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1 Overview

This document contains information for TPS3435, TPS3436, 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 and Figure 1-2 show the device functional block diagrams for reference.

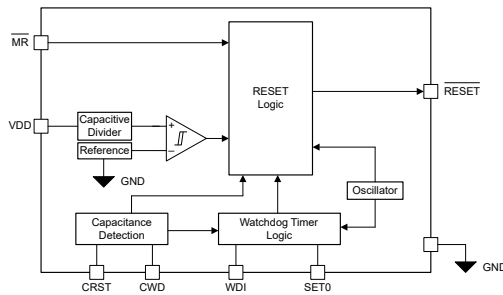


Figure 1-1. TPS35 and TPS36 Pinout Option A

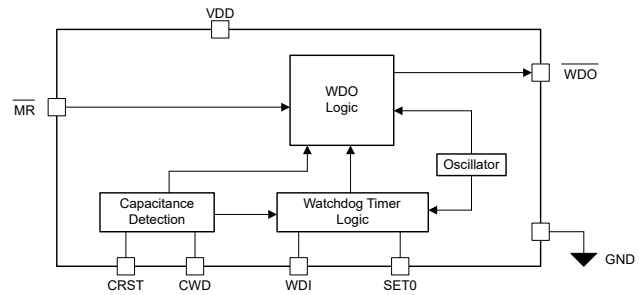


Figure 1-2. TSP3435 and TPS3436 Pinout Option A

TPS3435, TPS3436, 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 TPS3435, TPS3436, 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 TPS3435, TPS3436, TPS35, and TPS36 in [Table 3-1](#) and [Table 3-2](#) 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%

Table 3-2. Die Failure Modes and Distribution TPS3435 and TPS3436

Die Failure Modes	Failure Mode Distribution (%)
False Assert on Reset or WDO	1%
RESET or WDO remain asserted	4%
Incorrect Timing Operation (Early or late WDO faults, Reset/WDO de-assertion delays)	87%
Supply Current is out of spec	8%

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TPS3435, TPS3436, 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](#) and [Figure 4-2](#) show the TPS3435, TPS3436, TPS35, and TPS36 pin diagrams. For a detailed description of the device pins please refer to [TPS3435](#), [TPS3436](#), [TPS35](#), or [TPS36](#) in the *Pin Configuration and Functions* section of the data sheet.

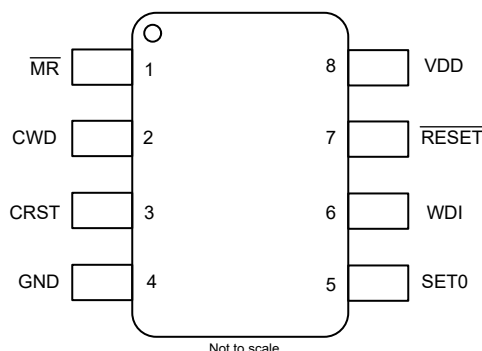


Figure 4-1. Pin Configuration Option A DDF Package, 8-Pin SOT-23, TPS35 and TPS36 Top View

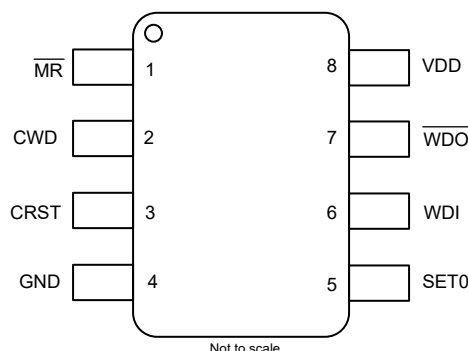


Figure 4-2. Pin Configuration Option A DDF Package, 8-Pin SOT-23, TPS3435 and TPS3436 Top View

