Functional safety at TI:
Understanding ISO 26262 hardware element classes

Presentation summary

Session summary:

The automotive functional safety standard ISO 26262 describes the development of an ISO 26262 compliant item. The standard states that products that have not originally been developed according to the ISO 26262 standard may be evaluated for use in compliant systems. This presentation explains how TI functional safety product categories align with ISO 26262 hardware element classes.

What you'll learn:

- What makes a product functional safety compliant?
- What are the three types of ISO 26262 hardware element classes?
- How do TI functional safety product categories align with the standard?
- What documentation does TI provide for customers to evaluate hardware architectural metrics?

TI Functional Safety product categories

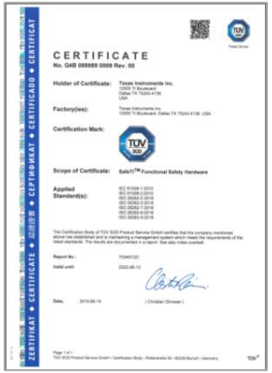
Functional Safety-Capable

Functional Safety Quality-Managed

Functional Safety-Compliant

TI functional safety product categories

		Functional Safety-Capable The simplest product category of analog products that can be evaluated for use in a functionally safe system	Functional Safety Quality-Managed Moderately complex products such as an MCU	Functional Safety-Compliant The most complex products such as MCUs, microprocessors and complex analog signal-chain and power products
Development process	TI quality-managed process	✓	✓	✓
	TI functional safety process			✓
Analysis report	Functional safety FIT rate calculation	✓	✓	✓
	Failure mode distribution (FMD) and/or pin FMA*	✓	Included in FMEDA	Included in FMEDA
	FMEDA		✓	✓
	Fault-tree analysis (FTA)*			✓
Diagnostics description	Functional safety manual		✓	✓
Certification	Functional safety product certificate**			✓



ZERTIFIKAT ◆ CERTIFICATE ◆ CERTIFICADO ◆ CERTIFICAT ◆ СЕРТИФИКАТ

CERTIFICATE
No. Q4B 088989 0009 Rev. 00

Holder of Certificate: Texas Instruments Inc.
12500 TI Boulevard
Dallas TX 75243-4136
USA

Factory(ies): Texas Instruments Inc.
12500 TI Boulevard, Dallas TX 75243-4136, USA

Certification Mark:

Scope of Certificate: SafeTI™ Functional Safety Hardware

Applied Standard(s):
IEC 61508-1:2010
IEC 61508-2:2010
ISO 26262-2:2018
ISO 26262-4:2018
ISO 26262-7:2018
ISO 26262-8:2018
ISO 26262-9:2018

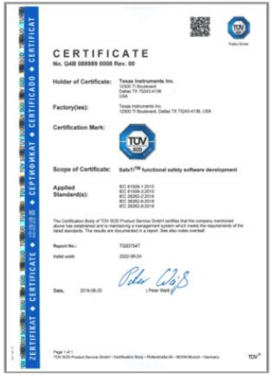
The Certification Body of TÜV SÜD Product Service GmbH certifies that the company mentioned above has established and is maintaining a management system which meets the requirements of the listed standards. The results are documented in a report. See also notes overleaf.

Report No.: TD94012C

Valid until: 2022-06-13

Date, 2019-06-14 (Christian Dirmeier)

Page 1 of 1
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany



ZERTIFIKAT ◆ CERTIFICATE ◆ CERTIFICADO ◆ CERTIFICAT ◆ СЕРТИФИКАТ

CERTIFICATE
No. Q4B 088989 0008 Rev. 00

Holder of Certificate: Texas Instruments Inc.
12500 TI Boulevard
Dallas TX 75243-4136
USA

Factory(ies): Texas Instruments Inc.
12500 TI Boulevard, Dallas TX 75243-4136, USA

Certification Mark:

Scope of Certificate: SafeTI™ functional safety software development

Applied Standard(s):
IEC 61508-1:2010
IEC 61508-3:2010
IEC 26262-2:2018
IEC 26262-6:2018
IEC 26262-8:2018

The Certification Body of TÜV SÜD Product Service GmbH certifies that the company mentioned above has established and is maintaining a management system which meets the requirements of the listed standards. The results are documented in a report. See also notes overleaf.

Report No.: TQ937547

Valid until: 2022-06-24

Peter Weiß

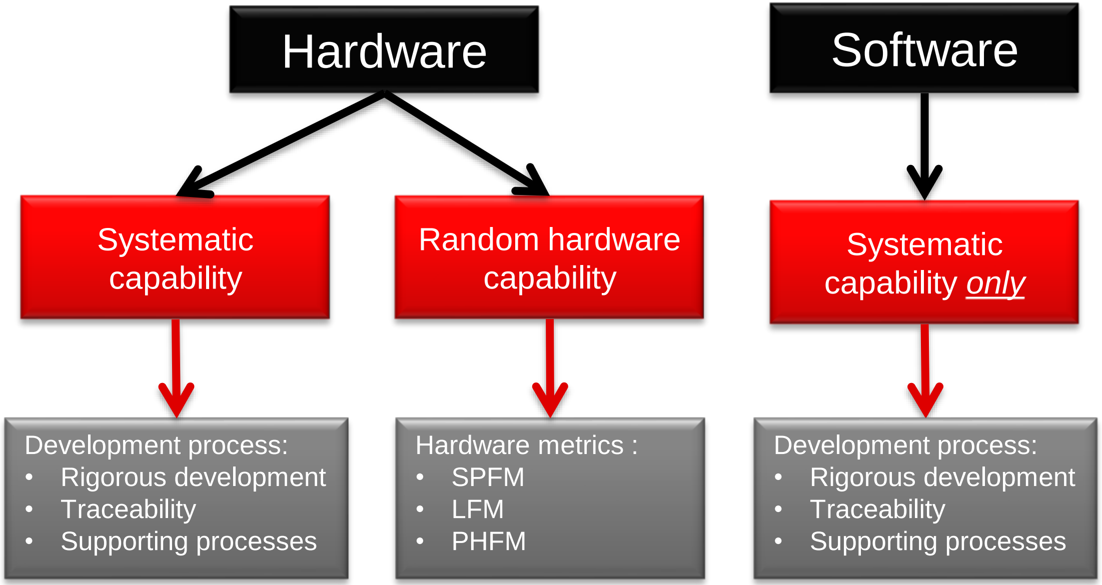
Date, 2019-06-25 (Peter Weiß)

Page 1 of 1
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

** May only be available for analog power and signal chain products.* *** Available for select products.*

Functional safety

- Functional safety is the absence of *unreasonable risk* due to hazards caused by *malfunctioning behavior* of E/E systems.
- For a component to be compliant, the hardware must have both random hardware and systematic capability.



