EVM User's Guide: TPS4HC120EVM

TPS4HC120-Q1 Evaluation Module

Description

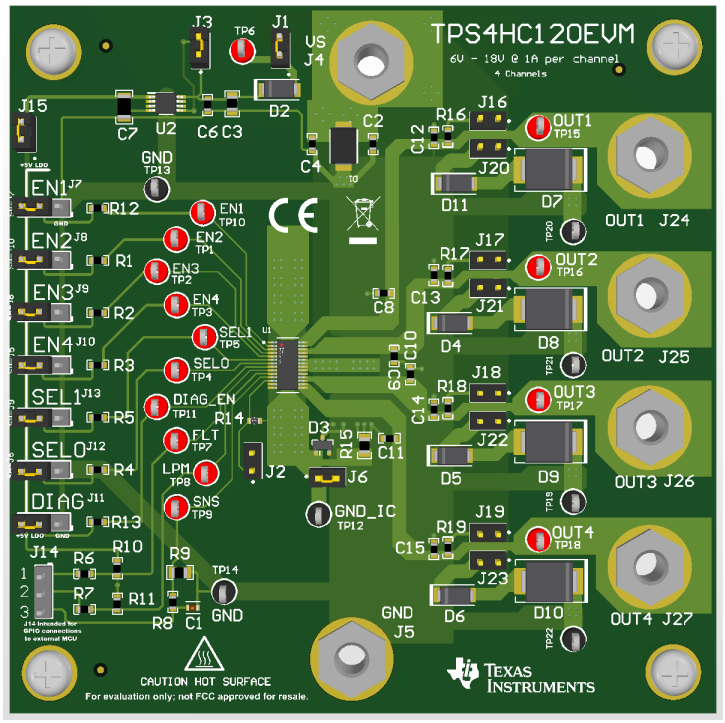
The TPS4HC120EVM is a hardware evaluation module (EVM) used to evaluate the functionality and performance of the TPS4HC120 high side switch. The evaluation module is fully equipped to test the TPS4HC120 to ease the device integration to various power system applications. The TPS4HC120EVM is designed to be used as a standalone board with an attached voltage supply and output load. Features such as overcurrent, short-to-ground, open-load, and short-to-battery detection are enabled for use on the evaluation module.

Features

1. Operating voltage: 3 – 28V
2. Ambient operating temperature: –40 to 125°C
3. Highly accurate current sense
4. Adjustable current limit with external resistor
5. Overcurrent, short-to-ground, open-load, and short-to-battery detection
6. Onboard LDO allowing for control signal manipulation
7. Output jumper to support inductive discharge configurations
8. Tested according to AECQ100-12
9. Certification of ISO7637-2 and ISO16750-2

Applications

- Multi-channel LED drivers, bulb drivers
- Multi-channel high-side power switches
- Multi-channel high-side relay drivers



TPS4HC120EVM

1 Evaluation Module Overview

1.1 Introduction

The TPS4HC120-Q1 evaluation module (EVM) contains a TPS4HC120-Q1 integrated circuit (IC), supporting quad-channel high-side switch applications. The purpose of this EVM is to facilitate evaluation of the TPS4HC120-Q1 for resistive, capacitive, and inductive load. The TPS4HC120-Q1 evaluation module is designed to evaluate the TPS4HC120-Q1 integrated circuit. This user's guide provides the connectors and test point description, the schematic, bill of materials, and board layout of the EVM. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TPS4HC120EVM.

1.2 Kit Contents

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

Table 1-1. Kit Contents

Item	Quantity
TPS4HC120EVM	1

1.3 Specification

The TPS4HC120EVM is compatible with the TPS4HC120 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 (All channels enabled)	Channel Count	Package
TPS4HC120-Q1	1A	4	DGQ (HVSSOP, 28)

1.4 Device Information

The TPS4HC120-Q1 family is a fully-protected quad-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. The device diagnostic reporting has two versions to support both digital status output and analog current sense report. The diagnostics can be disabled for multiplexing the sense pin between different devices. Thermal shutdown behaviors as latch off or auto-retry are internally fixed in the part.

