EVM User's Guide: TPS1HC120Q1EVM

TPS1HC120-Q1 Evaluation Module

Description

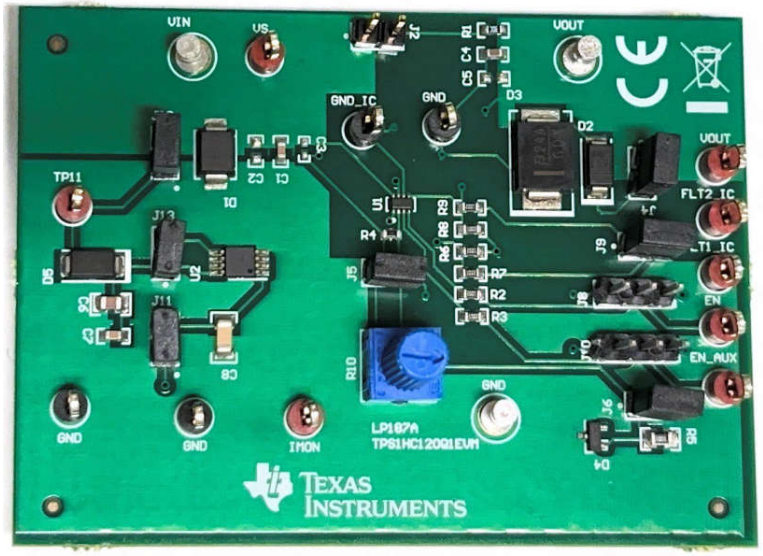
The TPS1HC120Q1EVM is a hardware evaluation module (EVM) used to evaluate the functionality and performance of the TPS1HC120-Q1 high side switch. The TPS1HC120Q1EVM is designed to be used as a standalone board with an attached voltage supply and output load. Features such as overcurrent, short-to-ground, and open-load detection are enabled for use on the evaluation module.

Features

- Operating voltage: 3V–28V
- Ambient operating temperature: –40 to 125°C
- Adjustable current limit with external resistor
- Overcurrent, short-to-ground, open-load, and short-to-battery detection
- Onboard LDO allowing for control signal manipulation
- Output jumper to support inductive discharge configurations

Applications

- ADAS modules
- Automotive display module
- Body control module



TPS1HC120Q1EVM

1 Evaluation Module Overview

1.1 Introduction

The TPS1HC120-Q1 evaluation module (EVM) contains a TPS1HC120-Q1 integrated circuit (IC), supporting single-channel high-side switch applications. The purpose of this EVM is to facilitate evaluation of the TPS1HC120-Q1 for resistive, capacitive, and inductive loads. This user's guide provides the connectors and test point descriptions, the board schematic and layout, and bill of materials. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TPS1HC120Q1EVM.

1.2 Kit Contents

The contents of the EVM kit is listed in Table 1-1. Contact the nearest Texas Instruments Product Information Center if any component is missing.

Table 1-1. Kit Contents

Item	Quantity
TPS1HC120Q1EVM	1

1.3 Specification

The TPS1HC120Q1EVM is compatible with the TPS1HC120-Q1 device. The unit that is populated to the EVM is listed in Table 1-2. Please refer to the device data sheet for more detailed specifications.

Table 1-2. Device Specifications

Part Number	Continuous Load Current	Channel Count	Package
TPS1HC120C-Q1	1.2A	1	DYC (SOT, 8)

1.4 Device Information

The TPS1HC120-Q1 is a fully-protected single-channel, high-side power switch, with integrated NMOS power FET and charge pump.

Full diagnostics and high accuracy current sense features enable intelligent control of the load. Thermal shutdown behaviors as latch off or auto-retry are internally fixed in the part; please see the following and refer to the data sheet for more information.

- TPS1HC120A-Q1: auto-retry
- TPS1HC120B-Q1: latch
- TPS1HC120C-Q1: hard-short auto-latch

The external programmable current limit feature improves system reliability by limiting inrush or overload current.

2 Hardware

2.1 Connection Descriptions

This section describes the connectors on the EVM and how to properly connect, set up, and use the TPS1HC120-Q1 EVM.

