Functional Safety Information

TPS7B69-Q1
Functional Safety FIT Rate, FMD and Pin FMA

Table of Contents

Trademarks

1 Overview

This document contains information for the TPS7B69-Q1 (SOT-223 and SOT-23 packages) to aid in a functional safety system design. Information provided are:

- Functional safety failure in time (FIT) rates of the semiconductor component estimated by the application of industry reliability standards
- Component failure modes and their distribution (FMD) based on the primary function of the device
- Pin failure mode analysis (pin FMA)

Figure 1-1 shows the device functional block diagram for reference.

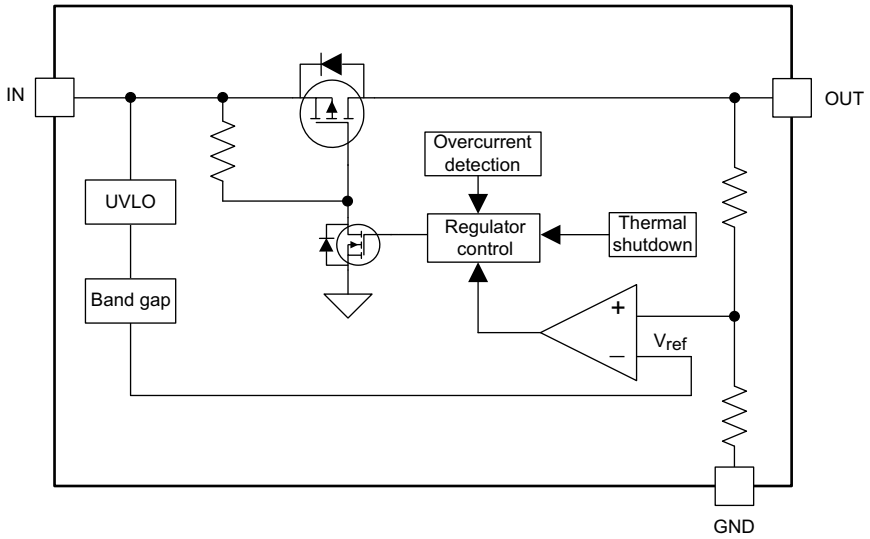

Figure 1-1. Functional Block Diagram

The TPS7B69-Q1 was developed using a quality-managed development process, but was not developed in accordance with the IEC 61508 or ISO 26262 standards.

2 Functional Safety Failure In Time (FIT) Rates

2.1 SOT-223 Package

This section provides functional safety failure in time (FIT) rates for the SOT-223 package of the TPS7B69-Q1 based on two different industry-wide used reliability standards:

- Table 2-1 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 2-2 provides FIT rates based on the Siemens Norm SN 29500-2

Table 2-1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10^9 Hours)
Total component FIT rate	14
Die FIT rate	5
Package FIT rate	9

The failure rate and mission profile information in Table 2-1 comes from the reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission profile: Motor control from table 11
- Power dissipation: 300 mW
- Climate type: World-wide table 8
- Package factor (lambda 3): Table 17b
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2-2. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
4	Power amplifier and regulators ≤ 1 Watt	40 FIT	70°C

The reference FIT rate and reference virtual T_J (junction temperature) in Table 2-2 come from the Siemens Norm SN 29500-2 tables 1 through 5. Failure rates under operating conditions are calculated from the reference failure rate and virtual junction temperature using conversion information in SN 29500-2 section 4.

2.2 SOT-23 Package

This section provides functional safety failure in time (FIT) rates for the SOT-23 package of the TPS7B69-Q1 based on two different industry-wide used reliability standards:

- Table 2-3 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 2-4 provides FIT rates based on the Siemens Norm SN 29500-2

Table 2-3. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10^9 Hours)
Total component FIT rate	18
Die FIT rate	16
Package FIT rate	2

The failure rate and mission profile information in Table 2-3 comes from the reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission profile: Motor control from table 11
- Power dissipation: 300 mW
- Climate type: World-wide table 8
- Package factor (lambda 3): Table 17b
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2-4. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
4	Power amplifier and regulators ≤ 1 Watt	40 FIT	70°C

The reference FIT rate and reference virtual T_J (junction temperature) in Table 2-4 come from the Siemens Norm SN 29500-2 tables 1 through 5. Failure rates under operating conditions are calculated from the reference failure rate and virtual junction temperature using conversion information in SN 29500-2 section 4.

3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for the TPS7B69-Q1 in Table 3-1 comes from the combination of common failure modes listed in standards such as IEC 61508 and ISO 26262, the ratio of sub-circuit function size and complexity, and from best engineering judgment.

The failure modes listed in this section reflect random failure events and do not include failures resulting from misuse or overstress.

Table 3-1. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
VOUT high (following VIN)	15
VOUT not in specification (voltage or timing)	60
VOUT low (no output)	20
Short circuit any two pins	5

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the TPS7B69-Q1 (SOT-223 and SOT-23 packages). The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to ground (see Table 4-2 and Table 4-6.)
- Pin open-circuited (see Table 4-3 and Table 4-7)
- Pin short-circuited to an adjacent pin (see Table 4-4 and Table 4-8)
- Pin short-circuited to supply (see Table 4-5 and Table 4-9)

Table 4-2 through Table 4-9 also indicate how these pin conditions can affect the device as per the failure effects classification in Table 4-1.