External programmable current limit improves the whole system’s reliability by limiting the 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 TPS4HC120-Q1 EVM.

2.1.1 Connections and Test Points

Connector and Test Point	Description
J4, TP6	Supply voltage VS
J24, TP15	Output voltage OUT1
J25, TP16	Output voltage OUT2
J26, TP17	Output voltage OUT3
J27, TP18	Output voltage OUT4
J5, TP13, TP14, and TP19-TP22	System GND
TP14	GND_IC test point
TP10, TP1, TP2, and TP3	ENABLE test points EN1-EN4
TP4, TP5	SELx test points SEL0-SEL1
TP11	DIAG_EN test point
TP7	FLT test point
TP8	LPM test point
TP9	SNS test point
J14 (GPIO connection)	1 connects to FLT pin, 2 connects to LPM pin, and 3 connects to SNS pin.

2.1.2 Jumper Configurations

Jumper	Function, Settings
J1	Connect 1 and 2 to power LDO from VS.
J3	Connect 1 and 2 to enable LDO.
J16	Connect 1 and 2 to pull-up for open load detection (OUT1).
J20	Connect 1 and 2 to route to GND through TVS diode network (OUT1).
J17	Connect 1 and 2 to pull-up for open load detection (OUT2).
J21	Connect 1 and 2 to route to GND through TVS diode network (OUT2).
J18	Connect 1 and 2 to pull-up for open load detection (OUT3).
J22	Connect 1 and 2 to route to GND through TVS diode network (OUT3).
J19	Connect 1 and 2 to pull-up for open load detection (OUT4).
J23	Connect 1 and 2 to route to GND through TVS diode network (OUT4).
J2	Connect 1 and 2 to bypass RILIM. Disconnect to use RILIM.
J6	Connect 1 and 2 to bypass the GND network. Disconnect to use GND network.
J15	Connect 1 and 2 to route LDO to device I/O pins.
J7	Connect 1 and 2 to GND EN1. Connect 2 and 3 to power EN1 from LDO.
J8	Connect 1 and 2 to GND EN.2 Connect 2 and 3 to power EN2 from LDO.
J9	Connect 1 and 2 to GND EN3. Connect 2 and 3 to power EN3 from LDO.
J10	Connect 1 and 2 to GND EN4. Connect 2 and 3 to power EN4 from LDO.
J11	Connect 1 and 2 to GND DIAG_EN. Connect 2 and 3 to power EN4 from LDO.
J12	Connect 1 and 2 to GND SEL0. Connect 2 and 3 to power SEL0 from LDO.
J13	Connect 1 and 2 to GND SEL1. Connect 2 and 3 to power SEL1 from LDO.

3 Implementation Results

3.1 Variable Resistor for CS and CL

3.1.1 Current Sense Resistor

The current sense function is internally implemented by a current mirror. This is reflected as an external resistor between the SNS pin and GND. The TPS4HC120 evaluation module resistor is located on pad R9. This can be adjusted externally but do take into consideration temperature and supply voltage.

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 10 settings that can be set based on RLIM. 1% tolerance resistors needs to be used in this application. R14 is the pad used for the adjustable current limit control.

Table 3-1. Current Limit Setting Through External Resistor

Resistor Value	Voltage Input	ILIM Threshold
57.6kΩ	0.06V	250mA
43.2kΩ	0.117V	500mA
31.6kΩ	0.234V	750mA
23.2kΩ	0.396V	1A
16.5kΩ	0.557V	1.25A
9.76kΩ	0.758V	1.5A
4.87kΩ	1.037V	1.75A
2.49kΩ	1.382V	2A
Short to GND	0V	2.25A
Open (> 80kΩ)	2.2V	5A

4 Hardware Design Files

4.1 TPS4HC120-Q1 Schematic

The EVM schematic is illustrated in Figure 4-1.

