Application Report
SLVA661–May 2014

Passing CISPR25 Radiated Emissions Using TPS54362B-Q1

Mahmoud Harmouch *MSA-ASI*

ABSTRACT

This application note provides a summary of CISPR25 Radiated Emissions test results using the TPS54362B-Q1 device. This buck converter is capable of passing CISPR25 and other automotive EMC test specifications. The TPS54362B-Q1 device does not require use of programmable frequency modulation. The device can pass EMC tests by optimizing external components selection, placement, and board layout.

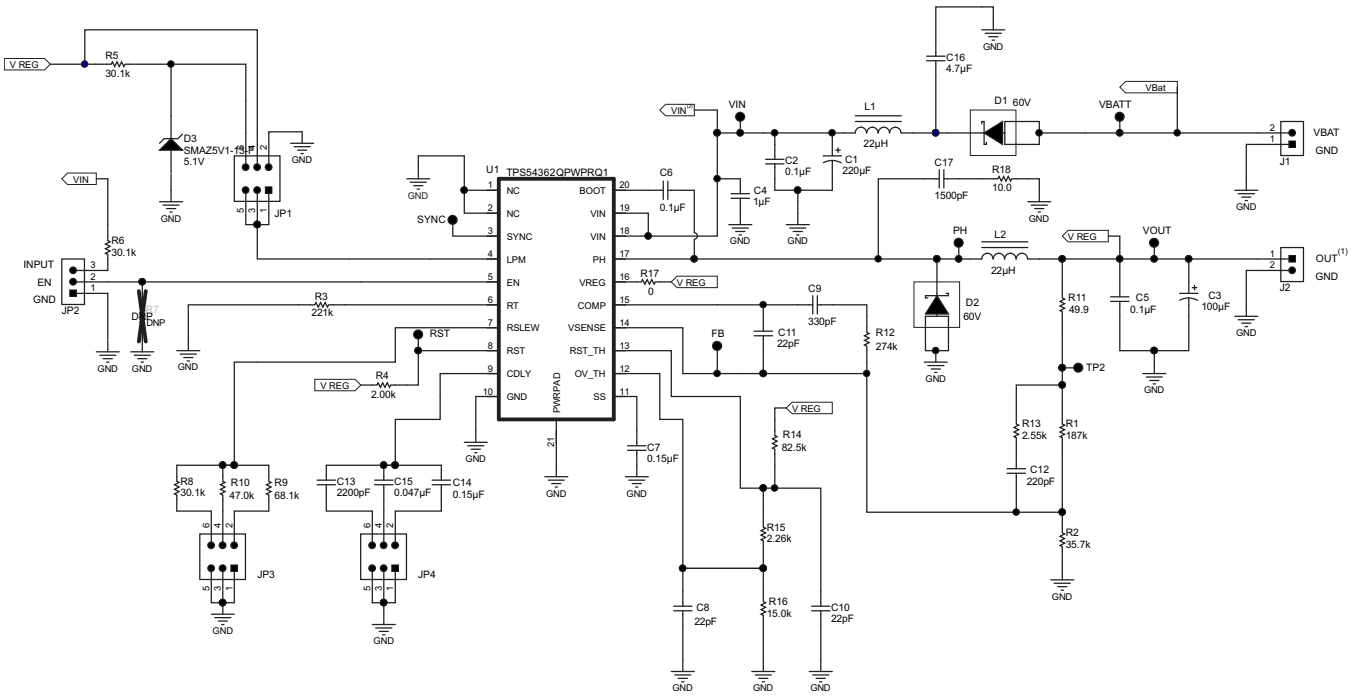
Contents

List of Figures

1 Schematics and Printed Circuit Board (PCB) Description

The TPS54362BEVM is the subject board designed for EMC required by the automotive specification CISPR25. The TPS54362BEVM PCB was used for all testing.