Hardware

Software

Systematic capability

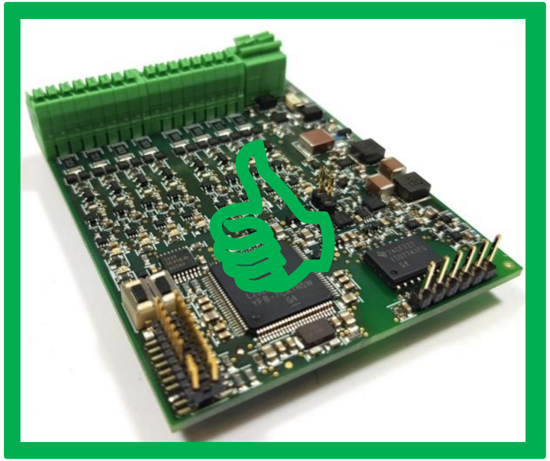
Random hardware capability

Systematic capability *only*

Development process:
- Rigorous development
- Traceability
- Supporting processes

Hardware metrics :
- SPFM
- LFM
- PHFM

Development process:
- Rigorous development
- Traceability
- Supporting processes



TI's role in satisfying systematic and random hardware capability

Functional Safety-Capable Functional Safety Quality-Managed		Functional Safety-Compliant	
Systematic capability	Random hardware capability	Systematic capability	Random hardware capability
TI quality managed development process + Customer evaluation of hardware elements	TI provides documentation for customers to conduct FMEDA analysis	TI functional safety development process	TI provides documentation for customers to conduct FMEDA analysis

Hardware element classification

ISO 26262-8:2018

Class I: No or few states, no internal safety mechanisms

Example hardware elements:

- Resistors, Capacitors
- Diodes, Transistors
- 3-pin LDO, level shifter
- Simple logic gates
- PTC temperature sensor

Evaluation of HW element:

- Evaluation by itself is not needed

Class II: Few states, no internal safety mechanisms

Example hardware elements:

- OP AMPS
- ADC
- DAC
- DC/DC converters
- CAN/LIN transceiver

Evaluation of HW element:

- Evaluation plan and argument are needed to prove functional performance
- Supported by evaluation analysis and testing

Class III: Many states, includes safety mechanisms

Example hardware elements:

- Microprocessors
- SOCs (system on a chip)
- Multichannel PMICs
- Motor drivers
- Higher function SBCs

Evaluation of HW element:

- Additional measures to argue that the risk of a safety requirement violation due to systematic faults is sufficiently low

TI functional safety product categories and ISO 26262 hardware element classes

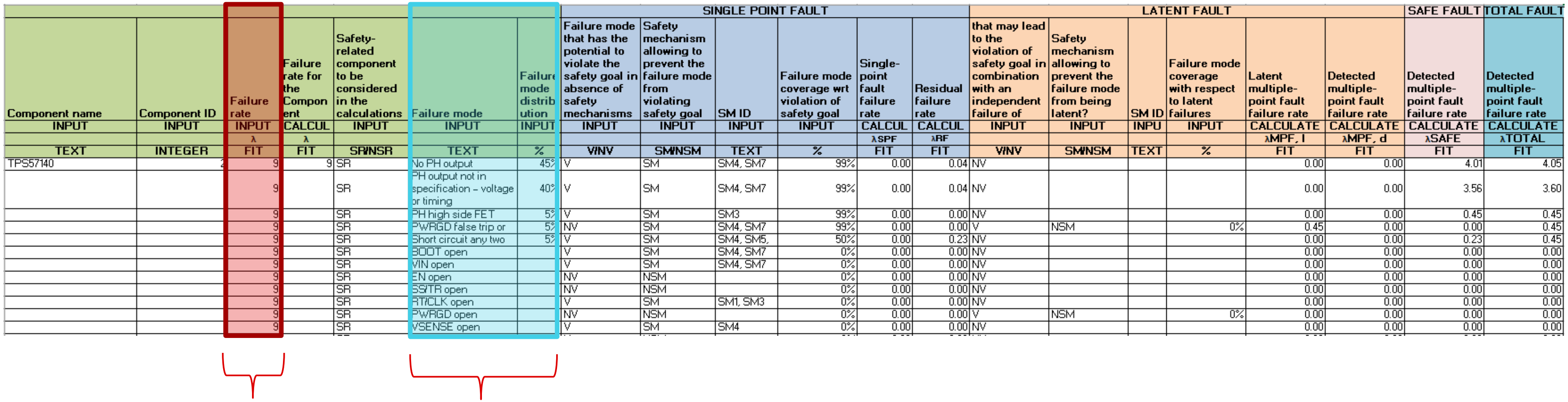
Safety Mechanism (SM)	Class I	Class II	Class III	Compliant
No	**Functional Safety-Capable**	**Functional Safety-Capable**	N/A	**Functional Safety-Compliant**
Yes	N/A	If SM is not used by customer in safety concept ***or*** if SM is used by customer in safety concept ***and*** the customer assumes a certain diagnostic coverage as defined in the standard for the SM: **Functional Safety-Capable**	If SM is used by customer in safety concept: **Functional Safety Quality-managed**	**Functional Safety-Compliant**

* *Mapping of TI functional safety product categories to ISO26262 hardware elements classes are approximations for illustration purposes. Customers are responsible for determining their own hardware element classifications.*

FMEDA hardware metrics

Data needed for calculations

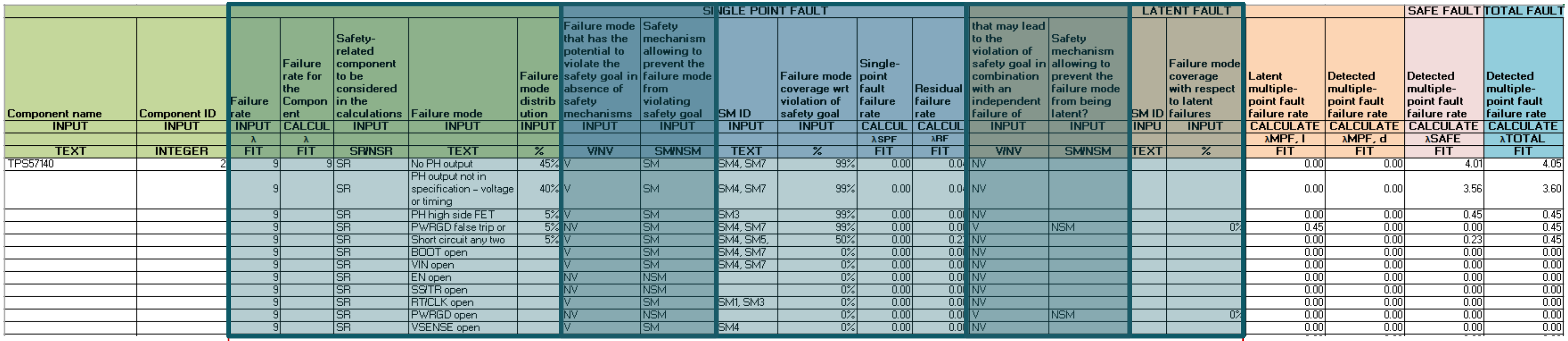
System FMEDA inputs for Functional Safety-Capable



