Functional Safety Information

TPS3899-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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Trademarks

1 Overview

This document contains information for TPS3899-Q1 (DSE package) 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.

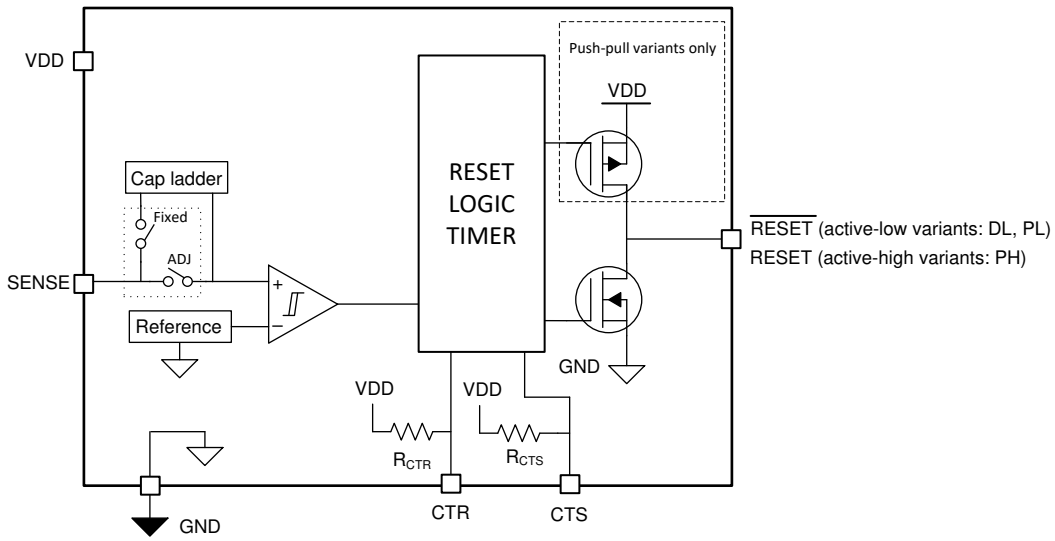

Figure 1-1. Functional Block Diagram

TPS3899-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

This section provides Functional Safety Failure In Time (FIT) rates for TPS3899-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	4
Die FIT Rate	2
Package FIT Rate	2

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: 10 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
5	CMOS, BICMOS Digital, analog / mixed	25 FIT	55°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.

3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for TPS3899-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 due to misuse or overstress.

Table 3-1. Die Failure Modes and Distribution

DIE FAILURE MODES	FAILURE MODE DISTRIBUTION (%)
RESET ($\overline{\text{RESET}}$) fails to trip	30%
RESET ($\overline{\text{RESET}}$) false trip	30%
RESET ($\overline{\text{RESET}}$) trip outside time specification	40%

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TPS3899-Q1. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground (see Table 4-2)
- Pin open-circuited (see Table 4-3)
- Pin short-circuited to an adjacent pin (see Table 4-4)
- Pin short-circuited to supply (see Table 4-5)

Table 4-2 through Table 4-5 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

Figure 4-1 shows the TPS3899-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TPS3899-Q1 data sheet.

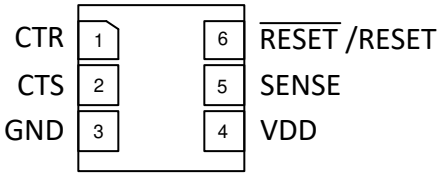

Figure 4-1. Pin Diagram

Following are the assumptions of use and the device configuration assumed for the pin FMA in this section:

- Unless otherwise specified, it is assumed that the voltages applied to all the pins are within the Recommended Operating Range specified in the data sheet
- Note that voltage maximum for some pins is referenced to VDD

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

PIN NAME	PIN NO.	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
CTR	1	No damage to device, can affect functionality. Forces RESET, $\overline{\text{RESET}}$ to be asserted.	B
CTS	2	No damage to device, can affect functionality. Forces RESET, $\overline{\text{RESET}}$ to be de-asserted.	B
GND	3	Normal operation.	D
VDD	4	No damage to device, can affect functionality. Shorts voltage supply to ground, increases system current.	C
SENSE	5	Defined operation, no damage to device. Forces $\overline{\text{RESET}}$ to be asserted.	C
$\overline{\text{RESET}}$ (open-drain)	6	No damage to device, can affect functionality. $\overline{\text{RESET}}$ stays asserted. Increased leakage current	B
$\overline{\text{RESET}}$ (push-pull)	6	May damage the device, can affect functionality. $\overline{\text{RESET}}$ stays asserted. Increased leakage current	A

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

PIN NAME	PIN NO.	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
CTR	1	Normal operation.	D
CTS	2	Normal operation.	D
GND	3	No damage to device, can affect functionality. Device is unpowered.	C
VDD	4	No damage to device, affects functionality. Device is unpowered.	B
SENSE	5	No damage to the device, sensed voltage indeterminate, output would be not as expected.	B
$\overline{\text{RESET}}$ (open-drain)	6	Reset functionality will be lost	B
$\overline{\text{RESET}}$ (push-pull)	6	Reset functionality will be lost	B

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

PIN NAME	PIN NO.	SHORTED TO	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
CTR	1	CTS	No damage to device, CTR, CTS delays not as expected.	C
CTS	2	GND	No damage to device, can affect functionality. Forces RESET, $\overline{\text{RESET}}$ to be de-asserted.	B
GND	3	VDD	No damage to device, can affect functionality. Shorts voltage supply to ground, increases current.	C
VDD	4	SENSE	No damage to device, can affect functionality. RESET, $\overline{\text{RESET}}$ does not pull low	B
SENSE	5	$\overline{\text{RESET}}$ (open-drain)	Potential damage to device and loss of functionality due to $\overline{\text{RESET}}$ pulling low fighting against SENSE.	A
SENSE	5	$\overline{\text{RESET}}$ (push-pull)	Potential damage to device and loss of functionality due to $\overline{\text{RESET}}$ pulling low and high fighting against SENSE.	A
$\overline{\text{RESET}}$ (open-drain)	6	CTR	No damage to device, can affect functionality. $\overline{\text{RESET}}$ does not pull high	C
$\overline{\text{RESET}}$ (push-pull)	6	CTR	No damage to device, can affect functionality. $\overline{\text{RESET}}$ does not pull high	C

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

PIN NAME	PIN NO.	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
CTR	1	No damage to device, can affection functionality. Forces RESET, $\overline{\text{RESET}}$ to be de-asserted.	B
CTS	2	No damage to device, can affection functionality. Forces RESET, $\overline{\text{RESET}}$ to be asserted.	B
GND	3	No damage to device, can affect functionality. Shorts voltage supply to ground, increases system current.	C
VDD	4	Normal operation.	D
SENSE	5	No damage to device, can affect functionality. RESET, $\overline{\text{RESET}}$ does not pull low	B
$\overline{\text{RESET}}$ (open-drain)	6	Might damage to device, can affect functionality. $\overline{\text{RESET}}$ stuck high. Increased leakage current.	A
$\overline{\text{RESET}}$ (push-pull)	6	Might damage the device, affects functionality. Increased leakage current	A

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