

TPSM365R6 and TPSM365R3 Functional Safety FIT Rate, FMD and Pin FMA



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1 Overview

This document contains information for TPSM365R6 and TPSM365R3 (VQFN-HR 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.

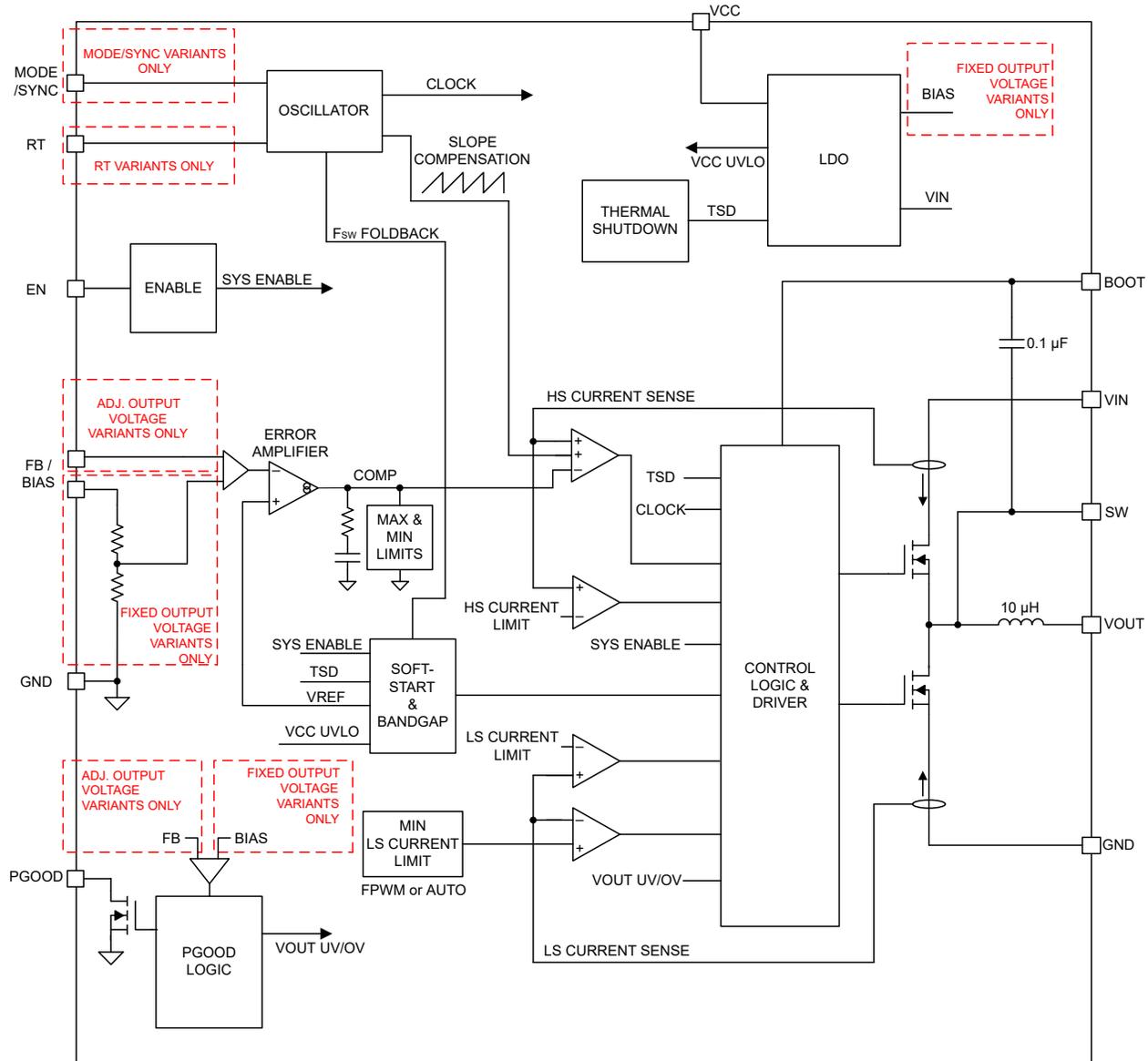


Figure 1-1. Functional Block Diagram

TPSM365R6 and TPSM365R3 was developed using a quality-managed development process, but was not developed in accordance with the IEC 61508 or ISO 26262 standards.