1.1 Schematic for TPS54362BEVM



Note: The RC snubber R18 and C17 is not needed with controlled slew rate of 1 V/2.5 ns. This slew rate value can be achieved with a pulldown resistor of 30 kΩ from device pin 7 to GND

(1) Output voltage = 5 V, load current = 3 A maximum

(2) Input voltage up to 48 V

Figure 1. Schematic

1.2 Bill of Materials (BOM) for TPS54362BEVM

Table 1. BOM

QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
1		Printed Circuit Board		HVL074	Any
1	TPS54362BQPWPRQ1	IC, 3 A, 60 V step down DC/DC converter with low I_Q	PWP20	TPS54362BQPWPRQ1	TI
1	220 µF	Capacitor, AL, 220 µF, 50 V, ±20%, 0.18 Ω, SMD	SMT Radial G	EEE-FK1H221P	Panasonic
3	0.1 µF	Capacitor, ceramic, 0.1 µF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H104KA93D	MuRata
1	100 µF	Capacitor, TA, 100 µF, 16 V, ±20%, 0.06 Ω, SMD	7343-31	TPSD107M016R0060	AVX
1	1 µF	Capacitor, ceramic, 1 µF, 50 V, ±10%, X7R, 1206	1206	GRM31MR71H105KA88L	MuRata
2	0.15 µF	Capacitor, ceramic, 0.15 µF, 25 V, ±10%, X7R, 0805	0805	08053C154KAT2A	AVX
3	22 pF	Capacitor, ceramic, 22 pF, 50 V, ±5%, C0G/NP0, 0603	0603	06035A220JAT2A	AVX
1	330 pF	Capacitor, ceramic, 330 pF, 50 V, ±5%, C0G/NP0, 0603	0603	C0603C331J5GACTU	Kemet
1	220 pF	Capacitor, ceramic, 220 pF, 50 V, ±5%, C0G/NP0, 0603	0603	C1608C0G1H221J	TDK
1	2200 pF	Capacitor, ceramic, 2200 pF, 50 V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H222JA01D	MuRata
1	0.047 µF	Capacitor, ceramic, 0.047 µF, 50 V, ±10%, X7R, 0603	0603	C1608X7R1H473K	TDK
1	4.7 µF	Capacitor, ceramic, 4.7 µF, 50 V, ±10%, X7R, 1206	1206	GRM31CR71H475KA12L	MuRata
1	1500 pF	Capacitor, ceramic, 1500 pF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H152KA01D	MuRata
2	60 V	Diode, Schottky, 60 V, 3 A, PowerDI5	PowerDI5	PDS360-13	Diodes Inc.
1	1.2V at 200 mA	Diode Zener 5.1 V, 1 W, SMA	DO-214AC, SMA	SMAZ5V1-13-F	Diodes Inc
8	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
3		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
2		Terminal Block, 6A, 3.5 mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
3		Header, 100 mil, 3 × 2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions
1		Header, male, 3 × 1, 100 mil, RA, TH	Header, 3x1, RA	PEC03SBAN	Sullins Connector Solutions
2	22 µH	Inductor, Shielded Drum Core, Ferrite, 22 µH, 4 A, 0.04 Ω, SMD	MSS1278T	MSS1278T-223MLB	Coilcraft
1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady
1	187 kΩ	Resistor, 187 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-07187KL	Yageo America
1	35.7 kΩ	Resistor, 35.7 kΩ, 1%, 0.1 W, 0603	0603	CRCW060335K7FKEA	Vishay-Dale
1	221 kΩ	Resistor, 221 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-07221KL	Yageo America
1	2 kΩ	Resistor, 2 kΩ, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
3	30.1 kΩ	Resistor, 30.1 kΩ, 1%, 0.1 W, 0603	0603	CRCW060330K1FKEA	Vishay-Dale
1	68.1 kΩ	Resistor, 68.1 kΩ, 1%, 0.1 W, 0603	0603	CRCW060368K1FKEA	Vishay-Dale