2.1.1 Test Points

Test Point	Description
TP1	VOUT test point
TP2/4	EN/EN_AUX test points
TP3/9/10	Ground test points
TP5	Current limit test point
TP6	IC ground test point
TP7/8	FLT1/FLT2 test points
TP11	LDO input test point
TP12	VS test point

2.1.2 Jumper Configurations

Jumper	Function
J2	Connects pullup resistor to VS for open load detection
J4	Connects VOUT to external diodes for inductive load energy dissipation
J5	Shorts the ILIM pin to ground
J6	Bypasses the ground network
J8/J10	Connects EN/EN_AUX to the LDO's 5V signal or ground
J9	Ties FLT1/FLT2 together (global output for GPIO connection)
J11	Connects the LDO's 5V output to the V_+5V net
J12	Connects VS to the input of the LDO; powers on-board LDO
J13	Connects the input of the LDO to the LDO's enable signal; required to output 5V for V_+5V net

3 Application-Based Modifications

3.1 External Modifications

3.1.1 Versions A and B

Samples of versions A and B of the device must be ordered separately and soldered on U1. External modifications must be made when using versions A and B of this device.

The current sense feature only applies to versions A and B of this device (in place of the FLT2 pin). The current sense function is internally implemented by a current mirror. This implementation is reflected as an external resistor between the SNS pin and GND. Connect a resistor externally to ground to translate the sense current into a voltage reading. Remove R8 and R9. Add a series resistor and capacitor to create a low pass filter to filter out noise; please see the data sheet's *Application Information* section for more information on this configuration.

No modifications are required for the DIAG_EN pin (in place of the EN_AUX pin) as the DIAG_EN pin is controlled in the same manner as the EN_AUX pin.

3.1.2 Adjustable Current Limit

The current limit regulates the output current to a set value. The EVM can be designed to hold different current limit values through an external resistor on the ILIM pin. There are 11 settings that can be set based on RLIM. 1% tolerance resistors must be used in this application. Either replace R4 with an appropriate resistor or use the potentiometer to modify the resistance on the pin. Please remove the other resistor that is not being used.

Any resistor settings that are not listed in the following table can be interpreted as one of the adjacent levels, which is not a recommended configuration.

Table 3-1. Current Limit Setting Through External Resistor

Resistor Value (kΩ)	ILIM Threshold (A)
6.75	2.0
7.5	1.8
8.4	1.6
9.6	1.4
11.3	1.2
13.5	1.0
16.9	0.8
22.9	0.6
33.75	0.4
67.5	0.2
Open, short, or out of range (< 7.5kΩ or > 75kΩ)	2

4 Hardware Design Files

4.1 TPS1HC120Q1EVM Schematic

Figure 4-1 illustrates the EVM schematic.

