Using the TPS22933AEVM-005 Triple-Input Power Multiplexer with Auto-Select and Integrated LDO

The TPS22933AEVM-005 evaluation module (EVM) allows the user to source up to 50mA from a fixed output Low Drop-Out Regulator (LDO) that is sourced by the highest of three inputs (2.5V to 12V). The EVM has fixed loads for each of the LDO outputs of 1mA and 25mA. The user can also supply an external load.

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1 Description

The TPS22933AEVM-001 evaluation module helps designers evaluate the operation and performance of the TPS22933A triple-input multiplexer with LDO. The board features the small 8-pin µQFN package for a small solution size. The TPS22933A LDO has one always on output (LOUT) and one switched output (VOUT). VOUT is enabled through the EN pin. When VOUT is disabled, the internal quick output discharge FET (QOD) is enabled to drain any residual voltage from the output.

Table 1. TPS22933A LDO Voltage Options[(1)]

EVM	Device	LOUT (V)
HVL005	TPS22933A	3.6 V

(1) Contact Factory for additional LDO output options.

1.1 Typical Applications

- Hand-held devices with multiple input sources (such as a battery, a USB port and a DC In jack).

1.2 Features

- Three integrated load switches automatically choose highest input
- Integrated 3.6V fixed LDO (contact factory for other LDO voltages)
- Switched and Always on LDO outputs
- Small µQFN package (1.5mm x 1.5mm)
- Input voltage range 2.5V to 12V
- Low ON-resistance (2.4Ω at 5V)
- 50mA max continuous current (split between LOUT and VOUT)
- Low threshold control input (EN)
- Switchover time 18µs typical
- Switchover voltage 150mV typical

2 Electrical Performance

Table 2. TPS22633AEVM-005 Electrical Performance

PARAMETER	TEST CONDITIONS [(1)]	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range		2.5		12	V
Maximum input current				50	mA
Electrical Characteristics					
Output voltage, LOUT	I_{LOUT} = 10 mA, VIN = 4.2 V		3.6		V
Output voltage, VOUT	I_{VOUT} = 10 mA, VIN = 4.2 V		3.6		V
ON resistance (Input to CAP)	VIN = 5.0 V, IOUT = 10 mA		2.4		Ω
ON resistance (LDO to VOUT)	IOUT = 10 mA		1.3		Ω
Pull-down resistance (VOUT to GND)	EN = 0 V		63.8		Ω
Systems Characteristics					
Switching Time			18		µs
Switching Voltage	VBAT = 4.2 V, VUSB rising from 4 V to 5 V		150		mV

(1) VIN = highest of BAT, USB, DC_IN

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3 Operation

3.1 Equipment

- **Voltage Sources:**
  - Three supplies capable of supplying 12V at 100mA are recommended.
  - Supply capable of ramping voltages (function generators may be useful) can be used to measure changeover times and voltages.
  - EN can be tied high or low on the EVM. It can also be driven by an external source.
- **Multimeters:**
  - One to three meters can be used to measure voltages (commonly CAP, LOUT and VOUT).
  - One or two ammeters may be useful for measuring currents (commonly I_{LOUT} and I_{VOUT}).
- **Output Load:**
  - The EVM comes with jumpers to allow 1mA and 25mA loads on each output (LOUT and VOUT).
  - Custom loads can be used by removing the EVM jumpers and using TP8 for the always on LDO output (LOUT) and TP10 for the switched LDO output (VOUT). Any of the ground test point can be used (TP14, TP15, TP16, TP17).
- **Oscilloscope:**
  - 4 channel 100MHz to monitor input supplies, EN, CAP, LOUT and VOUT as needed.
- **Recommended Wire Gauge:**
  - 22 AWG

