TS5A3159-Q1 Functional Safety FIT Rate, FMD and Pin FMA

1 Overview

This document contains information for TS5A3159-Q1 (SOT-23-6 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 shows the device functional block diagram for reference.

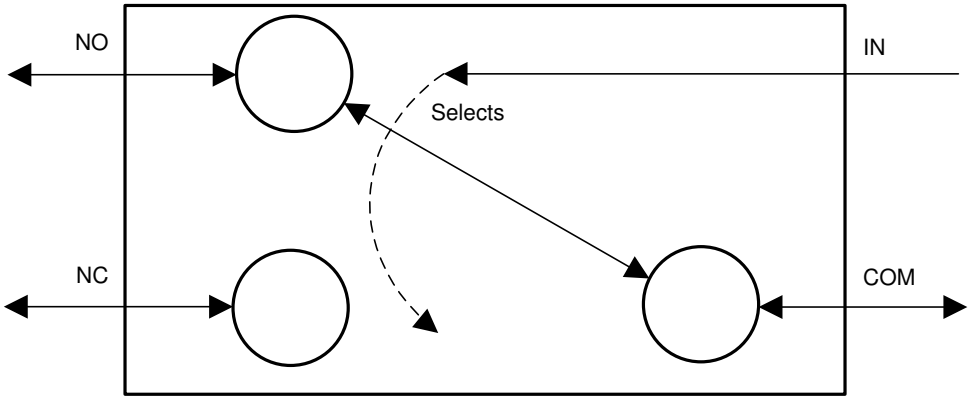

Figure 1. Functional Block Diagram

TS5A3159-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

2.1 SOT-23-6 Package

This section provides Functional Safety Failure In Time (FIT) rates for the SOT-23-6 package of TS5A3159-Q1 based on two different industry-wide used reliability standards:

- Table 1 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 2 provides FIT rates based on the Siemens Norm SN 29500-2

Table 1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10^9 Hours) SOT-23-6
Total Component FIT Rate	5
Die FIT Rate	3
Package FIT Rate	2

The failure rate and mission profile information in Table 1 comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 50 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
5	BICMOS ASICs Analog & Mixed = <50-V	20 FIT	55°C

The Reference FIT Rate and Reference Virtual T_J (junction temperature) in Table 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 TS5A3159-Q1 in Table 3 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. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
NO or NC no output (HIZ)	20%
NO or NC channel stuck on	10%
NO or NC channel stuck off	10%
NO or NC functional out of specification voltage or timing	60%

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TS5A3159-Q1 (SOT-23-6 package). The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to ground (see Table 5)
- Pin open-circuited (see Table 6)
- Pin short-circuited to an adjacent pin (see Table 7)
- Pin short-circuited to supply (see Table 8)

Table 5 through Table 8 also indicate how these pin conditions can affect the device as per the failure effects classification in Table 4.

Table 4. 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

4.1 SOT-23-6 Package

Figure 2 and shows the TS5A3159-Q1 pin diagram for the SOT-23-6 package. For a detailed description of the device pins please refer to the '*Pin Configuration and Functions*' section in the TS5A3159-Q1 datasheet.

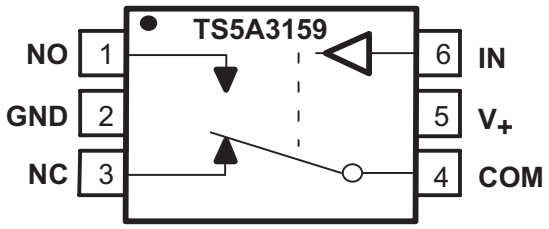

Figure 2. Pin Diagram (SOT-23-6 Package)

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
NO	1	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
GND	2	No effect, normal operation	D
NC	3	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
COM	4	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
V+	5	Device unpowered. Device not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
IN	6	IN stuck low. Cannot control switch states	B

Table 6. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
NO	1	Corruption of analog signal.	B
GND	2	No GND reference, device not functional.	B
NC	3	Corruption of analog signal.	B
COM	4	Corruption of analog signal.	B
V+	5	Device unpowered. Device not functional.	B
IN	6	Loss of control of IN pin. Switch in undefined state	B

Table 7. 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
NO	1	GND	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible.	A
GND	2	NC	Device functions but corruption of analog signal. If there is no limiting resistor in the switch path device damage possible.	A
NC	3	COM	Not considered, Corner pin.	
COM	4	V+	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible.	A
V+	5	IN	IN stuck high. Cannot control switch states.	B
IN	6	NO	Not considered, Corner pin.	D

Table 8. Pin FMA for Device Pins Short-Circuited to V+

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
NO	1	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
GND	2	Device unpowered. Device not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A
NC	3	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
COM	4	Corruption of analog signal. If there is no limiting resistor in the switch path device damage possible	A
V+	5	No effect, normal operation	D
IN	6	IN stuck high. Cannot control switch states	B

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265