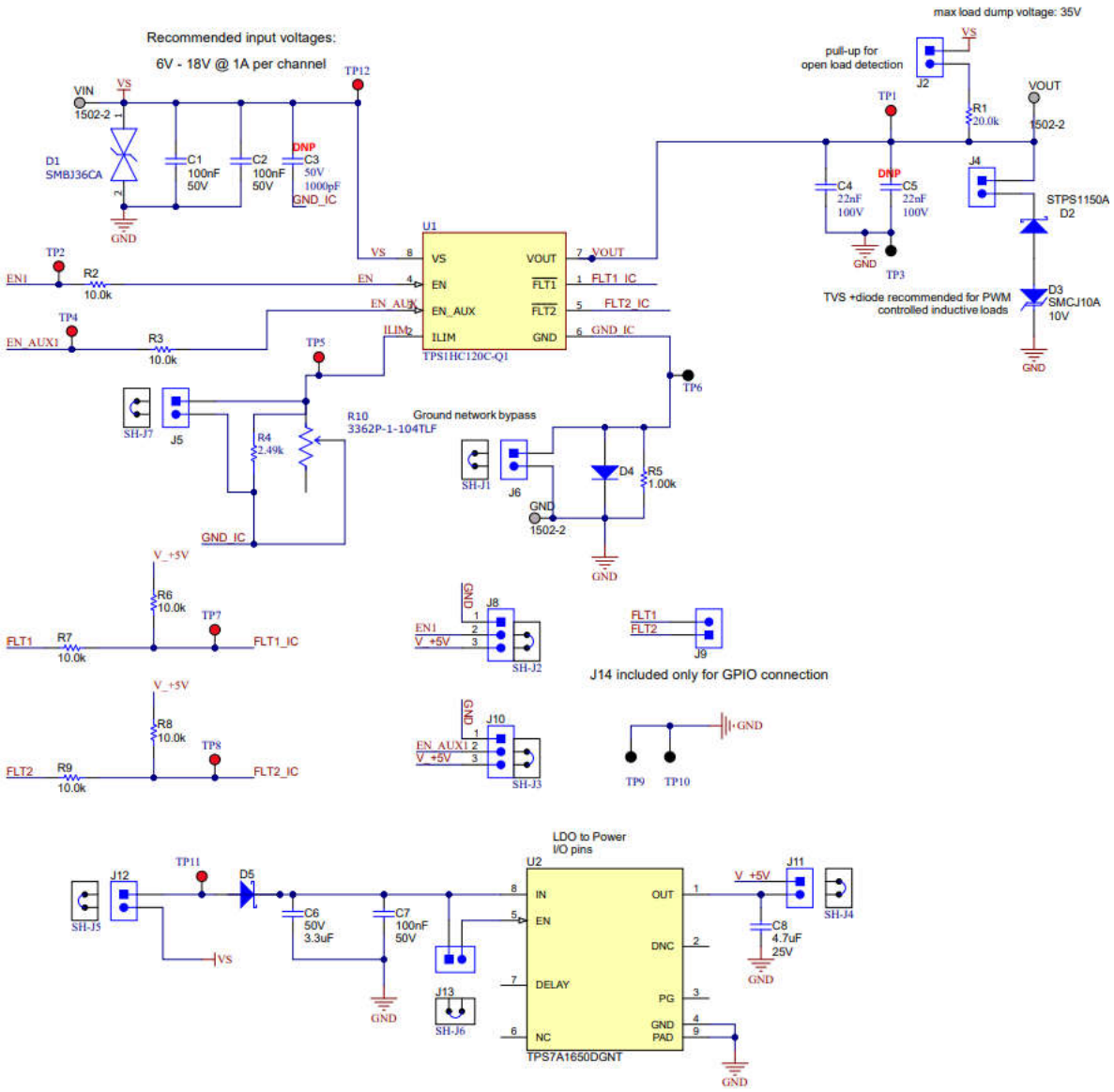


Figure 4-1. TPS1HC120Q1EVM Schematic

4.2 PCB Layouts

The design of the TPS1HC120-Q1 printed-circuit board (PCB) is shown in Figure 4-2 to Figure 4-5. All components are in an active area on the top side and all active traces to the top and bottom layers to allow the user to easily view, probe, and evaluate.