3.2 Recommended Operating Setup

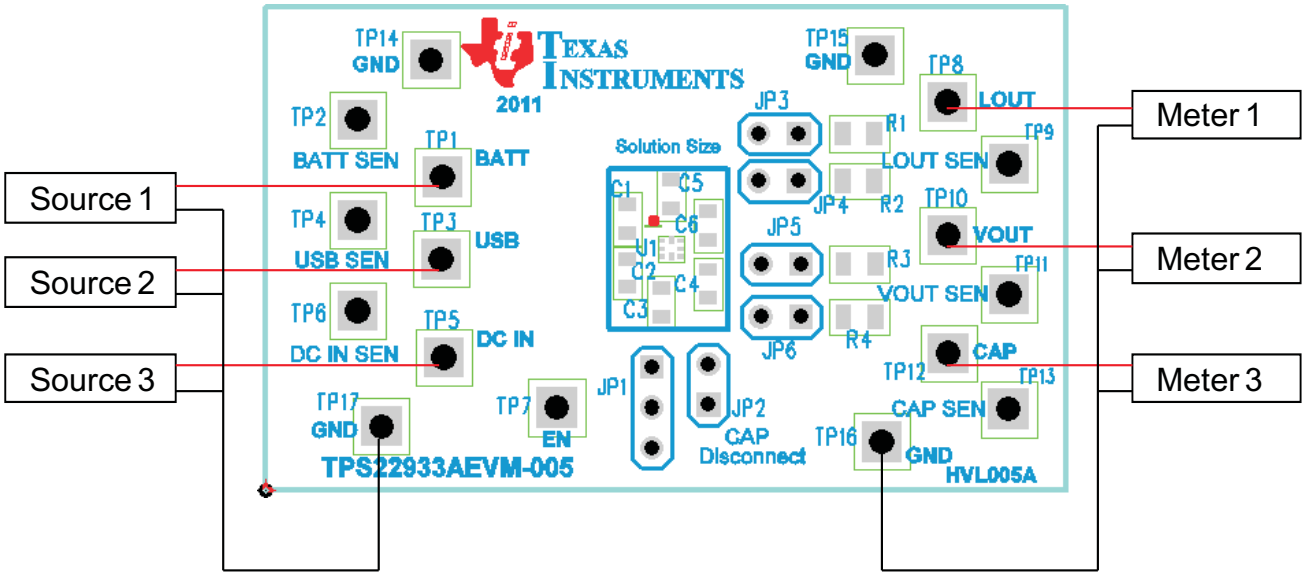

Figure 1. TPS22933AEVM-005 Recommended Operating Set Up

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3.3 List of Test Points

Table 3. The Functions of Each Test Points

Test Points	Name	Description
TP1	BATT	Input for BAT pin
TP2	BATT SEN	BAT pin sense
TP3	USB	Input for USB pin
TP4	USB SEN	USB pin sense
TP5	DC_IN	Input for DC_IN pin
TP6	DC IN SEN	DC_IN pin sense
TP7	EN	Enable pin force or measure
TP8	LOUT	Connection for LOUT load
TP9	LOUT SEN	LOUT pin sense
TP10	VOUT	Connection for VOUT load
TP11	VOUT SEN	VOUT pin sense
TP12	CAP	CAP pin measurement point
TP13	CAP SEN	CAP pin sense
TP14	GND	Ground Connection
TP15	GND	Ground Connection
TP16	GND	Ground Connection
TP17	GND	Ground Connection

3.4 List of Jumper Connections

Jumper JP1 is a two position Jumper to allow EN to be tied Low (2:3), High (1:2) or driven externally by tying pin 2 to a function generator or microcontroller.

Table 4. Jumper Settings

Jumpers	Jumper Not Installed	Jumper Installed
JP1	External Signal for EN	(1:2) – High, (2:3) – Low
JP2	No Capacitor from CAP to GND	1 nF capacitor between CAP and GND
JP3	—	1 mA load added to LOUT
JP4	—	25 mA load added to LOUT
JP5	—	1 mA load added to VOUT
JP6	—	25 mA load added to VOUT

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3.5 Operation Examples

The TPS22933A allows for much flexibility in a variety of applications and the EVM can be used to demonstrate its flexibility.

Application Examples:

3.5.1 Application Examples:

3.5.1.1 3-Input Multiplexer with Always On and Switched LDO

This example shows the most common use of the TPS22933A. Any handheld device might have three input sources: Lithium battery, USB port and a DC jack. Once power is applied to any of the inputs, the TPS22933A powers up the LDO and the MSP430 microcontroller is powered through the LOUT pin. At this point, the MSP430 may decide to enable the VOUT to supply current to a subsystem – or, it may wait until the specific functionality is required and power it then.