Table 1. BOM (continued)

QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
1	47 kΩ	Resistor, 47 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0747KL	Yageo America
1	49.9 Ω	Resistor, 49.9 Ω, 1%, 0.1 W, 0603	0603	CRCW060349R9FKEA	Vishay-Dale
1	274 kΩ	Resistor, 274 kΩ, 1%, 0.1 W, 0603	0603	CRCW0603274KFKEA	Vishay-Dale
1	2.55 kΩ	Resistor, 2.55 kΩ, 1%, 0.1 W, 0603	0603	CRCW06032K55FKEA	Vishay-Dale
1	82.5 kΩ	Resistor, 82.5 kΩ, 1%, 0.1 W, 0603	0603	CRCW060382K5FKEA	Vishay-Dale
1	2.23 kΩ	Resistor, 2.23 kΩ, 0.5%, 0.1 W, 0603	0603	RT0603DRE072K23L	Yageo America
1	15 kΩ	Resistor, 15 kΩ, 1%, 0.1 W, 0603	0603	CRCW060315K0FKEA	Vishay-Dale
1	0 Ω	Resistor, 0 Ω, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
1	10 µ	Resistor, 10.0 Ω, 0.1%, 0.1 W, 0603	0603	RT0603BRD0710RL	Yageo America
10	1 × 2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
0	0	Resistor, 0 Ω, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale

1.2.1 PCB Layout

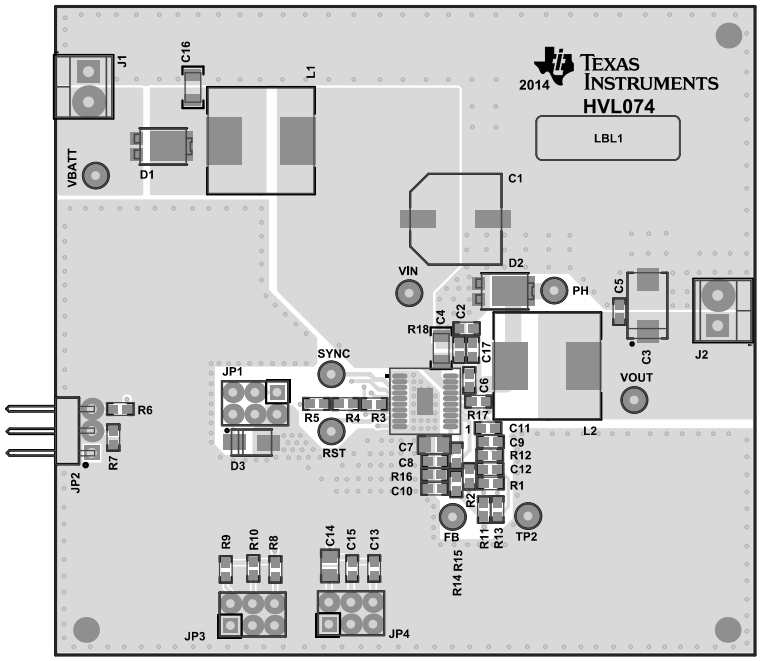


Figure 2. Top Assembly Layer

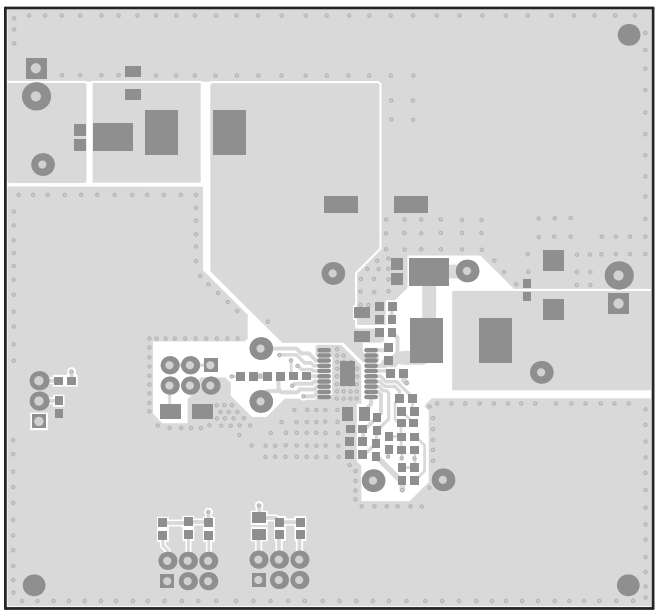


Figure 3. Top Layer Routing

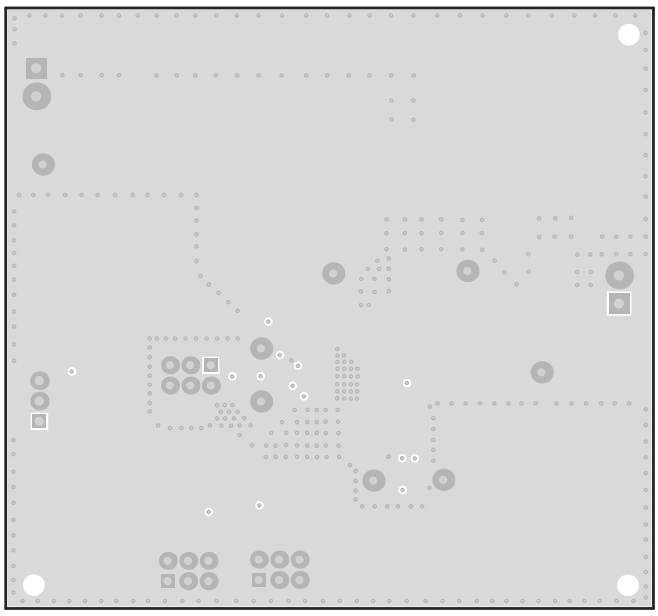


Figure 4. Inner Layer 2 (Ground Plane)