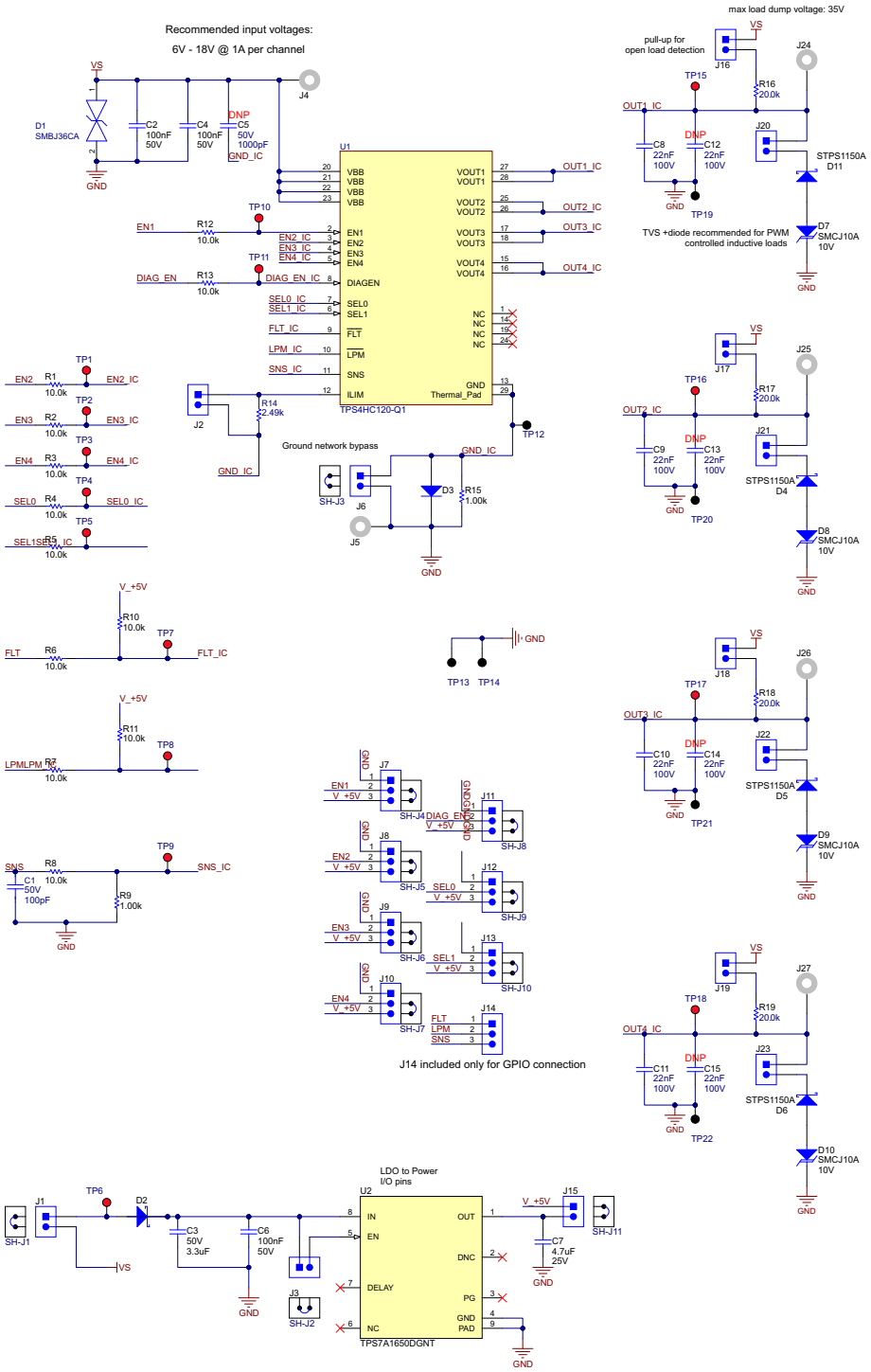


Figure 4-1. TPS4HC120-Q1EVM Schematic

4.2 TPS4HC120-Q1 EVM Assembly Drawings and Layout

The design of the TPS4HC120-Q1 printed-circuit board (PCB) is shown in Figure 4-2 to Figure 4-5. The EVM is designed using FR4 material, four-layer (2s2p), 2 × 70µm cubic in. top and