

# TPS65301EVM User's Guide

## 1 Introduction

The Texas Instruments TPS65301EVM evaluation module (EVM) evaluates the operation and performance of the TPS65301 power-supply IC for safety applications. The EVM contains the TPS65301 device and some circuitry for basic operation.

**Table 1. Device and Package Configurations**

CONVERTER	IC	PACKAGE
IC1	TPS65301QPWPRQ1	PWP-24

## 2 Background

## 3 Setup

This section describes the jumpers and connectors on the EVM, and how to properly connect, set up, and use the TPS65301EVM.

### 3.1 Input and Output Connector Descriptions

**Table 2. Connectors**

Connector	IN/OUT	Name	Description
J1	Output	VREG	Output terminal for the TPS65301 switch-mode converter
J2	Input	VBAT	Power input terminal for the device
J3	Input	IGN	Input terminal to enable the TPS65301
J4	Output	3.3V	Output terminal for the TPS65301 3.3-V linear regulator
J5	Output	1.2V	Output terminal for the TPS65301 1.2-V linear regulator
JP6	Output	5VS	Output terminal for the TPS65301 5-V linear regulator

### 3.2 Supply

The input voltage range for the converter is VBAT = 5.6 to 40 V. VBAT is supplied to J2.

**Table 3. EVM Voltages**

Name	IN/OUT	Connector	Pin	GND	Min	Typ	Max	Unit
VBAT	Input	J2	2, 4	12	5.6	13.8	40	V
VREG	Output	J1	22	12	5.3	5.45	5.6	
3.3V	Output	J4	18	12	3.234	3.3	3.366	
1.2V	Output	J5	16	12	1.176	1.2	1.224	
5V	Output	5V	10	12	4.9	5	5.1	
5VS	Output	J6	7	12	4.9	5	5.1	

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### 3.3 Jumper Settings

For proper operation of the TPS65301 device, jumpers must be properly configured. [Table 4](#) shows the recommended jumper settings.

**Table 4. EVM Jumper**

J	Description	Option	Standard
IGN	When IGN = High (jumper set), the device starts up.	Open shuts down the device	Set
EN	This jumper keeps the outputs of the devices active after ignition is turned off (IGN = low). However, a high level on IGN is required for initial start-up. Before initial start-up, the EN-jumper has no effect. Note that as opposed to IGN, the EN-pin is a logic-level-input, maximum input voltage must not exceed 5.25 V.	Open allows device shutdown with IGN	Set
3.3VPWR	This jumper supplies the 3.3-V regulator out of the buck regulator VREG.		Set
1.2VPWR	This jumper supplies the 1.2-V regulator out of the buck regulator VREG.		Set
J6	This jumper supplies 1.2-V regulator out of 3.3-V Regulator.		Open

### 3.4 Test Points

Test Points are placed to measure different nodes on the board.

**Table 5. Test Points**

Test Point	Description
VBAT	Power Input
VIN_D, VIN	Power Input after the reverse battery-protection diode
IGN	Ignition. This test point monitors if IGN-input is high, powering up the device.
IGN_EN	Ignition enable (IGN after series resistor)
BOOT_LDO	Voltage at the internal regulator, which supplies the power to charge the flying-boot capacitor.
VREG	Regulated output of the switch-mode converter, supplying 5.45 V
DELAY	Input for reset delay
SS	Input for soft start time
EN	Enable pin. When EN is high, the device remains active after IGN transitions to low.
GND (x7)	Ground
PH	Switch node, source of internal switching FET
nRST	Reset output for Switcher, which is asserted high after VREG and the 3.3-V and 1.2-V regulator outputs are regulating and after the delay timer expires.
3.3V	3.3-V linear-regulator output
3.3V DRIVE	DRIVE-Base drive for external 3.3-V-regulator bipolar transistor
1.2V	1.2-V linear-regulator output
1.2V DRIVE	DRIVE-Base drive for external 1.2-V-regulator bipolar transistor
VSENSE	Inverting node of the error amplifier for voltage-mode control of VREG
IGN_ST	Ignition input indicator which is asserted high while ignition input is high.
5V	Output of the 5-V linear regulator. Because no screw-terminal is provided for this output, use this test point to attach load.
5VS	Output of the 5-V-sensor linear regulator. Because no screw-terminal is provided for this output, use this test-point to attach load.