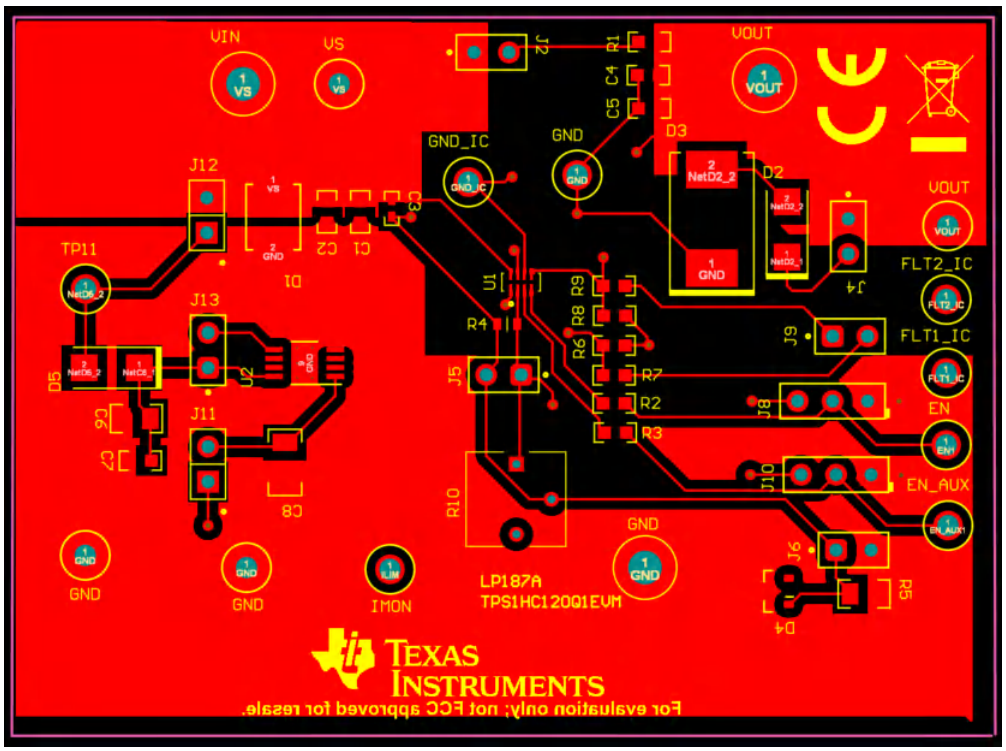


Figure 4-2. TPS1HC120Q1EVM Top Layer

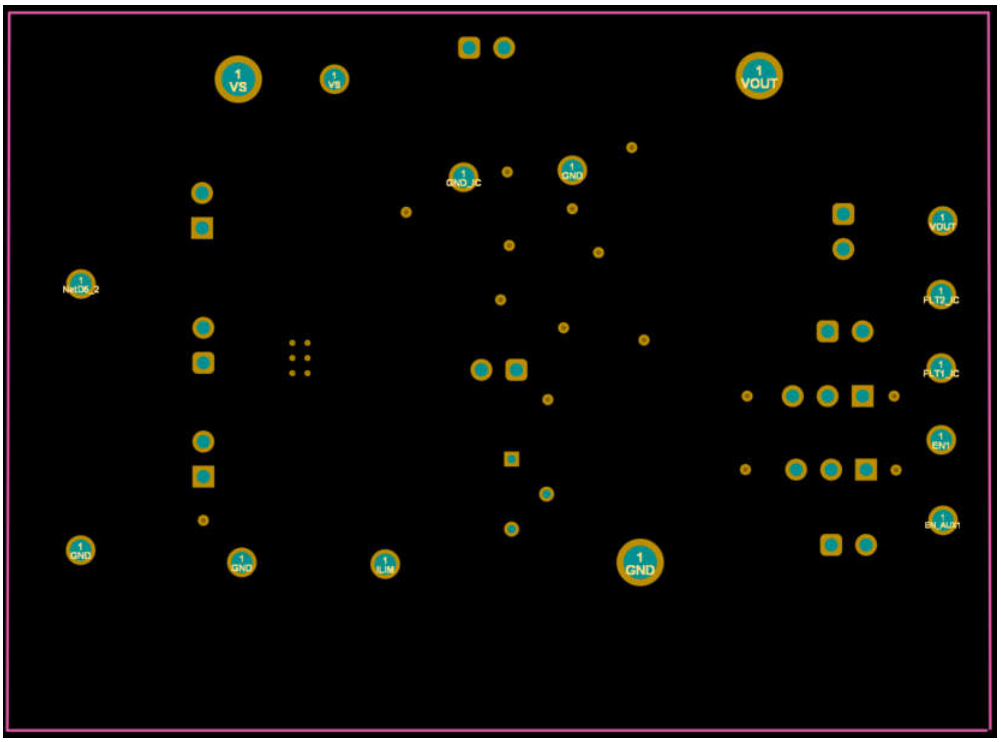