ADVANCE INFORMATION for preproduction products; subject to change without notice.

2 Functional Safety Failure In Time (FIT) Rates

2.1 TP3M365R6

This section provides Functional Safety Failure In Time (FIT) rates for TP3M365R6 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 | 29 |
| Die FIT Rate | 5 |
| Package FIT Rate | 24 |

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: 600 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 ASICs Analog & Mixed HV > 50-V supply | 30 FIT | 75°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 TP3M365R3

This section provides Functional Safety Failure In Time (FIT) rates for TP3M365R3 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 | 29 |
| Die FIT Rate | 5 |
| Package FIT Rate | 24 |

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 |
|-------|---|--------------------|----------------------------------|
| 5 | CMOS/ BICMOS ASICs Analog & Mixed HV > 50-V supply | 30 FIT | 75°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 TPSM365R6 and TPSM365R3 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 (%) |
|---|-------------------------------|
| No Output Voltage | 60% |
| Output not in specification - voltage or timing | 30% |
| Power Good - False Trip or Failure to Trip | 5% |
| 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 TPSM365R6 and TPSM365R3. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

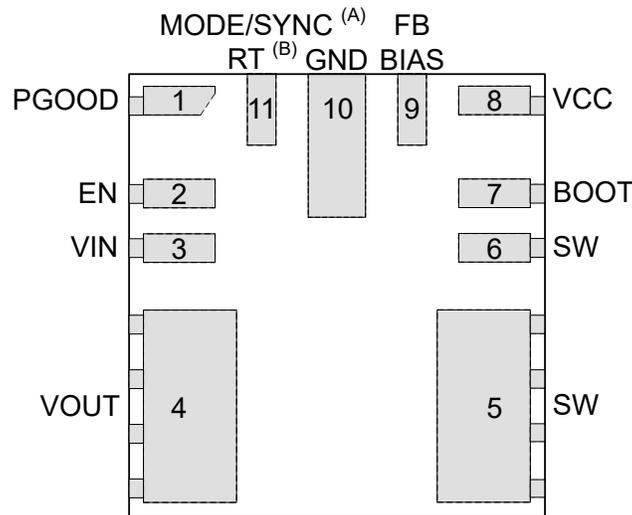
- Pin short-circuited to Ground (see [Table 4-2](#))
- Pin open-circuited (see [Table 4-3](#))
- Pin short-circuited to an adjacent pin (see [Table 4-4](#))
- Pin short-circuited to supply (see [Table 4-5](#))

[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 TPSM365R6 and TPSM365R3 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TPSM365R6 and TPSM365R3 data sheet.



1. See the *data sheet* for more details. Pin 1 trimmed and factory-set for externally adjustable switching frequency RT variants only.
2. Pin 11 factory-set for fixed switching frequency MODE/SYNC variants only.
3. Pin 9 trimmed and factory-set for fixed output voltage VOUT/BIAS variants only.
4. Pin 9 factory-set for adjustable output voltage FB variants only.

Figure 4-1. Pin Diagram

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 |
|-----------------|---------|--|----------------------|
| PGOOD | 1 | When not in use, this pin can be left open or grounded. However, PGOOD is no longer reliably relays Power-Good information to devices connected to this pin. | B |
| EN | 2 | VOUT = 0 V, device is disabled. | B |
| VIN | 3 | VOUT = 0 V. | B |
| VOUT | 4 | Goes into hiccup, short-circuit operation. | B |
| SW | 5, 6 | Damage occurs. | A |
| BOOT | 7 | VOUT = 0 V, HS FET does not turn on. | B |
| VCC | 8 | VOUT = 0 V. | B |
| VOUT/BIAS or FB | 9 | VOUT = 0 V. | B |
| GND | 10 | Normal operation. | D |
| RT or MODE | 11 | For RT, the switching frequency is set to 2.2 MHz. For MODE/SYNC the device goes into PFM mode. | B |