### 3.5 Switch Mode Output 5.45 V

The VREG voltage regulator is supplied by VBAT. Several blocking caps, C4 and C14, are connected from VBAT to GND and help stabilize the supply voltage. For long supply cables, additional bigger caps are helpful. The node PH is the switching node of the buck converter. L1 is the inductor connected to PH and VREG. The diode D1 is the freewheeling diode to allow current flow when the internal High-Side Transistor of the device is turned off. C1 and C2 are the output caps of the VREG regulator. The pin VREG is the feedback line used to close the control loop of the VREG regulator, and is also the supply node for internal use and for the 5-V and 5-VS regulator. The output voltage VREG is available at J1.

### 3.6 5V (5-V Linear Regulator)

5V is a fixed-regulated output of 5-V  $\pm 2\%$  over temperature and input supply using the precision-voltage sense-resistor network. A low-ESR ceramic capacitor is required for loop stabilization; this capacitor must be placed close to the pin of the IC. This output is protected against shorts to ground by a fold-back current limit for safe operating conditions, and by a current limit for limiting in-rush current due to depleted charge on the output capacitance. On initial IGN\_EN or EN power cycle the soft-start circuit on this regulator is initiated. The soft-start takes typically 13 ms. This output may require a larger output capacitor to ensure that during load transients the output does NOT drop below the required regulated specifications.

### 3.7 3.3V Linear-Regulator Controller (3.3-VSENSE)

The linear regulator controller requires an external NPN bipolar pass transistor of sufficient gain-stage to support the maximum load current required. The base-drive output current is protected by current-limiting both the source- and sink-drive circuitry. The 3.3VSENSE is the remote sense input of the output of REG3 supply and controls the 3.3VDRIVE output accordingly. This regulator is fixed at 3.3 V with  $\pm 2\%$  tolerance using a precision-voltage sense-resistor network. A low-ESR ceramic output capacitor is used for loop compensation of the regulator. A voltage on this pin of less-than approximately 50% of the regulated value initiates a current limit on the 3.3VDRIVE output. This output may require larger output capacitors to support load transients, so the output does *not* drop below 90% of 3.3 V.

### 3.8 1.2V Linear-Regulator Controller (1.2-VSENSE)

The linear regulator controller requires an external NPN bipolar pass transistor of sufficient gain stage to support the maximum load current required. The 1.2VSENSE is the remote-sense input of the output of 1.2-V supply and controls the 1.2VDRIVE output accordingly. This regulator output is 1.2 V with  $\pm 2\%$  tolerance using a precision-voltage sense-resistor network. A low-ESR ceramic-output capacitor is used for loop compensation of the regulator. A voltage on this pin of less-than approximately 50% of the regulated value initiates a current limit on the 1.2VDRIVE output. This output may require larger output capacitors to support load transients, so the output does *not* drop below 90% of 1.2 V.

### 3.9 5VS (Protected Sensor-Supply Linear Regulator)

5VS is a fixed-regulated output of 5-V  $\pm 2\%$  over temperature and input supply using a precision-voltage sense-resistor network. A low-ESR ceramic capacitor is required for loop stabilization; this capacitor must be placed close to the pin of the IC. This output is protected against shorts to ground by a fold-back current limit for safe operating conditions, and by a current limit for limiting in-rush current due to depleted charge on the output capacitance. This output is also protected against shorts to battery voltage by limiting the reverse current, and because of this, this supply is used to power a sensor outside the electrical-control unit, ECU.