Figure 4-3. TPS1HC120Q1EVM Second Layer

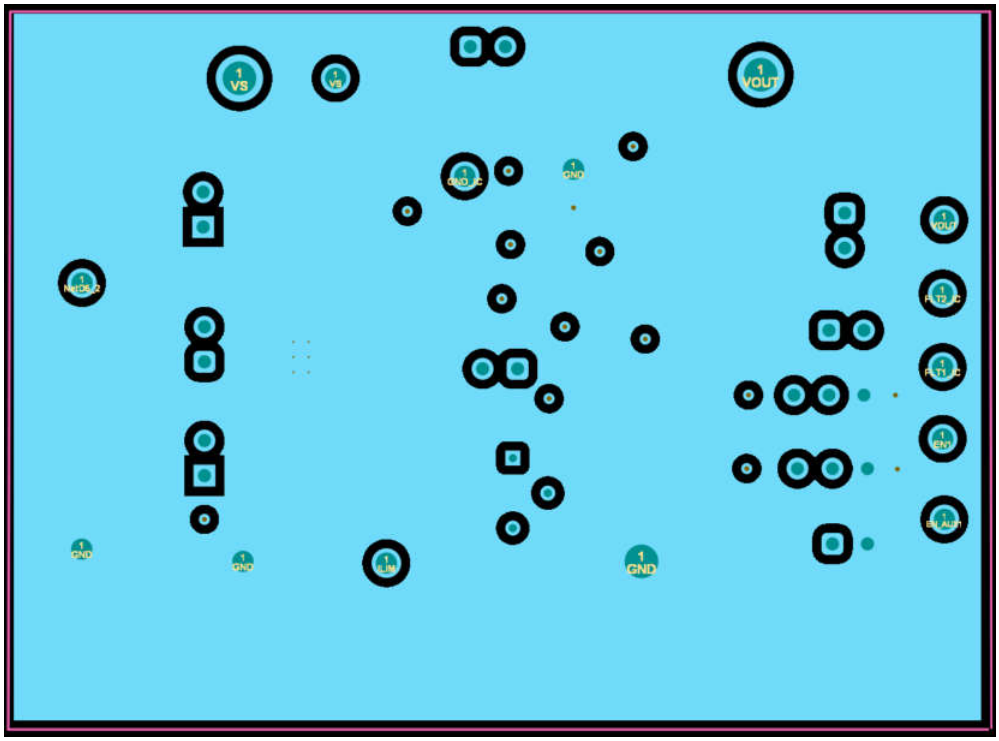


Figure 4-4. TPS1HC120Q1EVM Third Layer (Ground)

