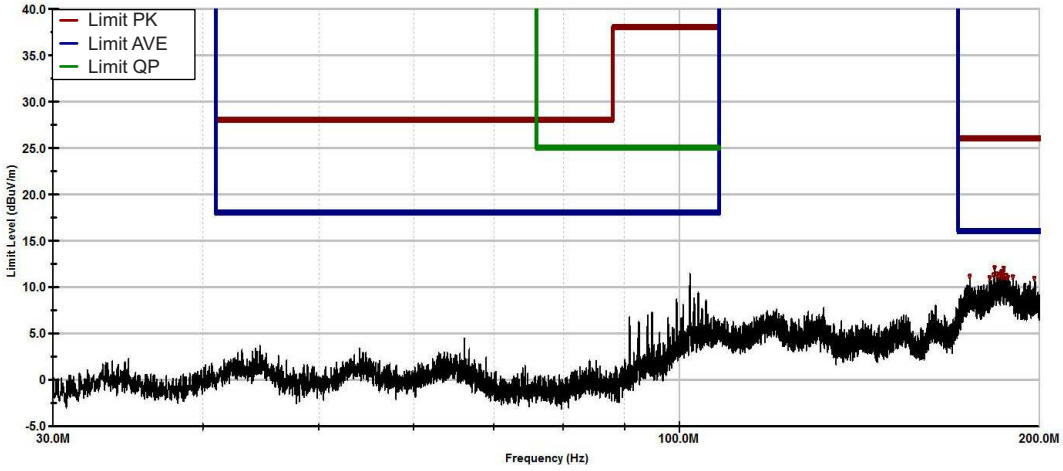

Figure 14. Bicon Horizontal Ambient

Table 6. Bicon Horizontal Ambient

Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB
174.819	16	11.1	–4.9		186.06	16	11.01	–4.99
181.64	16	10.95	–5.05		186.273	16	11.36	–4.64
181.704	16	10.99	–5.01		186.443	16	11.6	–4.4
183.064	16	11.28	–4.72		186.613	16	11.99	–4.01
183.382	16	12.02	–3.98		186.761	16	11.18	–4.82
184.169	16	11.37	–4.63		187.271	16	11.16	–4.84
184.849	16	11.09	–4.91		187.505	16	11.16	–4.84
184.912	16	11.12	–4.88		188.1	16	10.99	–5.01
185.635	16	11.36	–4.64		189.949	16	11.05	–4.95
185.89	16	11.62	–4.38		198.003	16	10.91	–5.09

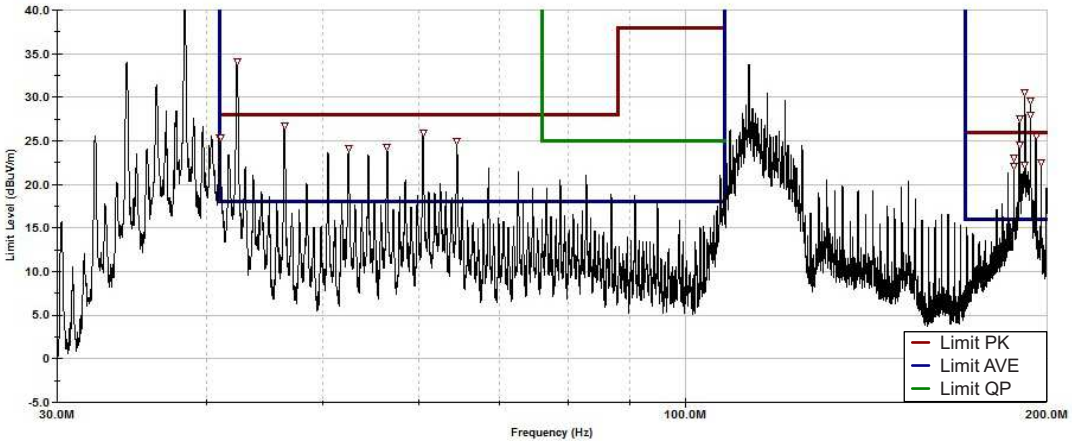

Figure 15. Bicon Horizontal Test Data

Table 7. Bicon Horizontal Test Data(1)

Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB		Frequency MHz	Limit dBµV/m	Peaks dBµV/m	Margin dB
41.0075	18	25.36	7.36		189.736	16	27.63	11.63
41.0712	18	25.34	7.34		189.8	16	27.6	11.6
42.3888	18	34.18	16.18		189.885	16	24.56	8.56
46.4263	18	26.83	8.83		191.606	16	22.22	6.22
52.4825	18	24.14	6.14		191.776	16	30.59	14.59
56.4988	18	24.26	6.26		191.84	16	30.54	14.54
60.5363	18	25.98	7.98		193.731	16	28.04	12.04
64.595	18	25.04	7.04		193.838	16	29.66	13.66
187.718	16	22.15	6.15		195.856	16	25.51	9.51
187.781	16	23.03	7.03		197.896	16	22.6	6.6

(1) Above 174 MHz the reference spike (ambient) is around 11 dBµV/m. By subtracting the ambient from the DUT peak, the equivalent peak for the DUT would be 30.59 – 11 = 19.59 dBµV/m.

3 Summary

Using this four layer board, the TPS65320-Q1 revision B is very close to passing CISPR25 Class 4 and 5 Radiated Emissions required for automotive. Test results only show a significant spike around 42 MHz.

Revision History

Changes from Original (May 2015) to A Revision	Page
• Replaced instance of *TPS65320B-Q1* with *TPS65320-Q1 revision B*	12

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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