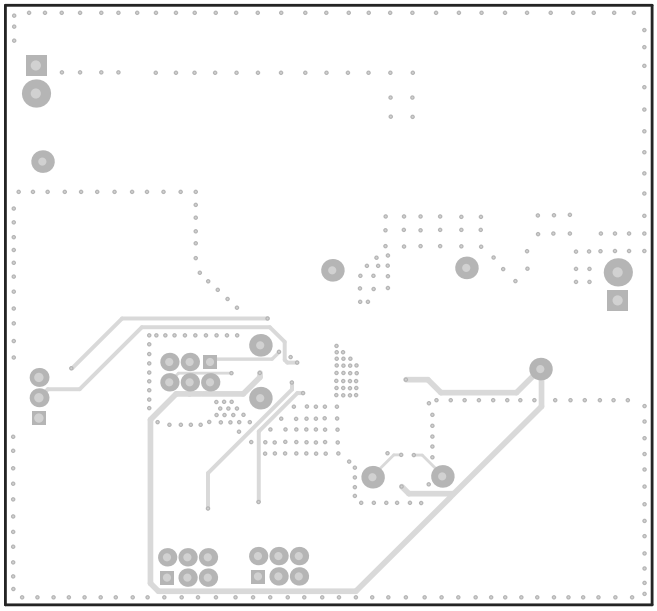


Figure 5. Inner Layer 3 Routing

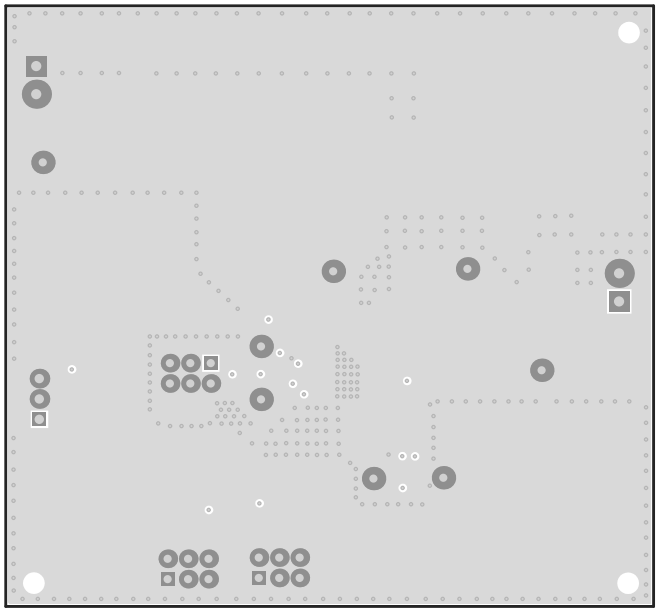


Figure 6. Bottom Layer (Ground Plane)

2 Description and Setup for Radiated Emissions Measurements

The TPS54362BEVM was used for all radiated emissions testing. Test results determined that the board could pass CISPR25, Class 5 per the BOM listed in Table 1.

The following sections list the setup conditions and test results.

2.1 Setup Conditions

- Device under test (DUT): TPS54362BEVM using the TPS54362B-Q1 device
- Input voltage: Car battery, (BAT+) = 12 V, (BAT–) = GND
- Switching frequency: f_S = 500 KHz
- Output voltage: V_O = 5 V
- Load current: I_O = 2 A
- The CISPR25 LISN is placed between BAT+ or BAT– and wire harness
- Length of wire harness (BAT+ or BAT–) = 1.7 m
- The wire harness and DUT placed on 50 mm of insulation with respect to test table.

2.2 Test Setup and Result for Monopole

Figure 7. Monopole

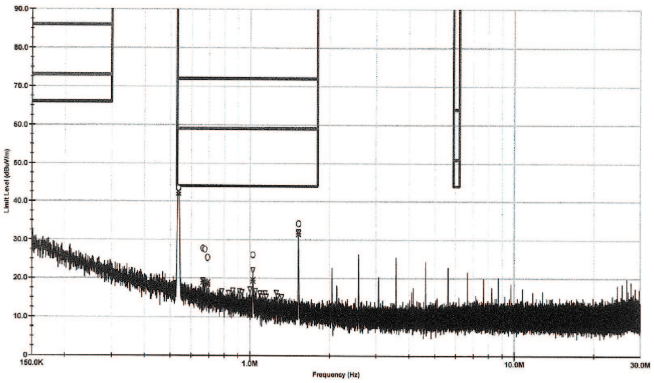


Figure 8. Monopole Test Results

FREQUENCY (MHz)	LIMIT (dBuV/m)	PEAKS (dBuV/m)	MARGIN (dB)
0.538	44	43.34	–0.66
0.667	44	19.45	–24.55
0.677	44	18.12	–25.88
0.693	44	17.65	–26.35
0.785	44	16.56	–27.44
0.833	44	16.17	–27.83
0.864	44	16.8	–27.2
0.916	44	16.68	–27.32
0.934	44	16.36	–27.64
1.002	44	17.1	–26.9
1.027	44	22.08	–21.92
1.049	44	16.72	–27.28
1.093	44	16.1	–27.9
1.107	44	15.29	–28.71
1.145	44	16.1	–27.9
1.155	44	15.24	–28.76
1.261	44	16.23	–27.77
1.277	44	15.31	–28.69
1.322	44	15.18	–28.82
1.531	44	32.04	–11.96

NOTE: The peak at 538 kHz can be lower by increasing the C16 capacitor to 10 µF.

