

Functional Safety Information

TPS35 and TPS36 Functional Safety FIT Rate, FMD and Pin FMA for Pinout D



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1 Overview

This document contains information for TPS35 and TPS36, (DDF 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 show the device functional block diagram for reference.

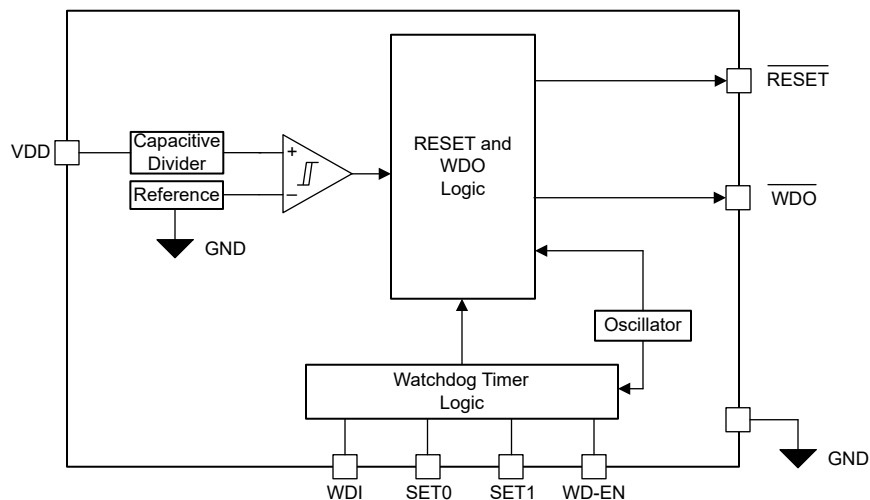


Figure 1-1. TPS35 and TPS36 Pinout Option D

TPS35 and TPS36 were developed using a quality-managed development process, but were 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 TPS35 and TPS36 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: 364 μ W
- Climate type: World-wide Table 8
- Package factor (λ_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 TPS35 and TPS36 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 TPS35 and TPS36

Die Failure Modes	Failure Mode Distribution (%)
False assert on RESET or WDO	1%
RESET or WDO remain asserted	3%
Incorrect timing operation (early or late WDO faults, RESET/WDO de-assertion delays)	66%
RESET trip outside of specification.	24%
Supply current is out of spec	6%

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TPS35 and TPS36. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

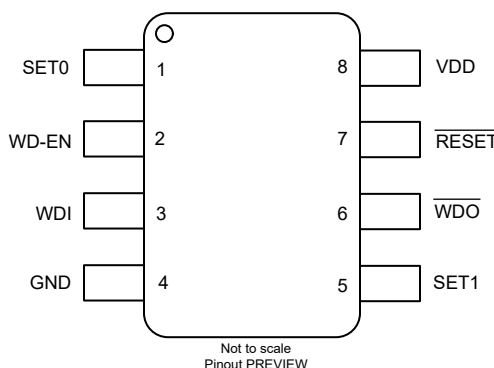
- Pin short-circuited to Ground (see [Table 4-2](#))
- Pin open-circuited (see [Table 4-3](#))
- Pin short-circuited to an adjacent pin (see [Table 4-4](#))
- Pin short-circuited to supply (see [Table 4-5](#))

[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](#) show the TPS35 and TPS36 pin diagram. For a detailed description of the device pins please refer to [TPS35](#), or [TPS36](#) in the *Pin Configuration and Functions* section of the data sheet.



**Figure 4-1. Pin Configuration Option D
DDF Package, 8-Pin SOT-23,
TPS35 and TPS36 Top View**

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

- Output reset Pullup Resistor (R_{PULLUP}) = 10k Ω , Output reset pullup voltage (V_{PULLUP})= 5.5V, output reset load (C_{LOAD}) = 10pF, WDO Pullup Resistor (R_{PULLUP_WDO}) = 10k Ω , WDO pullup voltage (V_{PULLUP_WDO} = 5.5V)
- Tables valid over the operating free-air temperature range of – 40°C to 125°C, unless otherwise noted.
- Typical values are at T_A = 25°C, VDD = 6.0V unless stated otherwise.

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
SET0	1	Unexpected behavior if application needs SET0 = 1.	B
WD-EN	2	Watchdog functionality disabled.	B
WDI	3	Constant WD timeout faults.	B
GND	4	Expected operating condition.	D
SET1	5	Unexpected behavior if application needs SET1 = 1.	B
WDO (Open Drain)	6	WDO constantly asserted; some additional current can flow through pullup resistor.	B
WDO (Push Pull)	6	Functionality lost and can cause permanent damage.	A
RESET (Open Drain)	7	RESET constantly asserted; some additional current can flow through pullup resistor.	B
RESET (Push Pull)	7	Functionality lost and can cause permanent damage.	A
VDD	8	Device non-operational.	B

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

PIN NAME	PIN NO.	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
SET0	1	Leads to large indeterminate voltage levels. This causes large currents that can damage the device. The output behavior is not deterministic.	A
WD-EN	2	Nothing happens until error condition or power cycle, then WD is disabled.	B
WDI	3	Leads to large indeterminate voltage levels. This causes large currents that can damage the device. The output behavior is not deterministic.	C
GND	4	Device is non-operational.	B
SET1	5	Leads to large indeterminate voltage levels. This causes large currents that can damage the device. The output behavior is not deterministic.	A
WDO (Open Drain)	6	Constant high, no WDO functionality.	B
WDO (Push Pull)	6	High impedance output, no WDO functionality.	B
RESET (Open Drain)	7	Constant high, no RESET functionality.	B
RESET (Push Pull)	7	High impedance output, no RESET functionality.	B
VDD	8	Device is non-operational.	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
SET0	1	WD-EN	SET0 toggles with WD-EN.	B
WD-EN	2	WDI	High current at a system level can flow to the device driving WD-EN or WDI.	B
WDI	3	GND	Constant WD timeout faults.	B
GND	4	SET1	Unexpected behavior if application needs SET1 = 1.	B
SET1	5	WDO (Open Drain)	High current can flow from SET1 or WDO based on the pullup resistor value.	B
SET1	5	WDO (Push Pull)	Can cause permanent damage.	A
WDO (Open Drain)	6	RESET (Open Drain)	Proper operation ORing WDO and RESET outputs.	B

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

PIN NAME	PIN NO.	SHORTED TO	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
RESET (Open Drain)	7	VDD	Large current can flow into RESET when in error condition. This can cause permanent damage.	A
RESET (Push Pull)	7	VDD	Can cause permanent damage.	A
VDD	8	SET0	Unexpected behavior if application needs SET0 = 0.	B

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

PIN NAME	PIN NO.	DESCRIPTION OF POTENTIAL FAILURE EFFECT(S)	FAILURE EFFECT CLASS
SET0	1	Unexpected behavior if application needs SET0 = 0.	B
WD-EN	2	Watchdog is always enabled, loss of WD-disable functionality.	B
WDI	3	Constant WD timeout faults.	B
GND	4	Device is non-operational.	B
SET1	5	Unexpected behavior if application needs SET1 = 0.	B
WDO (Open Drain)	6	Large current can flow into WDO when in error condition. This can cause permanent damage.	A
WDO (Push Pull)	6	Can cause permanent damage.	A
RESET (Open Drain)	7	Large current can flow into RESET when in error condition. This can cause permanent damage.	A
RESET (Push Pull)	7	Can cause permanent damage.	A
VDD	8	Normal operation.	D

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