

TPS7B4250-Q1 Pin FMEA

Jason Liu

HVAL - MSA - AVL

ABSTRACT

The TPS7B4250-Q1 device is a monolithic, integrated low-dropout voltage tracker. The device is available in an SOT-23 package. The TPS7B4250-Q1 device is designed to supply off-board sensors in an automotive environment. The IC has integrated protection for overload, over temperature, reverse polarity, and output short-circuit to the battery and ground.

A reference voltage applied at the adjust-input pin, ADJ, regulates supply voltages up to $V_{IN} = 45\text{ V}$ with high accuracy and loads up to 50 mA.

Pin FMEA

This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of the TPS7B4250-Q1 Voltage-Tracking LDO Regulator. The failure conditions covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground
- Pin short-circuited to TPS7B4250-Q1 V_{IN}
- Pin short-circuited to car battery
- Pin short-circuited to an adjacent pin
- Pin is open-circuited

This application note also details how these pin conditions affect the device:

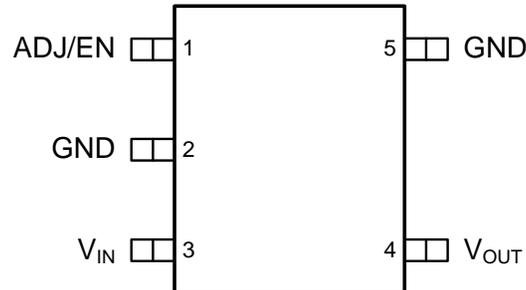
- Does the pin condition cause permanent damage?
- Is the device functional under the pin condition?
- How does the particular pin condition affect the device operation?

For purposes of this report:

- Unless otherwise specified, the voltage applied to the V_{IN} pin is within the TPS7B4250-Q1 Recommended Operating Range.
- The ADJ/EN pin is driven from an external source.
- Functionality = **YES** indicates the normal device operation.
- Damage = **YES** indicates damage to the device

Pin Configuration and Functions

DBV Package 5-Pin SOT23 Top View



Pin	Name	I/O	Description
1	ADJ/EN	I	This pin connects to the reference voltage. A low signal disables the IC and a high signal enables the IC. Connect the voltage reference directly or with a voltage divider for lower output voltages. To compensate for line influences, TI recommends placing a capacitor close to the IC pins.
2	GND	-	Device Ground. Internally connected to pin 5.
3	V_{IN}	I	This pin is the IC supply. To compensate for line influences, TI recommends placing a capacitor close to the IC pins.
4	V_{OUT}	O	V_{OUT} is an external capacitor that is required between V_{OUT} and GND with respect to the capacitance and ESR requirements given in the Recommended Operating Conditions.
5	GND	-	Device Ground. Internally connected to pin 2.

Table 1. Pin FMEA Analysis for Pin Short-Circuit to Ground

Pin		Short to Ground		
Number	Name	Damage	Functionality	Comments
1	ADJ/EN	No	No	Device is disabled
2	GND	No	Yes	Normal operation
3	V_{IN}	No	No	No output voltage. Either input supply is at 0.0 V, or input fuse is blown.
4	V_{OUT}	No	No	No output voltage. Output current limit is triggered and thermal shutdown may be activated.
5	GND	No	Yes	Normal operation

Table 2. Pin FMEA Analysis for Pin Short-Circuit to V_{IN}

Pin		Short to V_{IN}		
Number	Name	Damage	Functionality	Comments
1	ADJ/EN	Yes	No	Device may be damaged if V_{IN} is greater than 22 V
2	GND	No	No	V_{IN} is short to ground. Either input supply is at 0.0 V, or input fuse is blown.
3	V_{IN}	No	Yes	Normal operation
4	V_{OUT}	Yes	No	No V_{OUT} regulation. Output voltage is same as input voltage. Device may be damaged if V_{IN} is greater than 22 V.
5	GND	No	No	V_{IN} is short to ground. Either input supply is at 0.0 V, or input fuse is blown.

Table 3. Pin FMEA Analysis for Pin Short-Circuit to Car Battery Voltage

Pin		Short to Car Battery Voltage		
Number	Name	Damage	Functionality	Comments
1	ADJ/EN	Yes	No	Device may be damaged if battery voltage is greater than 22 V.
2	GND	No	No	Battery is short to ground. Either input supply is at 0.0 V, or input fuse is blown.
3	V _{IN}	No	Yes	Normal operation
4	V _{OUT}	Yes	No	No V _{OUT} regulation. Output voltage is same as input voltage. Device may be damaged if battery is greater than 22 V.
5	GND	No	No	Battery is shorted to ground. Either input supply is at 0.0 V, or input fuse is blown.

Table 4. Pin FMEA Analysis for Pin Short-Circuit to an Adjacent Pin

Pin		Shorted To		Short to Adjacent Pin		
Number	Name	Number	Name	Damage	Functionality	Comments
1	ADJ/EN	2	GND	No	No	Device is disabled
2	GND	3	V _{IN}	No	No	V _{IN} is short to ground. Either input supply is at 0.0 V, or input fuse is blown.
3	V _{IN}	4	V _{OUT}	Yes	No	No V _{OUT} regulation. Output voltage is same as input voltage. Device may be damaged if V _{IN} is greater than 22 V.
4	V _{OUT}	5	GND	No	No	No output voltage. Output current limit is triggered, and thermal shutdown may be activated.
5	GND	1	ADJ/EN	No	No	Device is disabled

Table 5. Pin FMEA Analysis for Pin Open-Circuit

Pin		Open		
Number	Name	Damage	Functionality	Comments
1	ADJ/EN	No	No	Device is disabled
2	GND	No	Yes	Device still functions because pin 5 is still connected
3	V _{IN}	No	No	No output voltage
4	V _{OUT}	No	No	No output voltage to load
5	GND	No	No	V _{OUT} is out of control because no reference of IC

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

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com