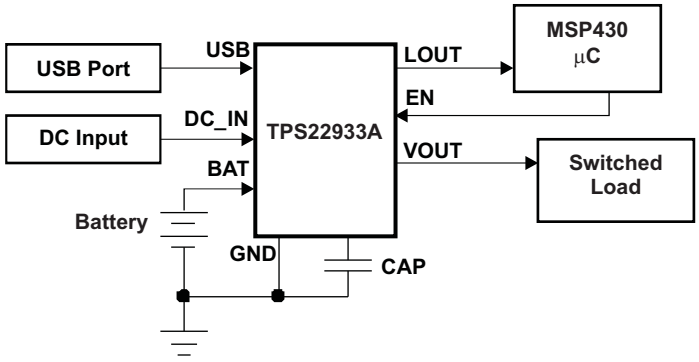

Figure 2. 3-Input MUX with LDO

3.5.1.2 3-Input Multiplexer with LDO Unused

This example shows the TPS22933A used solely as a 3-input multiplexer with the LDO left unused. The CAP pin is used as the output of the multiplexer. Since the CAP is simply the highest of the three inputs, the CAP pin will be as high as the input supply (minus the drop across the input switch). In this use in particular the user needs to keep in mind that the voltage picker has a 150mV (typical) switchover point. With a 2.4Ω R_{ON}, the maximum current would be limited by not only the power dissipation, but also by the switchover voltage. For 150mV and 2.4 Ω, a current of 62.5mA may result in a switch between supplies of equal voltage.

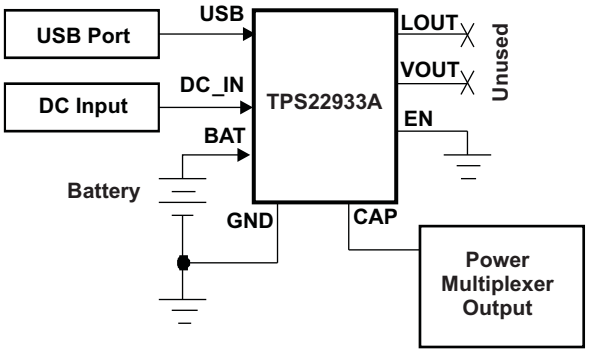

Figure 3. 3-Input Power MUX

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4 Operating Procedure

The TPS22933A will select the highest input voltage from BAT, USB and DC_IN to source the LDO. The CAP pin can be used to monitor the selection process. As one input pin becomes higher (typically 150mV) than the input currently driving the LDO, that input is selected to source the LDO. The CAP pin will change from the original voltage to the new higher voltage. Figure 4 and Figure 5 show examples of the transfer in LDO sourcing.

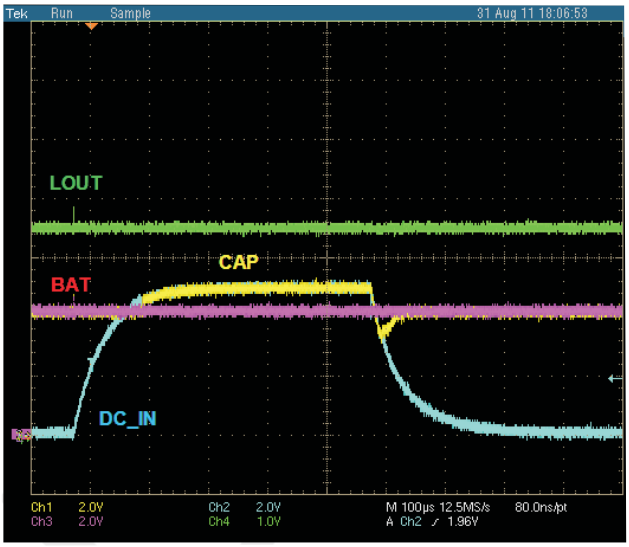

Figure 4. Voltage Changeover

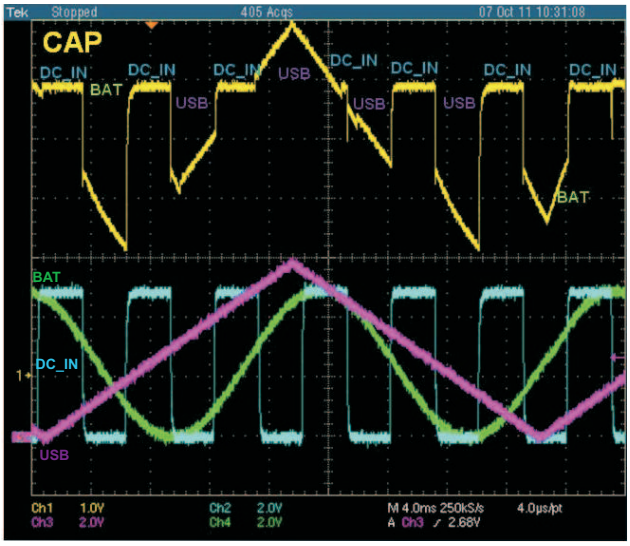

Figure 5. CAP Voltage During Switchover

Figure 4 shows the BAT pin (4.2V) controlling the LDO until the DC_IN supply overtakes the BAT voltage on its way to 5V. The CAP pin follows DC_IN up to 5V. As the DC_IN pin falls below BAT, the CAP pin goes back to the BAT voltage. Note that LOUT (at 3.6V) in unaffected by the changeover.