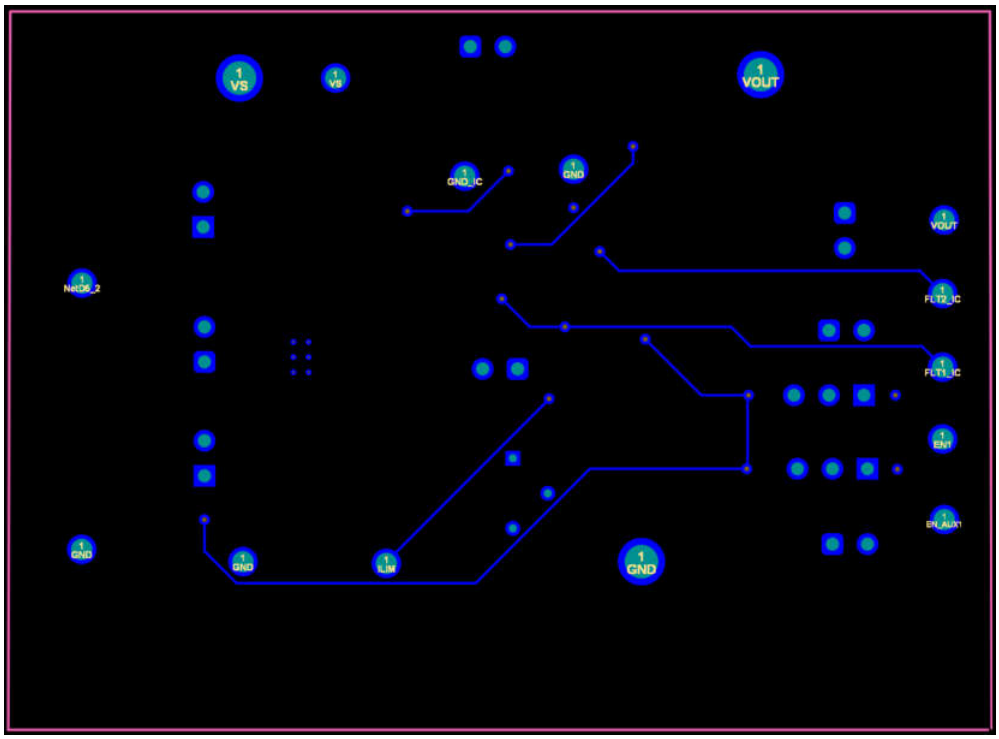


Figure 4-5. TPS1HC120Q1EVM Bottom Layer

4.3 Bill of Materials (BOM)

Table 4-1 lists the bill of materials (BOM).

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C7	2	0.1uF	CAP, CERM, 0.1µF, 50V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C104K5RACAUTO	Kemet
C4	1	0.022uF	CAP, CERM, 0.022uF, 100V, +/- 10%, X7R, 0603	0603	C1608X7R2A223K080AA	TDK
C6	1	3.3uF	CAP, CERM, 3.3uF, 50V, +/- 10%, X5R, 0805	0805	C2012X5R1H335K125AB	TDK
C8	1	4.7uF	CAP, CERM, 4.7uF, 25V, +/- 10%, X5R, 1206	1206	12063D475KAT2A	AVX
D1	1		Diode TVS Single Bi-Dir 36V 600W 2-Pin SMB	DO-214AA	SMBJ36CA	Littelfuse
D2	1	150V	Diode, Schottky, 150V, 1A, SMA	SMA	STPS1150A	STMicroelectronics
D3	1	10V	Diode, TVS, Uni, 10V, SMC	SMC	SMCJ10A	Bourns
D4	1	200V	Diode, Switching, 200V, 0.2A, SOT-23	SOT-23	BAS21-7F	Diodes Inc.
D5	1	50V	Diode, Schottky, 50V, 1A, SMA	SMA	B150-13F	Diodes Inc.
GND, VIN, VOUT	3		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J2, J4, J5, J6, J9, J13	6		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07G-S	Samtec
J8, J10	2		Header, 100mil, 3x1, Tin, TH	Header, 3x1, 100mil, TH	5-146278-3	TE Connectivity
J11, J12	2		Header, 100mil, 2x1, Tin, TH	Header 2x1	90120-0122	Molex
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650x 0.200 inch	THT-14-423-10	Brady
R1	1	20.0k	RES, 20.0k, 1%, 0.1W, 0603	0603	CRCW060320K0FKEA	Vishay-Dale
R2, R3, R6, R7, R8, R9	6	10.0k	RES, 10.0k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R4	1	2.49k	Res Thick Film 0603 2.49K Ohm 1% 1/10W ±100ppm/°C Molded SMD Punched Carrier T/R	0603	ERJ-3EKF2491V	Panasonic
R5	1	1.00k	RES, 1.00k, 1%, 0.125W, AEC-Q200 Grade 0, 0805	0805	CRCW08051K00FKEA	Vishay-Dale
R10	1	100kΩ	Res Cermet Trimmer 100K Ohm 10% 1/2W 1(Elec)/ 1(Mech)Turn 5mm (6.71X 7.04X 14.63mm) Pin Thru-Hole Tube	PTH_TRIMMER_6MM60_6MM99	3362P-1-104TLF	Bourns
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7	7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP4, TP5, TP7, TP8, TP11, TP12	8		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP3, TP6, TP9, TP10	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		TPS1HC120C-Q1	SOT583	TPS1HC120C-Q1	Texas Instruments

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U2	1		60V, 5uA Iq, 100mA Low-Dropout (LDO) Voltage Regulator With Enable and Power Good, DGN0008C (VSSOP-8)	DGN0008C	TPS7A1650DGNT	Texas Instruments

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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