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

| Pin Name | Pin No. | Description of Potential Failure Effect(s) | Failure Effect Class |
|------------|---------|--|----------------------|
| PGOOD | 1 | When not in use, this pin can be left open or grounded. However, PGOOD is no longer reliably relays Power-Good information to devices connected to this pin. | B |
| EN | 2 | VOUT behavior is not defined. VOUT may be 0V, but it also may be up. Do not float this pin. Device can no longer reliably be enabled or disabled by other devices connected to this pin. | B |
| VIN | 3 | VOUT = 0 V. | B |
| VOUT | 4 | VOUT = 0 V. | B |
| SW | 5, 6 | Normal operation. | D |
| BOOT | 7 | Normal operation. | D |
| VCC | 8 | VCC output is unstable, can increase above 5.5 V | A |
| FB | 9 | VOUT = 0 V. Do not float this pin. | B |
| GND | 10 | VOUT can be abnormal, as reference voltage is not fixed. | B |
| RT or MODE | 11 | If it is RT device, then frequency is not defined. If it is a MODE/SYNC device, then the device can go back and forth between FPWM and PFM. VOUT is up, but only partially functional. | C |

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 |
|----------|---------|------------|--|----------------------|
| PGOOD | 1 | EN | If EN > 20 V, it damages devices connected to the PGOOD pin. | A |
| EN | 2 | VIN | VOUT normal (enable is on, all other blocks work). However, the device can no longer be disabled. | B |
| VIN | 3 | VOUT | If VIN > 16 V, damage occurs. | A |
| VOUT | 4 | SW | Damage occurs. | A |
| SW | 6 | BOOT | VOUT = 0 V, HS does not turn on, no Cboot. | B |
| BOOT | 7 | VCC | Damage occurs to VCC LDO. The VCC LDO could no longer supply voltage to internal control circuits. | A |
| VCC | 8 | FB | Can be partially nonfunctional, no damage occurs. | B |
| FB | 9 | GND | VOUT = 0 V (for fixed option) switches at maximum duty cycle for ADJ option. | 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 |
|------------|---------|------------|--|----------------------|
| GND | 10 | RT or MODE | For RT, Switching Frequency is set to 2.2 MHz. For MODE/SYNC the device goes into PFM mode. | B |
| RT or MODE | 11 | PGOOD | If PGOOD is high and < 5.5 V, then Fsw = 1 MHz for RT, and is in FPWM mode for MODE/SYNC; If PGOOD is low, then Fsw = 2.2 MHz for RT, and PFM mode for RT. PGOOD absmax being 20 V, RT ESD damages if PG goes to 20 V. | A |

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

| Pin Name | Pin No. | Description of Potential Failure Effect(s) | Failure Effect Class |
|----------|---------|--|----------------------|
| PGOOD | 1 | If VIN > 20 V, it damages PGOOD. PGOOD is no longer reliably relays Power-Good information to devices connected to this pin. | A |
| EN | 2 | VOUT normal (enable is on, all other blocks work). However, the device can no longer be disabled. | B |
| VIN | 3 | Normal operation. | D |
| VOUT | 4 | Damage occurs, if VIN > 16 V. | A |
| SW | 5, 6 | Damage occurs. | A |
| BOOT | 7 | Damage occurs, the BOOT ESD clamp is damaged. | A |
| VCC | 8 | If Vin > 5.5 V, damage occurs. | A |
| FB | 9 | If VIN > 20 V, damage occurs. | A |
| GND | 10 | VOUT = 0 V. | A |
| RT | 11 | If Vin > 5.5 V, damage occurs. If Vin < 5.5 V, switching frequency is 1 MHz. | A |

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