Figure 6. TPS22933A with Varying Inputs and CAP

Figure 7. TPS22933A with Varying Inputs and Stable LOUT

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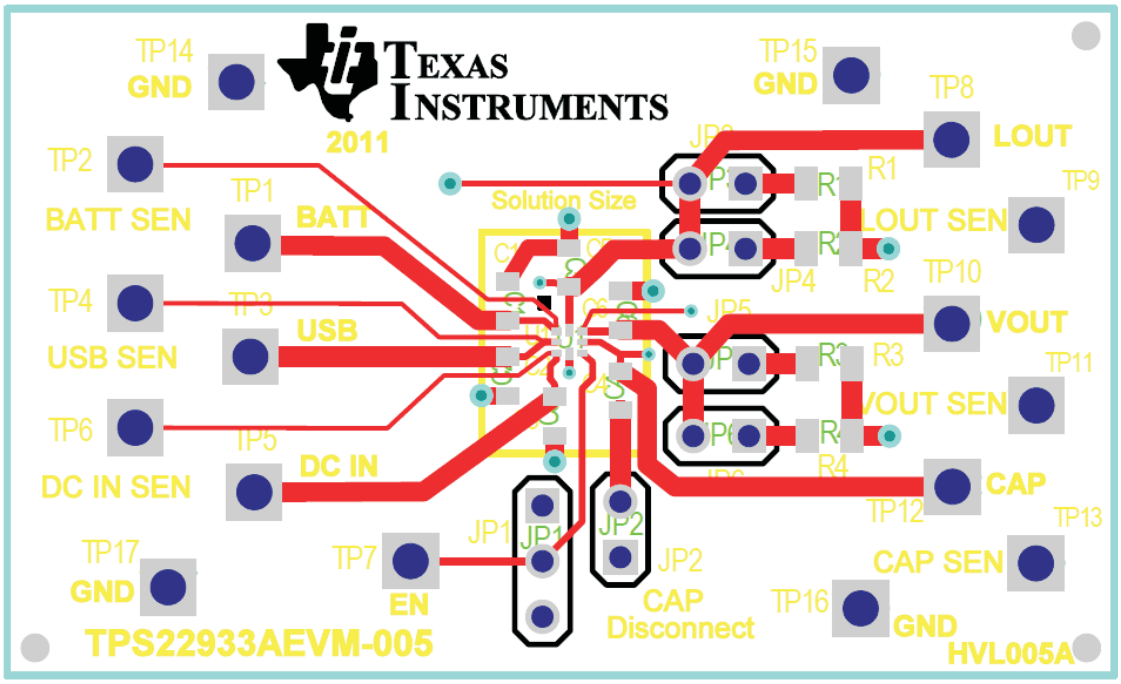
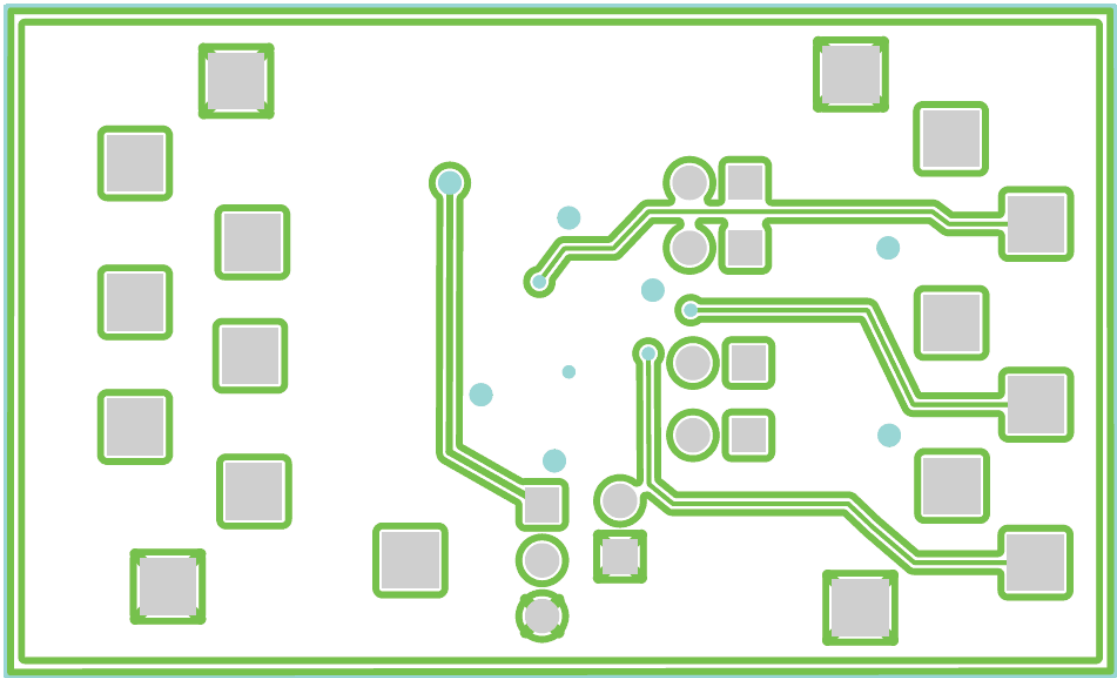
5 EVM Layout