On initial IGN\_EN or EN power cycle the soft-start circuit on this regulator is initiated. The soft-start takes typically 10 ms. This output may require a larger output capacitor to ensure that during load transients the output does *not* drop below the required regulated specifications.

4 EVM Schematic

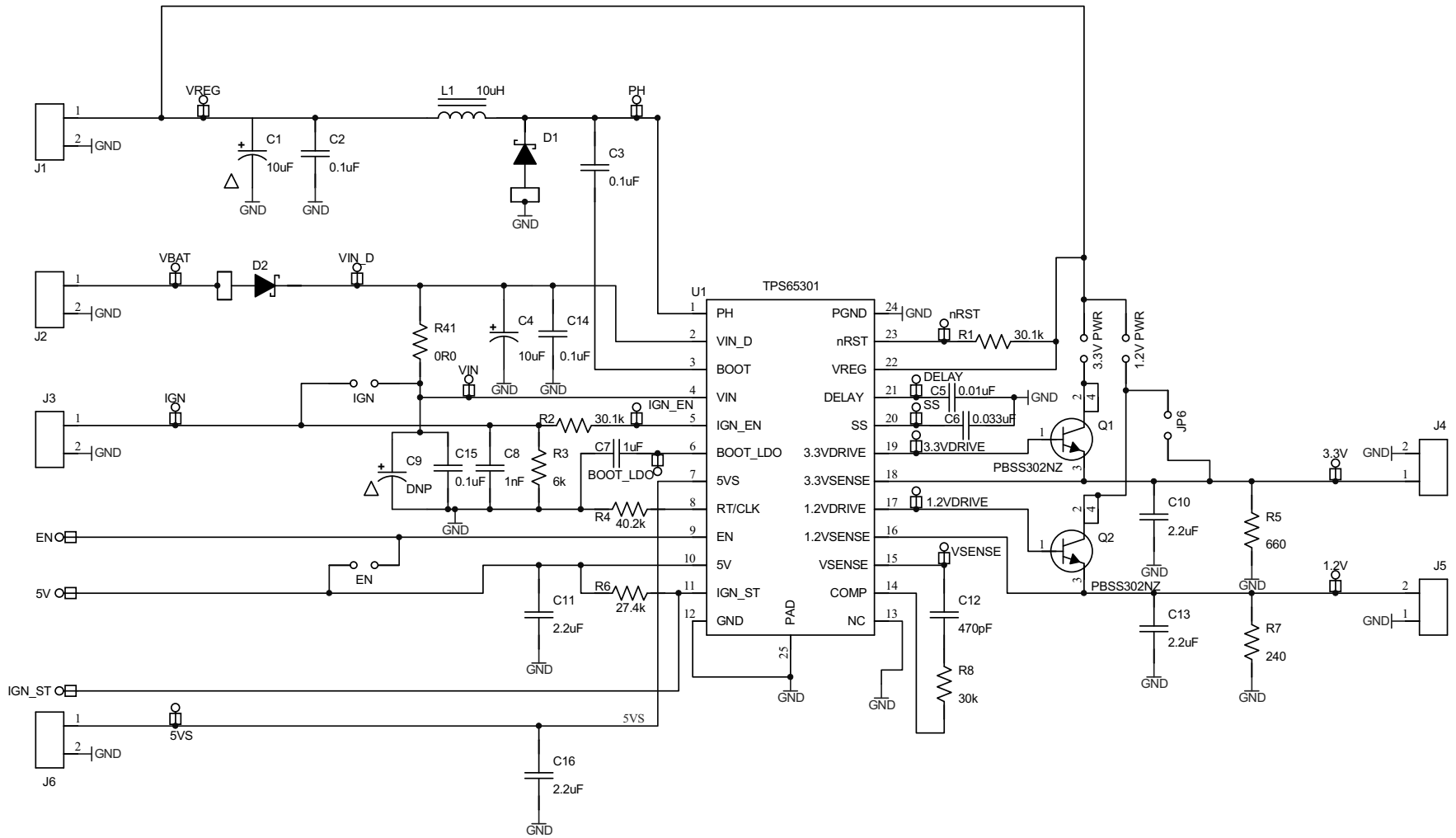


Figure 1. Schematic



## 7 Bill of Materials

Designator	Quantity	Description	Manufacturer	Part Number
PCB	1	Size 52.96 x 50.80 x 1,5 mm	Any	HVL057
C9	0	Uninstalled CAP1210	Uninstalled	CAP_0603 (UN)
C1	1	Capacitor, SMT, 1210, ceramic, 100 µF, 16V, 20%, X5R	TAIYO YUDEN	EMK325ABJ107MM
C10, C11, C13, C16	4	Capacitor, SMT, 1210, ceramic, 2.2 µF, 100V, 10%, X7R	KEMET	C1210C225K1RAC
C2, C3, C14, C15	4	Capacitor, SMT, 0603, ceramic, 50V, 10%, 0.1 µF, X7R	PANASONIC	ECJ-1VB1H104K
C5	1	Capacitor, SMT, 0603, ceramic, 0.01 µF, 100V, 5%, X7R	KEMET	C0603C103J1RAC
C7	1	Capacitor, SMT, 0603, ceramic, 1.0 µF, 16V, 10%, X5R	KEMET	C0603C105K4PAC
C8	1	Capacitor, SMT, 0603, ceramic, 0.001 µF, 50V, 5%, X7R	KEMET	C0603C102J5RAC
C6	1	Capacitor, SMT, 0603, ceramic, 10%_25V_0.033 µF	MURATA	GRM39X7R333K025A
C12	1	Capacitor, SMT, 0603, ceramic, 470pF, 5%, 50V, C0G(NP0)	KEMET	C0603C472J5RAC
