Functional Safety Information

LM5013-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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Trademarks

1 Overview

This document contains information for LM5013-Q1 (SO PowerPad 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.

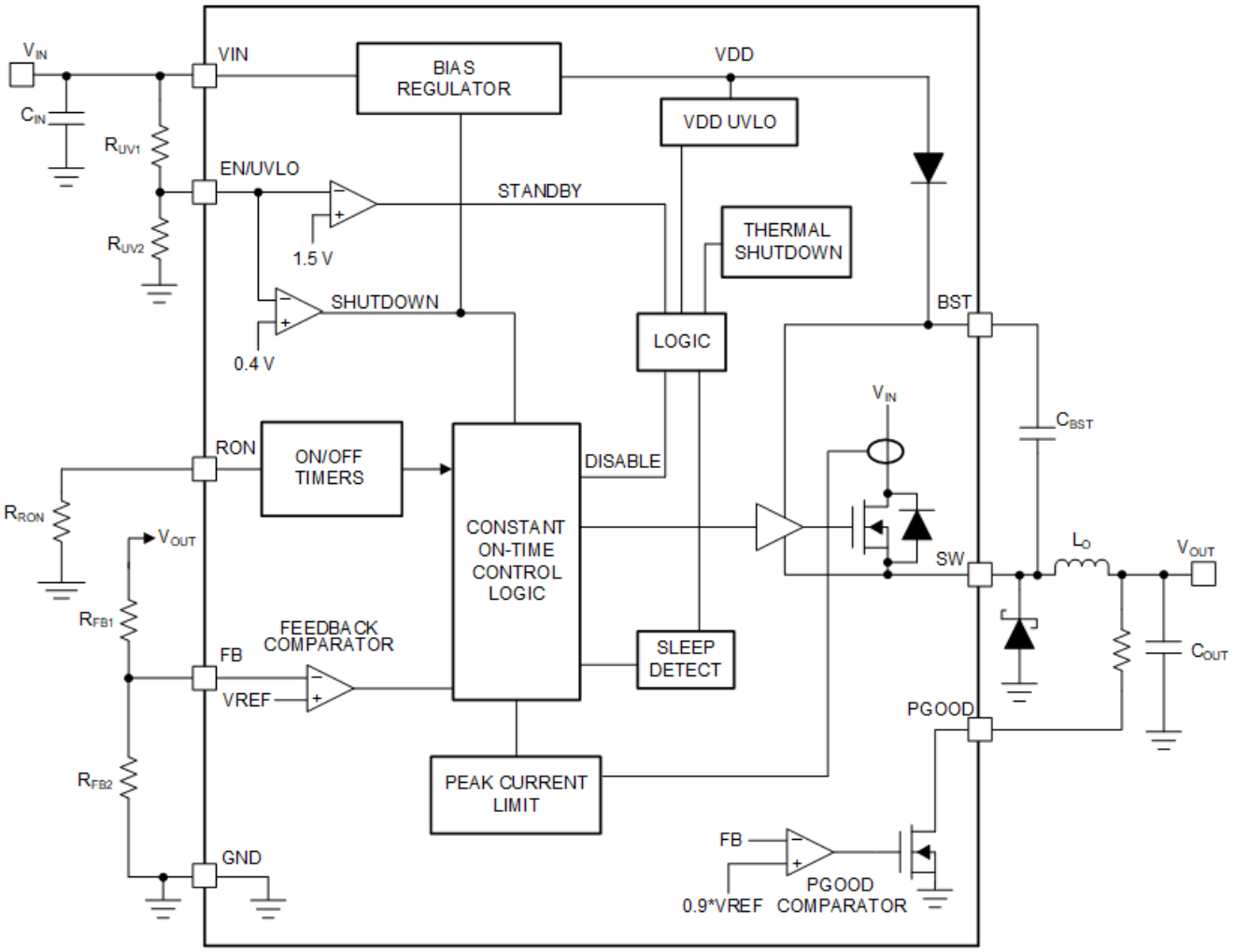

Figure 1-1. Functional Block Diagram

LM5013-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 LM5013-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	26
Die FIT Rate	17
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 dissipatiom: 1580mW
- 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 >50V 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.

3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for LM5013-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 (%)
No SW output	45%
SW output not in specification – voltage or timing	40%
SW power FET stuck on	5%
PGOOD false trip, fails to trip	5%
Short circuit any two pins	5%

The FMD in Table 3-1 excludes short circuit faults across the isolation barrier. Faults for short circuit across the isolation barrier can be excluded according to ISO 61800-5-2:2016 if the following requirements are fulfilled:

1. The signal isolation component is OVC III according to IEC 61800-5-1. If a SELV/PELV power supply is used, pollution degree 2/OVC II applies. All requirements of IEC 61800-5-1:2007, 4.3.6 apply.
2. Measures are taken to ensure that an internal failure of the signal isolation component cannot result in excessive temperature of its insulating material.

Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed-circuit board do not reduce this distance.

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the LM5013-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 LM5013-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the LM5013-Q1 data sheet.

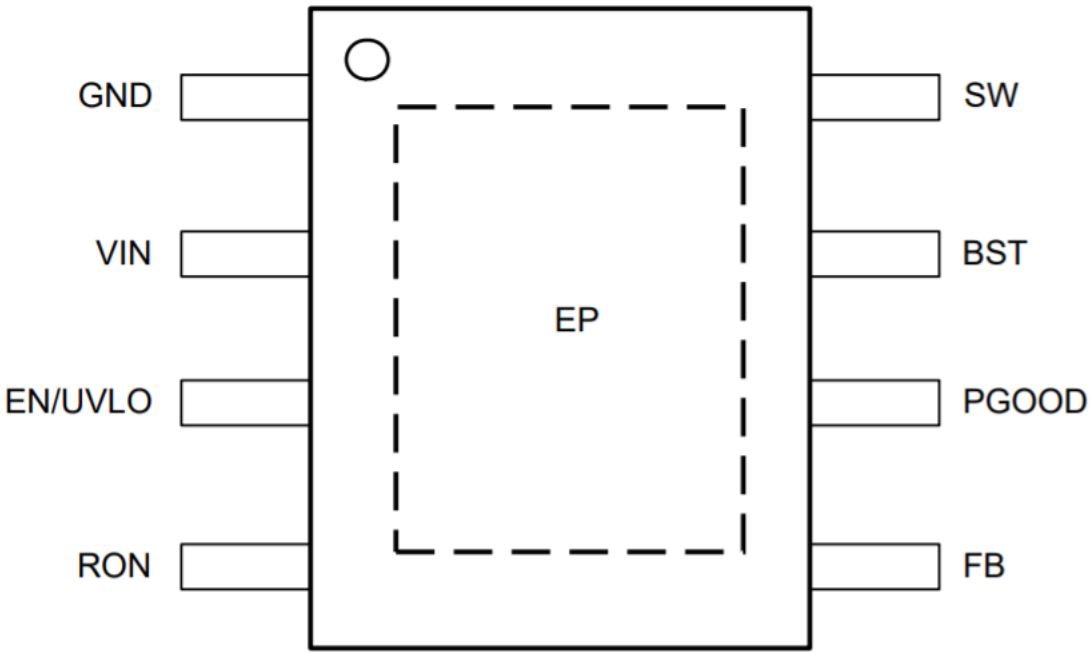

Figure 4-1. Pin Diagram

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

- Application circuit, as per the LM5013-Q1 data sheet is used
  - PGOOD is pulled up to VOUT

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
GND	1		D
VIN	2	V_{OUT} = 0 V	B
EN/UVLO	3	V_{OUT} = 0 V	B
RON	4	V_{OUT} unregulated; 0 ≤ V_{OUT} < set voltage	B
FB	5	V_{OUT} >> set voltage. PGOOD can become damaged if V_{IN} > 14 V.	A
PGOOD	6	PGOOD is invalid flag.	B
BST	7	V_{OUT} = 0 V	B
SW	8	Power FET damage	A

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

Pin Name	Pin No	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	V_{OUT} = 0 V	B
VIN	2	V_{OUT} = 0 V	B
EN/UVLO	3	V_{OUT} = 0 V	B
RON	4	V_{OUT} > set voltage	B
FB	5	V_{OUT} >> set voltage. PGOOD can become damaged if V_{IN} > 14 V.	A
PGOOD	6	PGOOD flag is invalid.	B
BST	7	V_{OUT} = 0 V	B
SW	8	V_{OUT} = 0 V	B

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

Pin Name	Pin No	Description of Potential Failure Effect(s)	Failure Effect Class
GND	1	V_{OUT} = 0 V	B
VIN	2		D
EN/UVLO	3	V_{IN} > 5.5 V can lead to device damage.	A
RON	4	V_{OUT} < set voltage	B
FB	5	PGOOD flag is invalid. V_{OUT} can be unregulated.	A
PGOOD	6	V_{OUT} = 0 V	B
BST	7	V_{OUT} = 0 V	B
SW	8	V_{OUT} = 0 V	B

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
GND	1	V_{OUT} = 0 V	B
VIN	2		D
EN/UVLO	3		D
RON	4	V_{IN} > 5.5 V can lead to device damage.	A
FB	5	V_{IN} > 5.5 V can lead to device damage.	A
PGOOD	6	V_{IN} > 14 V can lead to device damage.	A
BST	7	V_{OUT} = 0 V	B
SW	8	V_{OUT} = V_{IN}. PGOOD can be damaged if V_{IN} > 14 V.	A

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