							SINGLE POINT FAULT						LATENT FAULT						SAFE FAULT	TOTAL FAULT
Component name	Component ID	Failure rate	Failure rate for the Component	Safety-related component to be considered in the calculations	Failure mode	Failure mode distribution	Failure mode that has the potential to violate the safety goal in absence of safety mechanisms	Safety mechanism allowing to prevent the failure mode from violating safety goal	SM ID	Failure mode coverage wrt violation of safety goal	Single-point fault failure rate	Residual failure rate	that may lead to the violation of safety goal in combination with an independent failure of	Safety mechanism allowing to prevent the failure mode from being latent?	SM ID	Failure mode coverage with respect to latent failures	Latent multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate
INPUT	INPUT	INPUT	CALCUL	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	CALCUL	CALCUL	INPUT	INPUT	INPU	INPUT	CALCULATE	CALCULATE	CALCULATE	CALCULATE
		λ	λ								λSPF	λRF					λMPF, l	λMPF, d	λSAFE	λTOTAL
TEXT	INTEGER	FIT	FIT	SR/NSR	TEXT	%	V/NV	SM/NSM	TEXT	%	FIT	FIT	V/NV	SM/NSM	TEXT	%	FIT	FIT	FIT	FIT
TPS57140	2	9	9	SR	No PH output	45%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	4.01	4.05
		9		SR	PH output not in specification – voltage or timing	40%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	3.56	3.60
		9		SR	PH high side FET	5%	V	SM	SM3	99%	0.00	0.00	NV				0.00	0.00	0.45	0.45
		9		SR	PWRGD false trip or	5%	NV	SM	SM4, SM7	99%	0.00	0.00	V	NSM		0%	0.45	0.00	0.00	0.45
		9		SR	Short circuit any two	5%	V	SM	SM4, SM5,	50%	0.00	0.23	NV				0.00	0.00	0.23	0.45
		9		SR	BOOT open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	VIN open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	EN open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	SS/TR open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	RT/CLK open		V	SM	SM1, SM3	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	PWRGD open		NV	NSM		0%	0.00	0.00	V	NSM		0%	0.00	0.00	0.00	0.00
		9		SR	VSENSE open		V	SM	SM4	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00

1. **Product FIT**
2. **Product FMD and/or Product Pin FMA**

<span style="color:red">System FMEDA inputs for</span> Functional Safety Quality-Managed and Complaint



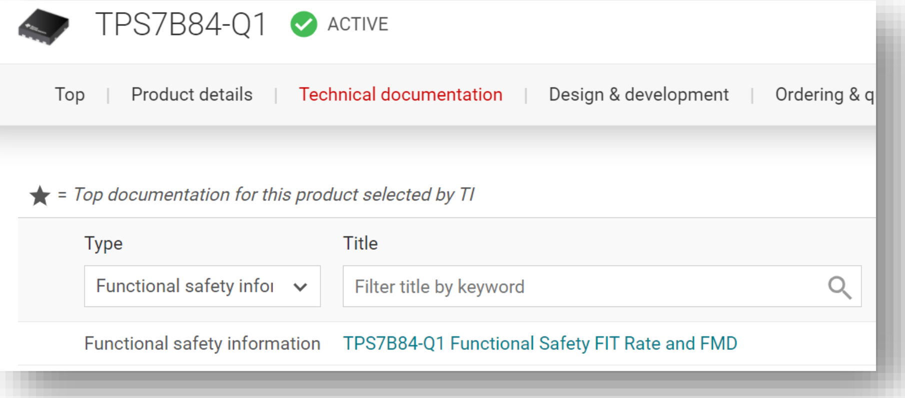
									SINGLE POINT FAULT						LATENT FAULT				SAFE FAULT	TOTAL FAULT
Component name	Component ID	Failure rate	Failure rate for the Component	Safety-related component to be considered in the calculations	Failure mode	Failure mode distribution	Failure mode that has the potential to violate the safety goal in absence of safety mechanisms	Safety mechanism allowing to prevent the failure mode from violating safety goal	SM ID	Failure mode coverage wrt violation of safety goal	Single-point fault failure rate	Residual failure rate	that may lead to the violation of safety goal in combination with an independent failure of	Safety mechanism allowing to prevent the failure mode from being latent?	SM ID	Failure mode coverage with respect to latent failures	Latent multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate
INPUT	INPUT	INPUT	CALCUL	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	CALCUL	CALCUL	INPUT	INPUT	INPU	INPUT	CALCULATE	CALCULATE	CALCULATE	CALCULATE
		λ	λ								λSPF	λRF					λMPF, l	λMPF, d	λSAFE	λTOTAL
TEXT	INTEGER	FIT	FIT	SR/NSR	TEXT	%	V/NV	SM/NSM	TEXT	%	FIT	FIT	V/NV	SM/NSM	TEXT	%	FIT	FIT	FIT	FIT
TPS57140	2	9	9	SR	No PH output	45%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	4.01	4.05
		9		SR	PH output not in specification – voltage or timing	40%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	3.56	3.60
		9		SR	PH high side FET	5%	V	SM	SM3	99%	0.00	0.00	NV				0.00	0.00	0.45	0.45
		9		SR	PWRGD false trip or	5%	NV	SM	SM4, SM7	99%	0.00	0.00	V	NSM		0%	0.45	0.00	0.00	0.45
		9		SR	Short circuit any two	5%	V	SM	SM4, SM5,	50%	0.00	0.23	NV				0.00	0.00	0.23	0.45
		9		SR	BOOT open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	VIN open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	EN open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	SS/TR open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	RT/CLK open		V	SM	SM1, SM3	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	PWRGD open		NV	NSM		0%	0.00	0.00	V	NSM		0%	0.00	0.00	0.00	0.00
		9		SR	VSENSE open		V	SM	SM4	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00

