TPS7B4250-Q1 Pin FMEA

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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 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

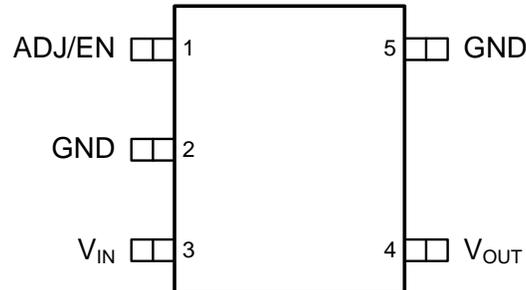This application note also details how these pin conditions affect the device:

- 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

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