Table 4-1. TI Classification of Failure Effects

Class	Failure Effects
A	Potential device damage that affects functionality
B	No device damage, but loss of functionality
C	No device damage, but performance degradation
D	No device damage, no impact to functionality or performance

4.1 SOT-223 Package

Figure 4-1 shows the TPS7B69-Q1 pin diagram for the SOT-223 package. For a detailed description of the device pins, see the *Pin Configuration and Functions* section in the TPS7B69-Q1 data sheet.

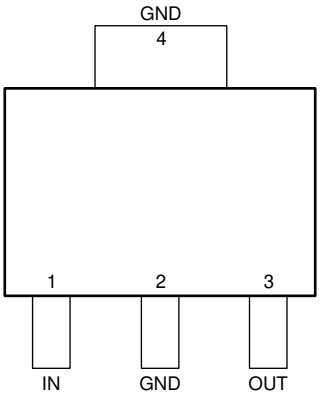

Figure 4-1. Pin Diagram (SOT-223 Package)

Table 4-2. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	No output voltage. System performance depends on the upstream current limit.	B
GND	2	No effect. Normal operation.	D
OUT	3	Current limit is triggered, and the device can repeatedly enter and exit thermal shutdown depending on power dissipation.	B
GND	4	No effect. Normal operation.	D

Table 4-3. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	Power is not supplied to the device, resulting in no output voltage.	B
GND	2	A floating GND pin can result in incorrect voltage regulation or no output voltage.	B
OUT	3	The output is disconnected from the load.	B
GND	4	A floating GND pin can result in incorrect voltage regulation or no output voltage.	B

Table 4-4. Pin FMA for Device Pins Short-Circuited to Adjacent Pin

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effects	Failure Effect Class
IN	1	GND	No output voltage. System performance depends on the upstream current limit.	B
GND	2	OUT	Current limit is triggered, and the device can repeatedly enter and exit thermal shutdown depending on power dissipation.	B
OUT	3	GND	Current limit is triggered, and the device can repeatedly enter and exit thermal shutdown depending on power dissipation.	B

Table 4-5. Pin FMA for Device Pins Short-Circuited to supply

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	No effect. Normal operation.	D
GND	2	No output voltage. System performance depends on the upstream current limit.	B
OUT	3	The output is not regulated. $V_{OUT} = V_{IN}$. The OUT pin can be damaged if the absolute maximum rating (7 V) is violated.	B/A
GND	4	No output voltage. System performance depends on the upstream current limit.	B

4.2 SOT-23 Package

Figure 4-2 shows the TPS7B69-Q1 pin diagram for the SOT-23 package. For a detailed description of the device pins, see the *Pin Configuration and Functions* section in the TPS7B69-Q1 data sheet.

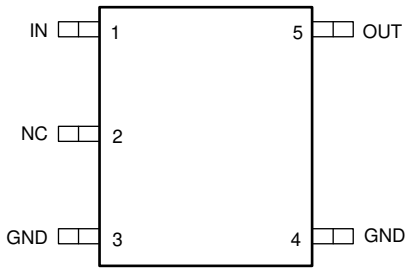

Figure 4-2. Pin Diagram (SOT-23 Package)

Table 4-6. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	No output voltage. System performance depends on the upstream current limit.	B
NC	2	No effect. Normal operation.	D
GND	3	No effect. Normal operation.	D
GND	4	No effect. Normal operation.	D
OUT	5	Current limit is triggered, and the device can repeatedly enter and exit thermal shutdown depending on power dissipation.	B

Table 4-7. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	Power is not supplied to the device, resulting in no output voltage.	B
NC	2	No effect. Normal operation.	D
GND	3	A floating GND pin can result in incorrect voltage regulation or no output voltage.	B
GND	4	A floating GND pin can result in incorrect voltage regulation or no output voltage.	B
OUT	5	The output is disconnected from the load.	B

Table 4-8. Pin FMA for Device Pins Short-Circuited to Adjacent Pin

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effects	Failure Effect Class
IN	1	NC	No effect. Normal operation.	D
NC	2	GND	No effect. Normal operation.	D
GND	3	GND	No effect. Normal operation.	D
GND	4	OUT	Current limit is triggered, and the device can repeatedly enter and exit thermal shutdown depending on power dissipation.	B

Table 4-9. Pin FMA for Device Pins Short-Circuited to supply

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
IN	1	No effect. Normal operation.	D
NC	2	No effect. Normal operation.	D
GND	3	No output voltage. System performance depends on the upstream current limit.	B
GND	4	No output voltage. System performance depends on the upstream current limit.	B
OUT	5	The output is not regulated. $V_{OUT} = V_{IN}$. The OUT pin can be damaged if the absolute maximum rating (7 V) is violated.	B/A

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

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