3. **Product FMEDA** contains safety mechanisms and diagnostic coverage

TI Functional Safety product categories

Examples of data provided by TI for FMEDA

Functional Safety-Capable

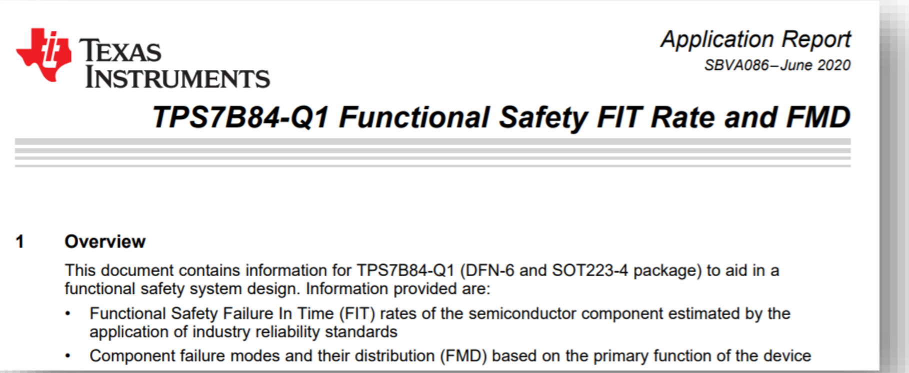


TPS7B84-Q1 ACTIVE

Top | Product details | Technical documentation | Design & development | Ordering & q

★ = *Top documentation for this product selected by TI*

Type	Title
Functional safety infor ⌄	Filter title by keyword 🔍
Functional safety information	TPS7B84-Q1 Functional Safety FIT Rate and FMD



TEXAS INSTRUMENTS

Application Report

SBVA086–June 2020

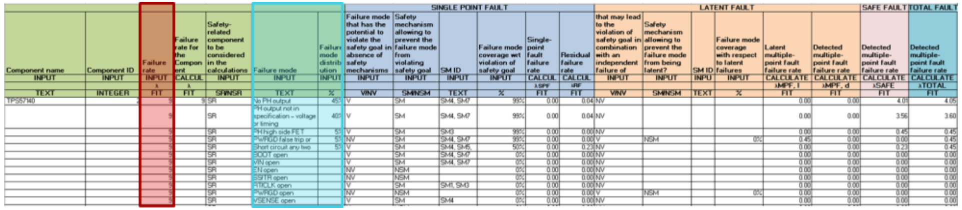
TPS7B84-Q1 Functional Safety FIT Rate and FMD

1 Overview

This document contains information for TPS7B84-Q1 (DFN-6 and SOT223-4 package) to aid in a functional safety system design. Information provided are:

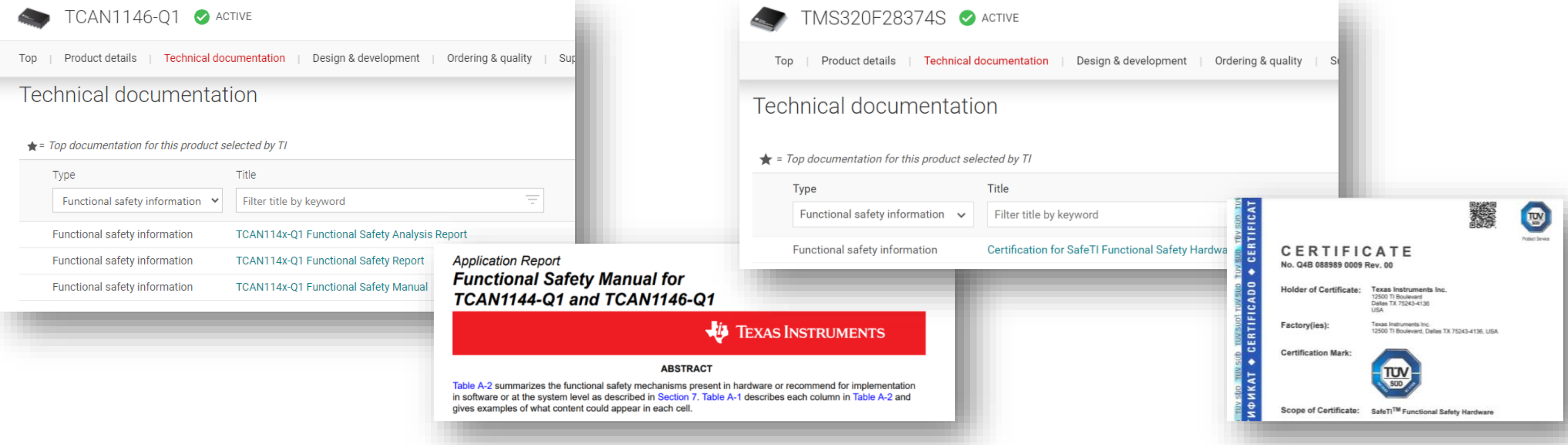
- Functional Safety Failure In Time (FIT) rates of the semiconductor component estimated by the application of industry reliability standards
- Component failure modes and their distribution (FMD) based on the primary function of the device

1. **Product FIT**
2. **Product FMD and/or Product Pin FMA**



							SINGLE POINT FAULT						LATENT FAULT						SAFE FAULT	TOTAL FAULT
Component name	Component ID	Failure rate	Failure rate for the Component	Safety-related component to be considered in the calculations	Failure mode	Failure mode distribution	Failure mode that has the potential to violate the safety goal in absence of safety mechanisms	Safety mechanism allowing to prevent the failure mode from violating safety goal	SM ID	Failure mode coverage wrt violation of safety goal	Single-point fault failure rate	Residual failure rate	that may lead to the violation of safety goal in combination with an independent failure of	Safety mechanism allowing to prevent the failure mode from being latent?	SM ID	Failure mode coverage with respect to latent failures	Latent multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate
INPUT	INPUT	INPUT	CALCUL	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	CALCUL	CALCUL	INPUT	INPUT	INPU	INPUT	CALCULATE	CALCULATE	CALCULATE	CALCULATE
		λ	λ								λSPF	λRF					λMPF, l	λMPF, d	λSAFE	λTOTAL
TEXT	INTEGER	FIT	FIT	SR/NSR	TEXT	%	V/NV	SM/NSM	TEXT	%	FIT	FIT	V/NV	SM/NSM	TEXT	%	FIT	FIT	FIT	FIT
TPS57140	2	9	9	SR	No PH output	45%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	4.01	4.05
		9		SR	PH output not in specification – voltage or timing	40%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	3.56	3.60
		9		SR	PH high side FET	5%	V	SM	SM3	99%	0.00	0.00	NV				0.00	0.00	0.45	0.45
		9		SR	PWRGD false trip or	5%	NV	SM	SM4, SM7	99%	0.00	0.00	V	NSM		0%	0.45	0.00	0.00	0.45
		9		SR	Short circuit any two	5%	V	SM	SM4, SM5,	50%	0.00	0.23	NV				0.00	0.00	0.23	0.45
		9		SR	BOOT open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	VIN open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	EN open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	SS/TR open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	RT/CLK open		V	SM	SM1, SM3	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	PWRGD open		NV	NSM		0%	0.00	0.00	V	NSM		0%	0.00	0.00	0.00	0.00
		9		SR	VSENSE open		V	SM	SM4	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00