2.3 Test Setup and result for Bicon Vertical

Figure 9. Bicon Vertical

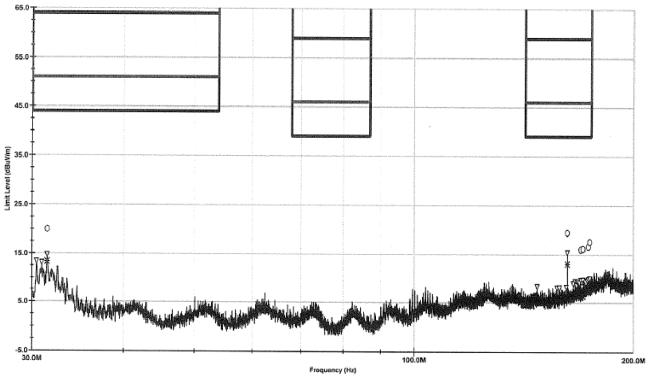


Figure 10. Bicon Vertical Test Results

FREQUENCY (MHz)	LIMIT (dBuV/m)	PEAKS (dBuV/m)	MARGIN (dB)
30.425	44	13.44	–30.56
30.956	44	13.13	–30.87
31.466	44	14.77	–29.23
147.491	39	8.36	–30.64
157.118	39	8.05	–30.95
158.159	39	8.12	–30.88
161.750	39	8.2	–30.8
162.387	39	15.47	–23.53
165.405	39	8.94	–30.06
166.191	39	9.52	–29.48
166.956	39	8.59	–30.41
167.53	39	9.38	–29.62
168.529	39	9.04	–29.96
169.379	39	9.75	–29.25
169.995	39	8.35	–30.65
170.505	39	9.81	–29.19
172.035	39	9.14	–29.86
172.779	39	9.61	–29.39
173.352	39	9.93	–29.07
174.118	39	10.1	–28.9

2.4 Test Setup and result for Bicon Horizontal

Figure 11. Bicon Horizontal

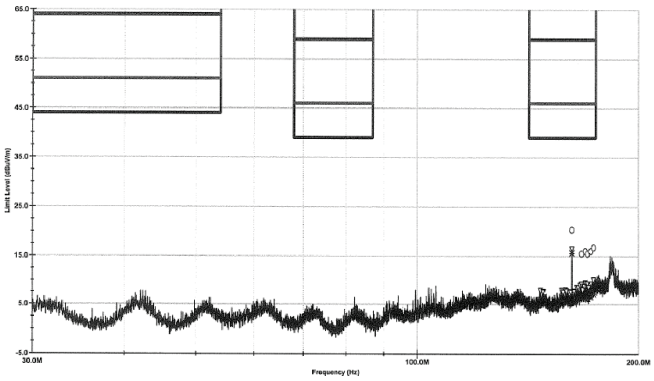


Figure 12. Bicon Horizontal Test Results

FREQUENCY (MHz)	LIMIT (dBuV/m)	PEAKS (dBuV/m)	MARGIN (dB)
1.47.257	39	7.8	–31.2
148.490	39	7.55	–31.45
157.330	39	7.8	–31.2
158.053	39	7.49	–31.51
159.158	39	7.92	–31.08
159.667	39	7.69	–31.31
161.856	39	7.5	–31.5
162.409	39	16.56	–22.44
163.45	39	7.62	–31.38
164.874	39	8.44	–30.56
165.66	39	8.37	–30.63
166.68	39	8.91	–30.09
167.403	39	9.19	–29.81
167.955	39	7.92	–31.08
168.678	39	8.69	–30.31
169.315	39	9.5	–29.5
170.505	39	9.26	–29.74
171.058	39	8.44	–30.56
172.290	39	9.22	–29.78
173.778	39	10.18	–28.82

3 Summary

The TPS54362B-Q1 device passed CISPR25 Class 4 and 5 Radiated Emissions required for automotive. The passing results can be achieved using careful components selection, placement, and PCB layout.

TPS54362BEVM EMC test board can be ordered on-line at TI's website, or through local TI Sales.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265