C4	1	Capacitor aluminum elec, 10 µF, 50 V, 20%, SMD	PANASONIC	EEE-1HA100WAR
D1, D2	2	Diode, Schottky, 7 A, 60 V	DIODES INC	PDS760-13
J1, J2, J3, J4, J5, J6	6	TBLK_6A_2x3.5mm_Terminal, 2 pin, 6 A, 3,5 mm	OnShore technology Inc.	ED555/2DS
JP2, JP3, JP4, JP5, JP6	5	Header, THU, 1 x 2, 2,54 mm	Sullins	PEC02SAAN
L1	1	Festinduktoren 10 µH 11.2 A 0.0172 Ω	Coiltronics	DR127-100-R
Q1, Q2	2	20 V, 5.8 A NPN low VCEsat (BISS) transistor	NXP	PBSS302NZ
R1, R2	2	Resistor, SMT, 0603, 1%, 1/10 W, 30.1K	VISHAY	CRCW06033012F
R4	1	Resistor, SMT, 0603, 1%, 1/10W, 40.2K	VISHAY	CRCW06034022F
R6	1	Resistor, SMT, 0603, 1%, 1/10 W, 27.4K	VISHAY	CRCW06032742F
R41	1	Resistor, SMT, 0603, 1/10 W, 0 Ω	VISHAY	CRCW0603000Z
R8	1	Resistor, SMT, 0603, 5%, 1/10 W, 30K	PANASONIC	ERJ-3GSYJ303
R3	1	Resistor, SMT, 0603, 1%, 1/10 W, 6.04K	VISHAY	CRCW06036041F
R5	1	Resistor, SMT, 1206, 1%, ¼ W, 665 Ω	VISHAY	CRCW12066650F
R7	1	Resistor, SMT, 1206, 1%, ¼ W, 243 Ω	VISHAY	CRCW12062430F
TP1-TP27	27	Testpoint mini , 040'D black, Glass Beaded Test Point	Keystone	5001
U1	1	DUT, SMT, PWP, R-PDSO-G24, 0,65 mm LS, 7,9 x 6,6 x 1,2 mm, Thermal Pad	TI	TPS65301QPWPRQ1

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- 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.

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