Functional Safety Quality-Managed



TCAN1146-Q1 ACTIVE

Top | Product details | Technical documentation | Design & development | Ordering & quality | Sup

Technical documentation

★ = Top documentation for this product selected by TI

Type	Title
Functional safety information	Filter title by keyword
Functional safety information	TCAN114x-Q1 Functional Safety Analysis Report
Functional safety information	TCAN114x-Q1 Functional Safety Report
Functional safety information	TCAN114x-Q1 Functional Safety Manual

Application Report

Functional Safety Manual for TCAN1144-Q1 and TCAN1146-Q1

TEXAS INSTRUMENTS

ABSTRACT

Table A-2 summarizes the functional safety mechanisms present in hardware or recommend for implementation in software or at the system level as described in Section 7. Table A-1 describes each column in Table A-2 and gives examples of what content could appear in each cell.

TMS320F28374S ACTIVE

Top | Product details | Technical documentation | Design & development | Ordering & quality | S

Technical documentation

★ = Top documentation for this product selected by TI

Type	Title
Functional safety information	Filter title by keyword
Functional safety information	Certification for SafeTI Functional Safety Hardwa

TÜV SÜD ◆ CERTIFICAT ◆ CERTIFICADO ◆ СЕРТИФИКАТ

TÜV SÜD Product Service

CERTIFICATE

No. Q4B 088989 0009 Rev. 00

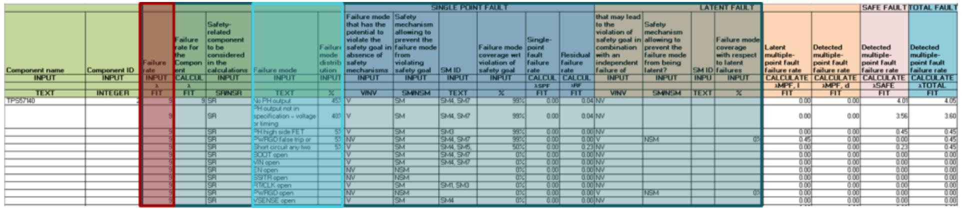
Holder of Certificate: Texas Instruments Inc.
12500 TI Boulevard
Dallas TX 75243-4136
USA

Factory(ies): Texas Instruments Inc.
12500 TI Boulevard, Dallas TX 75243-4136, USA

Certification Mark: TÜV SÜD

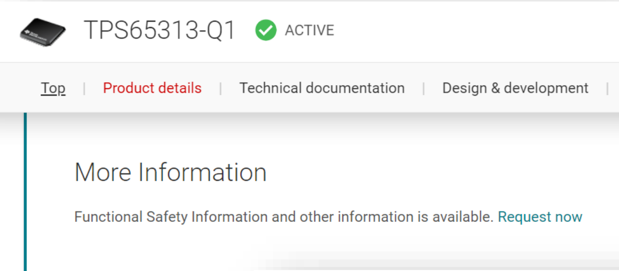
Scope of Certificate: SafeTI™ Functional Safety Hardware

1. **Product FIT**
2. **Product FMD and/or Product Pin FMA**
3. **Product FMEDA**
4. **Functional Safety Manual**



							SINGLE POINT FAULT						LATENT FAULT						SAFE FAULT	TOTAL FAULT
Component name	Component ID	Failure rate	Failure rate for the Component	Safety-related component to be considered in the calculations	Failure mode	Failure mode distribution	Failure mode that has the potential to violate the safety goal in absence of safety mechanisms	Safety mechanism allowing to prevent the failure mode from violating safety goal	SM ID	Failure mode coverage wrt violation of safety goal	Single-point fault failure rate	Residual failure rate	that may lead to the violation of safety goal in combination with an independent failure of	Safety mechanism allowing to prevent the failure mode from being latent?	SM ID	Failure mode coverage with respect to latent failures	Latent multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate
INPUT	INPUT	INPUT	CALCUL	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	CALCUL	CALCUL	INPUT	INPUT	INPU	INPUT	CALCULATE	CALCULATE	CALCULATE	CALCULATE
		λ	λ								λSPF	λRF					λMPF, l	λMPF, d	λSAFE	λTOTAL
TEXT	INTEGER	FIT	FIT	SR/NSR	TEXT	%	V/NV	SM/NSM	TEXT	%	FIT	FIT	V/NV	SM/NSM	TEXT	%	FIT	FIT	FIT	FIT
TPS57140	2	9	9	SR	No PH output	45%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	4.01	4.05
		9		SR	PH output not in specification – voltage or timing	40%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	3.56	3.60
		9		SR	PH high side FET	5%	V	SM	SM3	99%	0.00	0.00	NV				0.00	0.00	0.45	0.45
		9		SR	PWRGD false trip or	5%	NV	SM	SM4, SM7	99%	0.00	0.00	V	NSM		0%	0.45	0.00	0.00	0.45
		9		SR	Short circuit any two	5%	V	SM	SM4, SM6,	50%	0.00	0.23	NV				0.00	0.00	0.23	0.45
		9		SR	BOOT open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	VIN open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	EN open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	SS/TR open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	RT/CLK open		V	SM	SM1, SM3	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	PWRGD open		NV	NSM		0%	0.00	0.00	V	NSM		0%	0.00	0.00	0.00	0.00
		9		SR	VSENSE open		V	SM	SM4	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00