bottom layers, and 2 × 35µm cubic in. internal plane layers. 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. Moving components to both sides of the PCB offers additional size reduction for space-constrained systems.

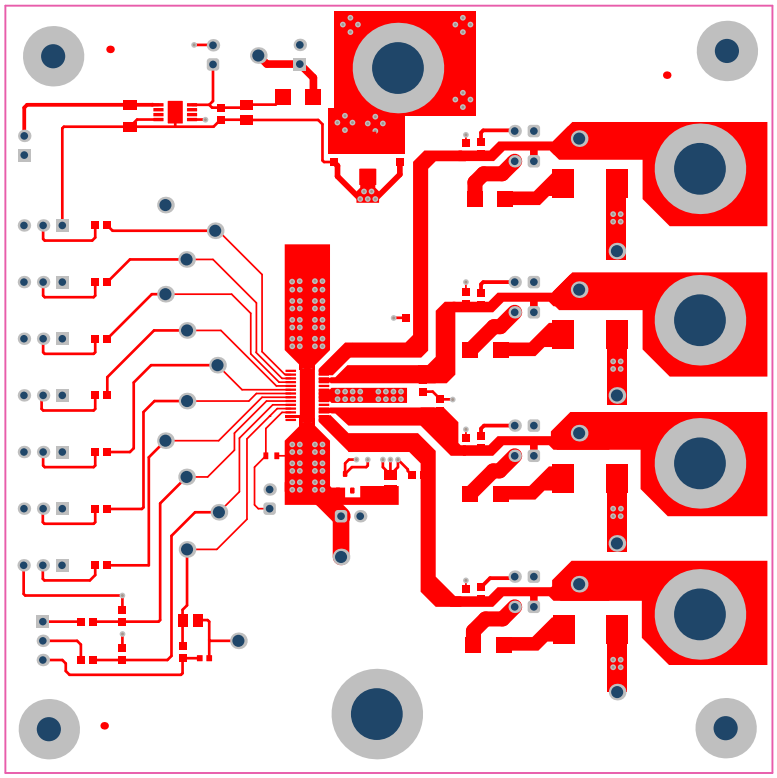


Figure 4-2. TPS4HC120-Q1EVM First Layer (Top View)

