Application Report
SLVA739–September 2015

# TPS7B69xx-Q1 Pin FMEA

*David Xu* *HVAL - MSA - AVL*

**ABSTRACT**

The TPS7B69xx-Q1 is a low-dropout (LDO) linear regulator designed for up to 40-V $V_{IN}$ operations. With only 15-µA typical quiescent current at light load, they are quite suitable for standby micro control unit systems especially in automotive applications.

The devices feature an integrated short-circuit and overcurrent protection. The devices operate during –40°C to 125°C temperature range. Because of these features, these devices are well suited in power supplies for various automotive applications.

## Pin FMEA

This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of the TPS7B69xx-Q1 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 TPS7B69xx-Q1 $V_{IN}$
- Pin short-circuited to an adjacent pin
- Pin is open-circuited

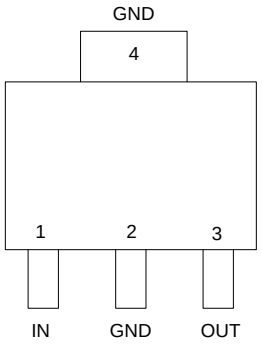
This application note also details how these pin conditions affect the device:

- 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 IN pin is within the TPS7B69xx-Q1 Recommended Operating Range.
- Functionality = YES indicates the normal device operation.
- Damage = YES indicates damage to the device

## Pin Configuration and Functions




| Pin No. SOT223 | Pin Name | Type | Description |
|---|---|---|---|
| 1 | IN | P | Input power supply voltage |
| 2, 4 | GND | G | Ground reference |
| 3 | OUT | P | Output voltage |

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

| Pin | | Short to Ground | | |
|---|---|---|---|---|
| Number | Name | Damage | Functionality | Comments |
| 1 | IN | No | No | No output voltage. Either input supply is at 0.0 V, or input fuse is blown. |
| 2 | GND | No | Yes | No effect |
| 3 | OUT | No | No | Output is forced OFF, $V_{OUT}$ is 0.0 V, current limit is triggered |
| 4 | GND | No | Yes | No effect |

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

| Pin | | Short to $V_{IN}$ | | |
|---|---|---|---|---|
| Number | Name | Damage | Functionality | Comments |
| 1 | IN | No | Yes | No effect |
| 2 | GND | No | No | No output voltage. Either input supply is at 0.0 V, or input fuse is blown. |
| 3 | OUT | Yes | No | No $V_{OUT}$ regulation. Output voltage is same as input voltage. Device may be damaged if $V_{IN}$ is greater than 7 V. |
| 4 | GND | No | No | No output voltage. Either input supply is at 0.0 V, or input fuse is blown. |

**Table 3. 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 | IN | 2 | GND | No | No | No output voltage. Either input supply is 0.0 V, or input fuse is blown. |
| 2 | GND | 3 | OUT | No | No | Output is forced OFF, $V_{OUT}$ is 0.0 V, current limit is triggered |
| 3 | OUT | 4 | GND | No | No | Output is forced OFF, $V_{OUT}$ is 0.0 V, current limit is triggered |
| 4 | GND | 1 | IN | No | No | No output voltage. Either input supply is 0.0 V, or input fuse is blown. |

**Table 4. Pin FMEA Analysis for Pin Open-Circuit**

| Pin | | Open | | |
|---|---|---|---|---|
| Number | Name | Damage | Functionality | Comments |
| 1 | IN | No | No | No output voltage |
| 2 | GND | No | Yes | No effect |
| 3 | OUT | No | No | No output voltage to load |
| 4 | GND | No | Yes | No effect |

## 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** | | **Applications** | |
|---|---|---|---|
| Audio | www.ti.com/audio | Automotive and Transportation | www.ti.com/automotive |
| Amplifiers | amplifier.ti.com | Communications and Telecom | www.ti.com/communications |
| Data Converters | dataconverter.ti.com | Computers and Peripherals | www.ti.com/computers |
| DLP® Products | www.dlp.com | Consumer Electronics | www.ti.com/consumer-apps |
| DSP | dsp.ti.com | Energy and Lighting | www.ti.com/energy |
| Clocks and Timers | www.ti.com/clocks | Industrial | www.ti.com/industrial |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Security | www.ti.com/security |
| Power Mgmt | power.ti.com | Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Microcontrollers | microcontroller.ti.com | Video and Imaging | www.ti.com/video |
| RFID | www.ti-rfid.com | | |
| OMAP Applications Processors | www.ti.com/omap | **TI E2E Community** | e2e.ti.com |
| Wireless Connectivity | www.ti.com/wirelessconnectivity | | |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265