Functional Safety-Compliant

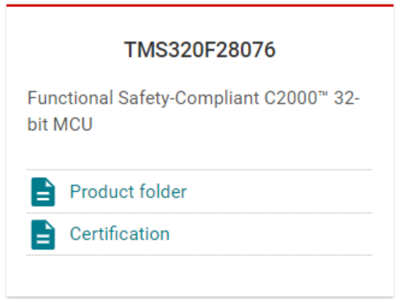


TPS65313-Q1 ACTIVE

Top | Product details | Technical documentation | Design & development |

More Information

Functional Safety Information and other information is available. Request now

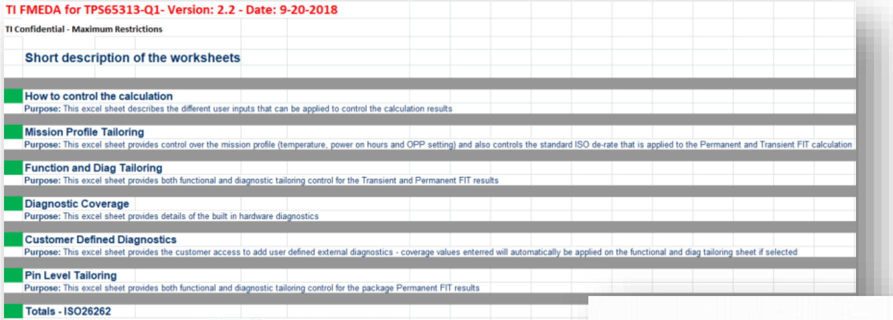


TMS320F28076

Functional Safety-Compliant C2000™ 32-bit MCU

Product folder

Certification



TI FMEDA for TPS65313-Q1- Version: 2.2 - Date: 9-20-2018

TI Confidential - Maximum Restrictions

Short description of the worksheets

🟩 **How to control the calculation**
Purpose: This excel sheet describes the different user inputs that can be applied to control the calculation results

🟩 **Mission Profile Tailoring**
Purpose: This excel sheet provides control over the mission profile (temperature, power on hours and OPP setting) and also controls the standard ISO de-rate that is applied to the Permanent and Transient FIT calculation

🟩 **Function and Diag Tailoring**
Purpose: This excel sheet provides both functional and diagnostic tailoring control for the Transient and Permanent FIT results

🟩 **Diagnostic Coverage**
Purpose: This excel sheet provides details of the built in hardware diagnostics

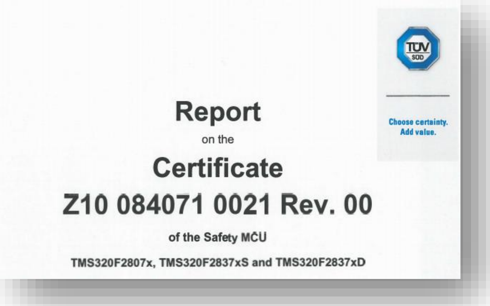
🟩 **Customer Defined Diagnostics**
Purpose: This excel sheet provides the customer access to add user defined external diagnostics - coverage values entered will automatically be applied on the functional and diag tailoring sheet if selected

🟩 **Pin Level Tailoring**
Purpose: This excel sheet provides both functional and diagnostic tailoring control for the package Permanent FIT results

🟩 **Totals - ISO26262**
Purpose: This excel sheet reports summarized ISO26262 FIT rates and metrics computation results

🟩 **Details-ISO26262**
Purpose: This excel sheet reports module level details of ISO26262 FIT rates and metrics computation results

🟩 **Summary - ISO26262**
Purpose: This excel sheet manages the final calculations that are in turn summarized on the "Totals - ISO26262" worksheet



TÜV SÜD

Choose certainty. Add value.

Report

on the

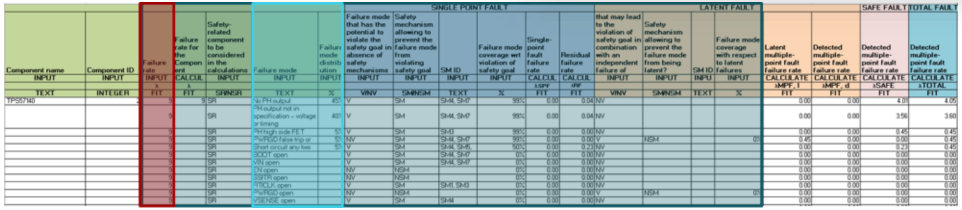
Certificate

Z10 084071 0021 Rev. 00

of the Safety MCU

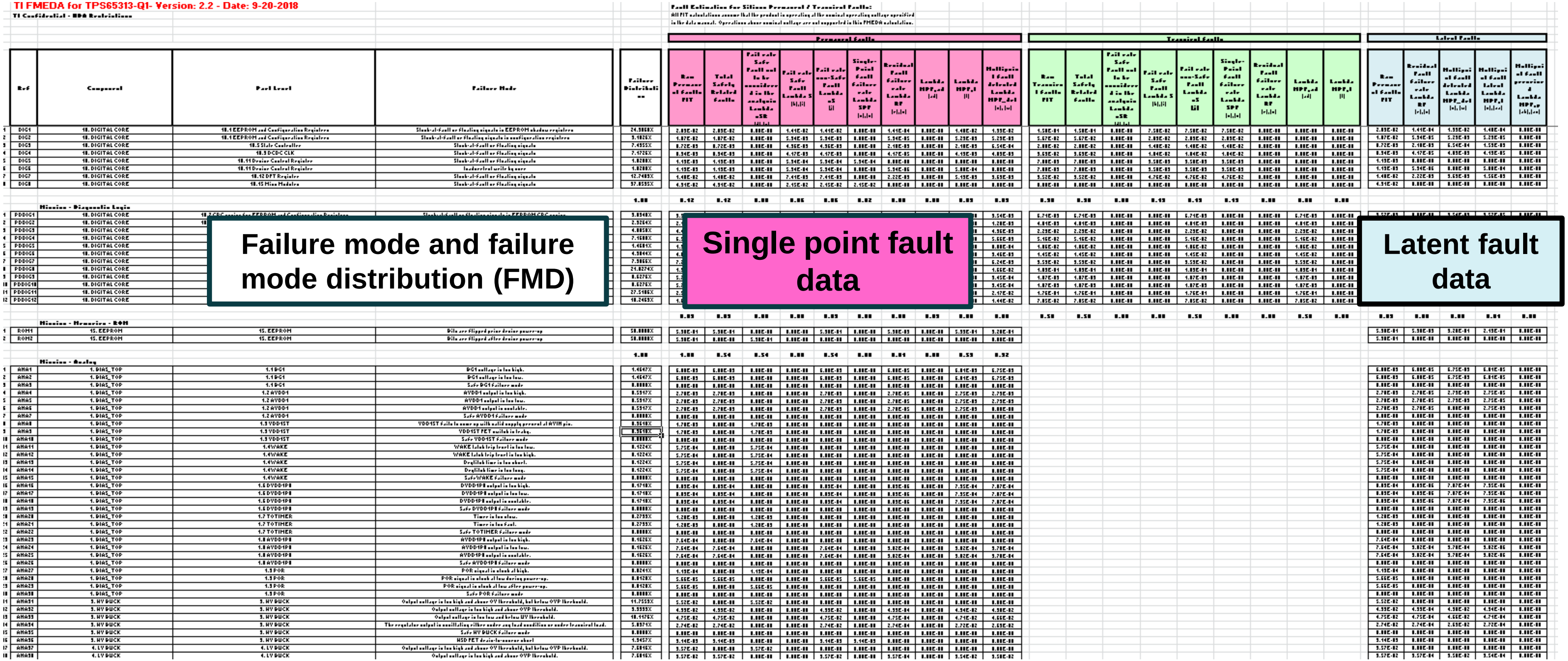
TMS320F2807x, TMS320F2837xS and TMS320F2837xD