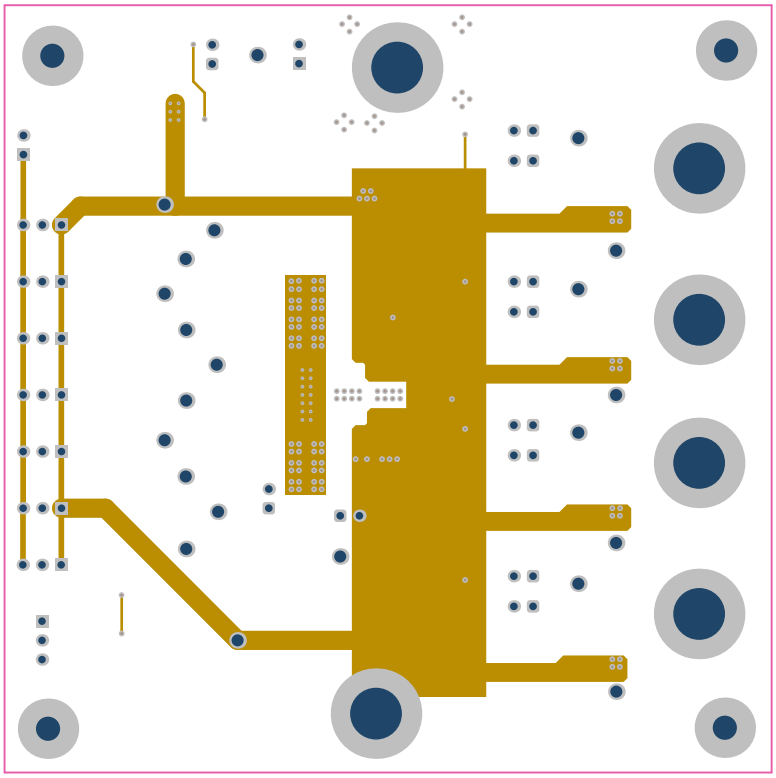


Figure 4-3. TPS4HC120-Q1EVM Second Layer GND (Top View)

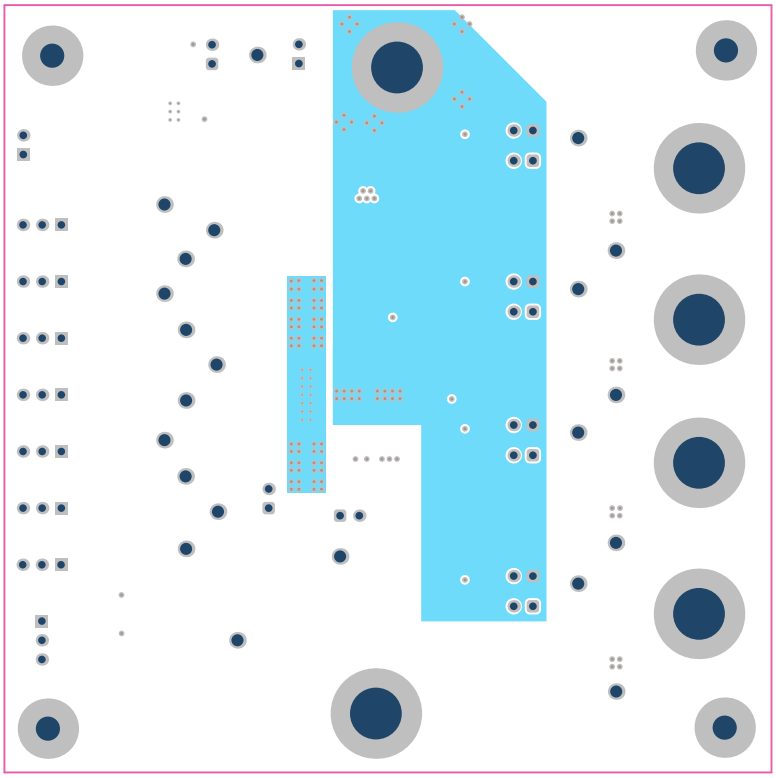


Figure 4-4. TPS4HC120-Q1EVM Third Layer VCC (Top View)