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

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

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
\overline{MR}	1	RESET/ \overline{WDO} is asserted.	B
CWD	2	Capacitance value is detected after startup, or error detection. If it's shorted to ground then the WD is disabled.	B
CRST (TPS35 and TPS36)	3	t_D is the max value. Please refer to the switching characteristics table in the TPS35 , or TPS36 data sheets for more information.	B
CRST (TPS3435 and TPS3436)	3	\overline{WDO} stays asserted.	B
GND	4	Expected operating condition.	D
SET0	5	Unexpected behavior if application needs SET0 = 1.	B
WDI	6	Constant WD timeout faults.	B
\overline{WDO} / RESET(Open Drain)	7	\overline{WDO} / RESET constantly asserted; some additional current can flow through pullup resistor.	B
\overline{WDO} / 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
\overline{MR}	1	Device can not pass \overline{MR} to RESET.	B
CWD	2	Output is asserted.	B
CRST	3	Nothing happens until error condition, then reset delay is 2 mS.	C
GND	4	Device is non-operational.	B
SET0	5	Leads to large indeterminate voltage levels. This causes large currents that can damage the device. The output behavior is not deterministic	A
WDI	6	Leads to large indeterminate voltage levels. This causes large currents that can damage the device.	A
\overline{WDO} / RESET(Open Drain)	7	Constant high, no \overline{WDO} /RESET functionality.	B
\overline{WDO} / RESET(Push Pull)	7	High impedance output, no \overline{WDO} /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
\overline{MR}	1	CWD	If \overline{MR} is pulled up device can charge CWD capacitor at an unpredictable rate that depends on pullup resistor value. If \overline{MR} is active low, then the WD is disabled.	B
CWD	2	CRST	Device stays in error condition. Output assert time can be higher than expected. If either capacitor is outside the range, then the WD can be disabled.	B
CRST (TPS35 and TPS36)	3	GND	t_D is the max value. Please refer to the switching characteristics table in the TPS35 , or TPS36 data sheets for more information.	B
CRST (TPS3435 and TPS3436)	3	GND	\overline{WDO} stays asserted.	B
GND	4	SET0	Unexpected behavior if application needs SET0 = 1.	B
SET0	5	WDI	SET0 toggles with WDI.	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
WDI	6	\overline{WDO} / RESET(Open Drain)	Incorrect error output. If WDI is being driven high, then high current can flow into an active low WDO/RESET. This causes damage if the current is higher than the abs max. Please refer to the Absolute Maximum Ratings table in the TPS3435 , TPS3436 , TPS35 , or TPS36 data sheets for more information.	A
WDI	6	\overline{WDO} / RESET(Push Pull)	Incorrect error output. If WDI is being driven high, then high current can flow into an active low WDO/RESET. This causes damage if the current is higher than the abs max. Please refer to the Absolute Maximum Ratings table in the TPS3435 , TPS3436 , TPS35 , or TPS36 data sheets for more information.	A
\overline{WDO} / RESET(Open Drain)	7	VDD	Large current can flow into WDO/RESET when in error condition. This can cause permanent damage.	A
\overline{WDO} / RESET(Push Pull)	7	VDD	Can cause permanent damage.	A
VDD	8	\overline{MR}	Large current can flow into device driving \overline{MR} signal.	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
\overline{MR}	1	Large current can flow into device driving \overline{MR} signal.	B
CWD	2	\overline{WDO} / RESET asserts. Possibility of high current which can cause device damage.	A
CRST	3	t_D/t_{WDO} is 2 ms. Possibility of high current which can cause device damage.	A
GND	4	Device is non-operational.	B
SET0	5	Unexpected behavior if application needs SET0 = 0.	B
WDI	6	Constant WD timeout faults.	B
\overline{WDO} / RESET(Open Drain)	7	Large current can flow into WDO/RESET when in error condition. This can cause permanent damage.	A
\overline{WDO} / RESET(Push Pull)	7	Can cause permanent damage.	A
VDD	8	Normal operation.	D

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