1. **Product FIT**
2. **Product FMD and/or Product Pin FMA**
3. **Product FMEDA**
4. **Functional Safety Manual**



							SINGLE POINT FAULT									LATENT FAULT			SAFE FAULT	TOTAL FAULT
Component name	Component ID	Failure rate	Failure rate for the Component	Safety-related component to be considered in the calculations	Failure mode	Failure mode distribution	Failure mode that has the potential to violate the safety goal in absence of safety mechanisms	Safety mechanism allowing to prevent the failure mode from violating safety goal	SM ID	Failure mode coverage wrt violation of safety goal	Single-point fault failure rate	Residual failure rate	that may lead to the violation of safety goal in combination with an independent failure of	Safety mechanism allowing to prevent the failure mode from being latent?	SM ID	Failure mode coverage with respect to latent failures	Latent multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate	Detected multiple-point fault failure rate
INPUT	INPUT	INPUT	CALCUL	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	CALCUL	CALCUL	INPUT	INPUT	INPU	INPUT	CALCULATE	CALCULATE	CALCULATE	CALCULATE
		λ	λ								λSPF	λRF					λMPF, l	λMPF, d	λSAFE	λTOTAL
TEXT	INTEGER	FIT	FIT	SR/NSR	TEXT	%	V/NV	SM/NSM	TEXT	%	FIT	FIT	V/NV	SM/NSM	TEXT	%	FIT	FIT	FIT	FIT
TPS57140	2	9	9	SR	No PH output	45%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	4.01	4.05
		9		SR	PH output not in specification – voltage or timing	40%	V	SM	SM4, SM7	99%	0.00	0.04	NV				0.00	0.00	3.56	3.60
		9		SR	PH high side FET	5%	V	SM	SM3	99%	0.00	0.00	NV				0.00	0.00	0.45	0.45
		9		SR	PWRGD false trip or	5%	NV	SM	SM4, SM7	99%	0.00	0.00	V	NSM		0%	0.45	0.00	0.00	0.45
		9		SR	Short circuit any two	5%	V	SM	SM4, SM6,	50%	0.00	0.23	NV				0.00	0.00	0.23	0.45
		9		SR	BOOT open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	VIN open		V	SM	SM4, SM7	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	EN open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	SS/TR open		NV	NSM		0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	RT/CLK open		V	SM	SM1, SM3	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00
		9		SR	PWRGD open		NV	NSM		0%	0.00	0.00	V	NSM		0%	0.00	0.00	0.00	0.00
		9		SR	VSENSE open		V	SM	SM4	0%	0.00	0.00	NV				0.00	0.00	0.00	0.00

Functional Safety-Compliant FMEDA



TI FMEDA for TPS65313-Q1- Version: 2.2 - Date: 9-20-2018

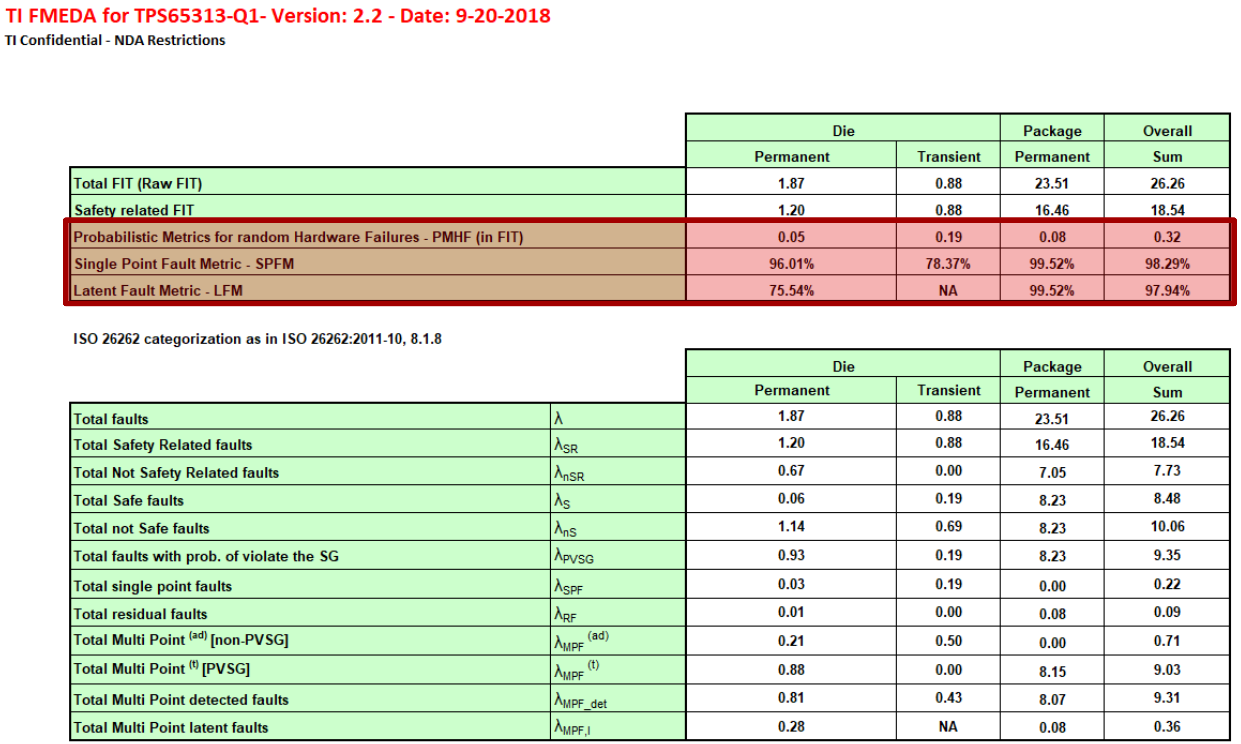
Failure mode and failure mode distribution (FMD)