5.1 Top Side



5.2 Bottom Side



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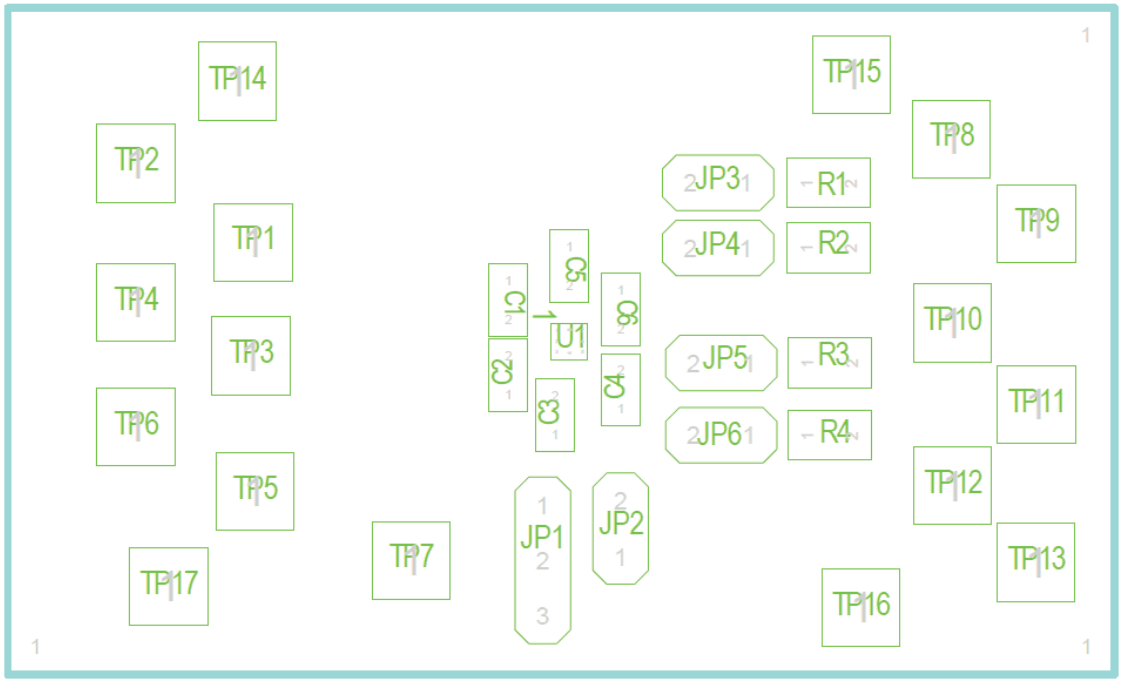
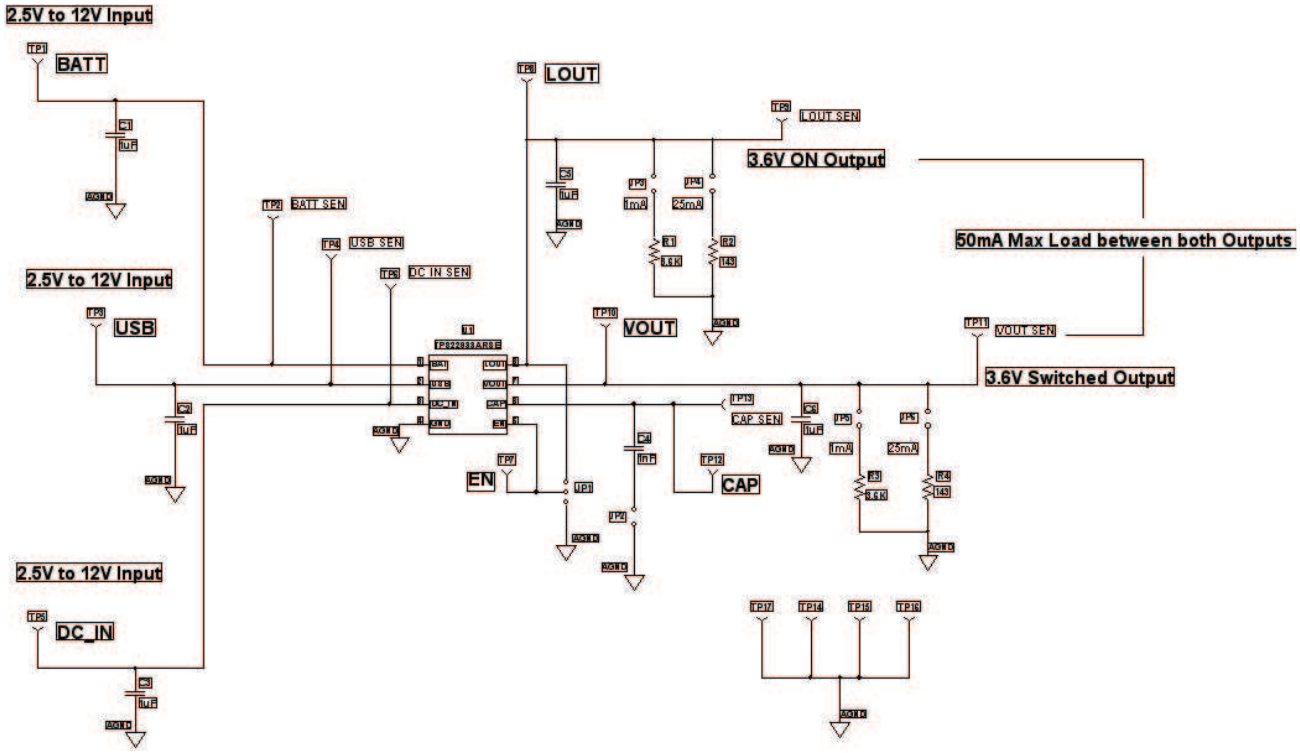
5.3 Top Assembly



