Application Report
SCDA022–May 2020

TS5A3357-Q1 Functional Safety FIT Rate, FMD and Pin FMA

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1 Overview

This document contains information for TS5A3357-Q1 (VSSOP 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)

TS5A3357-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 TS5A3357-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)
Total Component FIT Rate	6
Die FIT Rate	3
Package FIT Rate	3

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 supply	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 TS5A3357-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 (%)
MUX no output (HIZ)	20%
MUX channel stuck on	10%
MUX channel stuck off	10%
MUX 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 TS5A3357-Q1. 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.

Figure 1 shows the TS5A3357-Q1 pin diagram. For a detailed description of the device pins please refer to the '*Pin Configuration and Functions*' section in the TS5A3357-Q1 datasheet.

SC-70 (DCU) PACKAGE
(TOP VIEW)

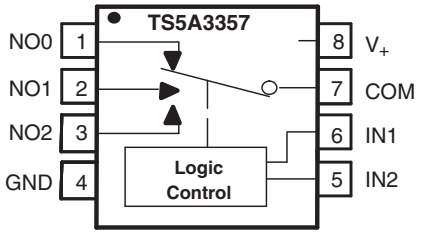

Figure 1. Pin Diagram

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
NO0	1	Corruption of signal passed onto the COM pin. If there is no limiting resistor in the switch path device damage is possible.	A
NO1	2	Corruption of signal passed onto the COM pin. If there is no limiting resistor in the switch path device damage is possible.	A
NO2	3	Corruption of signal passed onto the S pins. If there is no limiting resistor in the switch path device damage is possible.	A
GND	4	No effect, normal operation.	D
IN2	5	IN2 Stuck low. Cannot control switch states.	B
IN1	6	IN1 Stuck low. Cannot control switch states	B
COM	7	Corruption of signal passed onto the NOx pins. If there is no limiting resistor in the switch path device damage possible.	A
V+	8	Device unpowered. Device is not functional. Observe that the absolute maximum ratings for all pins of the device are met, otherwise device damage may be plausible.	A

Table 6. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
NO0	1	Corruption of signal passed onto the COM pin.	B
NO1	2	Corruption of signal passed onto the COM pin.	B
NO2	3	Corruption of signal passed onto the S pins.	B
GND	4	Device unpowered. Device not functional.	B
IN2	5	Loss of control of IN2 pin. Cannot control switch.	B
IN1	6	Loss of control of IN1 pin. Cannot control switch.	B
COM	7	Corruption of signal passed onto the NOx pins.	B
V+	8	Device unpowered. Device not functional.	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
NO0	1	NO1	Possible corruption of signal passed onto the COM pin.	B
NO1	2	NO2	Possible corruption of signal passed onto the COM pin.	B
NO2	3	GND	Corruption of signal passed onto the S pins. If there is no limiting resistor in the switch path device damage possible.	A
GND	4	IN2	Not considered, corner pin.	
IN2	5	IN1	Loss of control of switch state.	B
IN1	6	COM	Possible corruption of signal passed onto the NOx pins. Loss of control of switch state.	B
COM	7	V+	Corruption of signal passed onto the NOx pins. If there is no limiting resistor in the switch path device damage possible.	A
V+	8	NO0	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
NO0	1	Corruption of signal passed onto the COM pin. If there is no limiting resistor in the switch path device damage possible.	A
NO1	2	Corruption of signal passed onto the COM pin. If there is no limiting resistor in the switch path device damage possible.	A
NO2	3	Corruption of signal passed onto the S pins. If there is no limiting resistor in the switch path device damage possible.	A
GND	4	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
IN2	5	IN2 Stuck high. Cannot control switch states.	B
IN1	6	IN1 Stuck high. Cannot control switch states.	B
COM	7	Corruption of signal passed onto the NOx pins. If there is no limiting resistor in the switch path device damage possible.	A
V+	8	No effect, normal operation.	D

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