Single point fault data

Latent fault data

Tab: Details-ISO26262

Functional Safety-Compliant FMEDA



TI FMEDA for TPS65313-Q1- Version: 2.2 - Date: 9-20-2018

TI Confidential - NDA Restrictions

	Die		Package	Overall
	Permanent	Transient	Permanent	Sum
Total FIT (Raw FIT)	1.87	0.88	23.51	26.26
Safety related FIT	1.20	0.88	16.46	18.54
Probabilistic Metrics for random Hardware Failures - PMHF (in FIT)	0.05	0.19	0.08	0.32
Single Point Fault Metric - SPFM	96.01%	78.37%	99.52%	98.29%
Latent Fault Metric - LFM	75.54%	NA	99.52%	97.94%

ISO 26262 categorization as in ISO 26262:2011-10, 8.1.8

		Die		Package	Overall
		Permanent	Transient	Permanent	Sum
Total faults	λ	1.87	0.88	23.51	26.26
Total Safety Related faults	λ_{SR}	1.20	0.88	16.46	18.54
Total Not Safety Related faults	λ_{nSR}	0.67	0.00	7.05	7.73
Total Safe faults	λ_{S}	0.06	0.19	8.23	8.48
Total not Safe faults	λ_{nS}	1.14	0.69	8.23	10.06
Total faults with prob. of violate the SG	λ_{PVSG}	0.93	0.19	8.23	9.35
Total single point faults	λ_{SPF}	0.03	0.19	0.00	0.22
Total residual faults	λ_{RF}	0.01	0.00	0.08	0.09
Total Multi Point $^{(ad)}$ [non-PVSG]	$\lambda_{MPF}^{(ad)}$	0.21	0.50	0.00	0.71
Total Multi Point $^{(t)}$ [PVSG]	$\lambda_{MPF}^{(t)}$	0.88	0.00	8.15	9.03
Total Multi Point detected faults	λ_{MPF_det}	0.81	0.43	8.07	9.31
Total Multi Point latent faults	$\lambda_{MPF,l}$	0.28	NA	0.08	0.36

Metric	ASIL A	ASIL B	ASIL C	ASIL D
PMHF	-	< 100 FIT	< 100 FIT	< 10 FIT
SPFM	-	>= 90%	>= 97%	>= 99%
LFM	-	>= 60%	>= 80%	>= 90%

$$PMHF= \frac{\lambda SPF + \lambda RF + \lambda MPF(t) \times \lambda MPF(sm\_latent) \times Total\ Hr}{10\text{^}9}$$

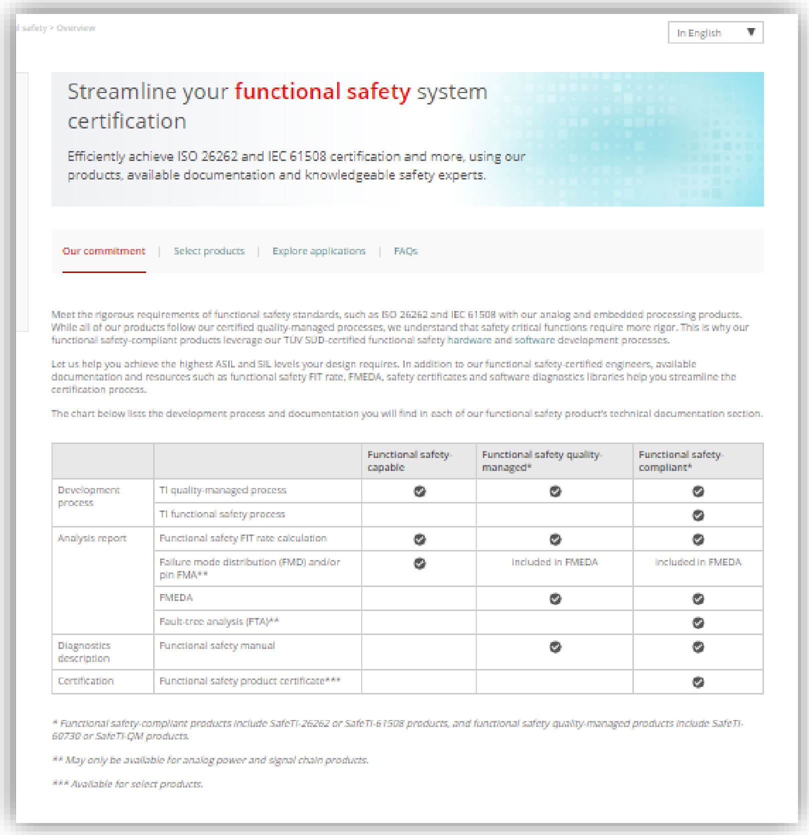
$$SPFM = \frac{\lambda S + \lambda MPF\ (ad) + \lambda MPF\ (t)}{\lambda S + \lambda nS}$$

$$LFM = \frac{\lambda S + \lambda MPF\ (det)}{\lambda S + \lambda nS - \lambda RF - \lambda SPF}$$

Tab: Totals-ISO26262

To learn more about functional safety at TI …

Go to www.ti.com/functionalsafety



l safety > Overview
In English ▼

Streamline your functional safety system certification

Efficiently achieve ISO 26262 and IEC 61508 certification and more, using our products, available documentation and knowledgeable safety experts.

Our commitment | Select products | Explore applications | FAQs

Meet the rigorous requirements of functional safety standards, such as ISO 26262 and IEC 61508 with our analog and embedded processing products. While all of our products follow our certified quality-managed processes, we understand that safety critical functions require more rigor. This is why our functional safety-compliant products leverage our TÜV SÜD-certified functional safety hardware and software development processes.

Let us help you achieve the highest ASIL and SIL levels your design requires. In addition to our functional safety-certified engineers, available documentation and resources such as functional safety FIT rate, FMEDA, safety certificates and software diagnostics libraries help you streamline the certification process.

The chart below lists the development process and documentation you will find in each of our functional safety product's technical documentation section.

		Functional safety-capable	Functional safety quality-managed*	Functional safety-compliant*
Development process	TI quality-managed process	✓	✓	✓
	TI functional safety process			✓
Analysis report	Functional safety FIT rate calculation	✓	✓	✓
	Failure mode distribution (FMD) and/or pin FMA**	✓	Included in FMEDA	Included in FMEDA
	FMEDA		✓	✓
	Fault-tree analysis (FTA)**			✓
Diagnostics description	Functional safety manual		✓	✓
Certification	Functional safety product certificate***			✓

** Functional safety-compliant products include SafeTI-26262 or SafeTI-61508 products, and functional safety quality-managed products include SafeTI-60730 or SafeTI-QM products.*

*** May only be available for analog power and signal chain products.*

**** Available for select products.*