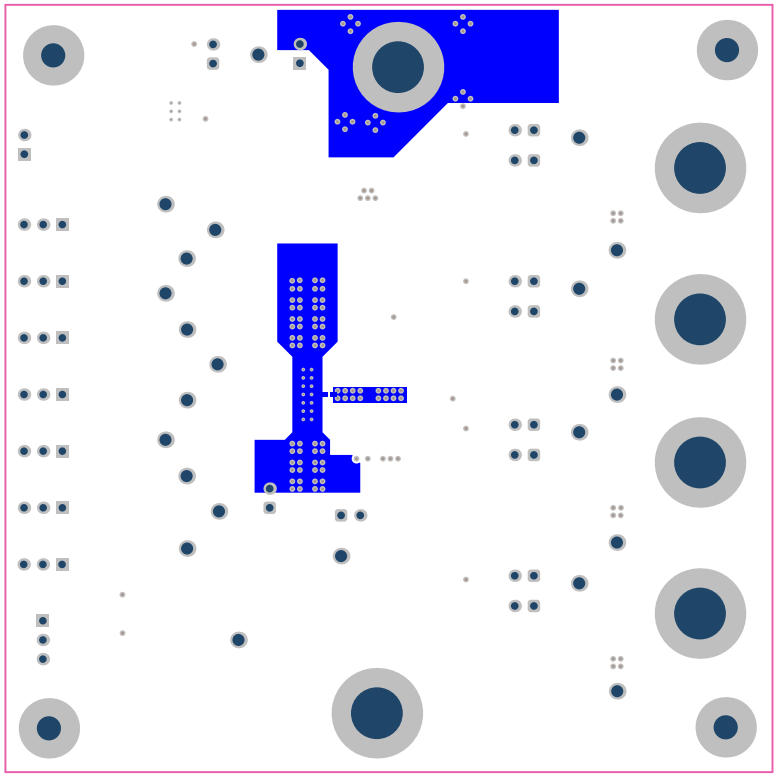


Figure 4-5. TPS4HC120-Q1EVM Fourth Layer (Top View)

4.3 Bill of Materials

The EVM BOM is listed in Table 4-1.

Table 4-1. Bill of Materials

Designator	Quantity	Value	Part Number	Package Reference	Manufacturer
C1	1	100pF	CL10C101JB8NNNC	0603	Samsung
C2, C6	2	0.1uF	C0603C104K5RACAUTO	0603	Kemet
C3	1	3.3uF	C2012X5R1H335K125AB	0805	TDK
C7	1	4.7uF	12063D475KAT2A	1206	AVX
C8, C9, C10, C11	4	0.022uF	C1608X7R2A223K080AA	0603	TDK
D1	1		SMBJ36CA	DO-214AA	Littelfuse
D2	1	50V	B150-13-F	SMA	Diodes Inc.
D3	1	200V	BAS21-7-F	SOT-23	Diodes Inc.
D4, D5, D6, D11	4	150V	STPS1150A	SMA	STMicroelectronics
D7, D8, D9, D10	4	10V	SMCJ10A	SMC	Bourns
H1, H3, H5, H7	4		1902C	Standoff	Keystone
H2, H4, H6, H8	4		NY PMS 440 0025 PH	Screw	B&F Fastener Supply
J1, J15	2		90120-0122	Header 2x1	Molex
J2, J3, J6, J16, J17, J18, J19, J20, J21, J22, J23	11		TSW-102-07-G-S	2x1 Header	Samtec
J4, J5, J24, J25, J26, J27	6		108-0740-001	Banana Jack	Cinch Connectivity
J7, J8, J9, J10, J11, J12, J13, J14	8		5-146278-3	Header, 3x1, 100mil, TH	TE Connectivity
R1, R2, R3, R4, R5, R6, R7, R8, R10, R11, R12, R13	12	10.0k	CRCW060310K0FKEA	0603	Vishay-Dale
R9	1	1.00k	ERJ-P06F1001V	0805	Panasonic
R14	1	2.49k	ERJ-3EKF2491V	0603	Panasonic
R15	1	1.00k	CRCW08051K00FKEA	0805	Vishay-Dale
R16, R17, R18, R19	4	20.0k	MCR03EZPD2002	0603	Rohm
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11	11	1x2	SNT-100-BK-G	Shunt	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP15, TP16, TP17, TP18	15		5010	Red Multipurpose Test point	Keystone
TP12, TP13, TP14, TP19, TP20, TP21, TP22	7		5011	Black Multipurpose Test point	Keystone
U1	1		TPS4HC120-Q1	VSSOP28	Texas Instruments
U2	1		TPS7A1650DGNT	DGN0008C	Texas Instruments

5 Additional Information

5.1 Trademarks

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