6 Schematic and Bill of Materials

6.1 Schematic



6.2 Bill of Materials

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Count	Reference Designator	Value	Description	SIZE	Part Number	MFR
1	--		PCB, 1.2" x 2.0" x 0.062"		HVL005	Any
1	C4	1000pF	Capacitor, Ceramic, 25-V, NPO,5%	603	Std	Std
5	C1–C3, C5–C6	1uF	Capacitor, Ceramic, 25-V, X5R,10%	603	Std	Std
2	R1,R3	3.6K	Resistor, Chip 1/8W 5%	805	Std	Std
2	R2,R4	143	Resistor, Chip 1/8W 1%	805	Std	Std
5	JP2-JP6	PEC02SAAN	Header,2pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
1	JP1	PEC03SAAN	Header,3pin, 100mil spacing	0.100 inch x 3	PEC03SAAN	Sullins
1	U1	TPS22933ARSE	IC, Single Chip, Triple Load Switch w/ integrated LDO	RSE	TPS22933ARSE	TI
6	TP1, TP3, TP5, TP9, TP11, TP13	5012	Test Point PC Multipurpose WHT	0.063" (1.60mm) Hole Diameter	5012	Keystone
6	TP2, TP4, TP6, TP8, TP10, TP12	5014	Test Point PC Multipurpose YLW	0.063" (1.60mm) Hole Diameter	5014	Keystone
4	TP14–TP17	5011	Test Point PC Multipurpose BLK	0.063" (1.60mm) Hole Diameter	5011	Keystone
1	TP7	5010	Test Point PC Multipurpose RED	0.063" (1.60mm) Hole Diameter	5010	Keystone
3	NA	NA	Shunt, 100-mil, Black	0.100	929950-00	3M

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 14 V and the output voltage range of 3 V to 5 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

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During normal operation, some circuit components may have case temperatures greater than 50° C. The EVM is designed to operate properly with certain components above 50° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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