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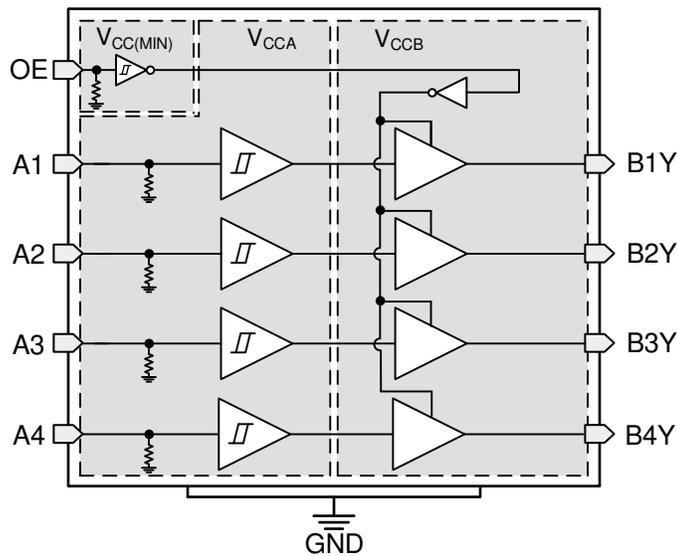
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## 1 Overview

This document contains information for TXU0104-Q1 (TSSOP-14 and VQFN-14 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**

TXU0104-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 TSSOP-14 Package

This section provides Functional Safety Failure In Time (FIT) rates for TSSOP-14 package of TXU0104-Q1 based on industry-wide used reliability standards:

- [Table 2-1](#) provides FIT rates based on IEC TR 62380 / ISO 26262 part 11

**Table 2-1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11**

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10 <sup>9</sup> Hours)
Total Component FIT Rate	8
Die FIT Rate	2
Package FIT Rate	6

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: 30 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

### 2.2 VQFN-14 Package

This section provides Functional Safety Failure In Time (FIT) rates for the VQFN-14 package of TXU0104-Q1 based on industry-wide used reliability standards:

- [Table 2-2](#) provides FIT rates based on IEC TR 62380 / ISO 26262 part 11

**Table 2-2. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11**

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10 <sup>9</sup> Hours)
Total Component FIT Rate	9
Die FIT Rate	2
Package FIT Rate	7

The failure rate and mission profile information in [Table 2-2](#) comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 30 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

## 2.3 TSSOP-14 and VQFN-14 Packages

This section provides Functional Safety Failure In Time (FIT) rates for TSSOP-14 and VQFN-14 packages of TXU0104-Q1 based on industry-wide used reliability standards:

- [Table 2-3](#) provides FIT rates based on IEC TR 62380 / ISO 26262 part 11

**Table 2-3. Component Failure Rates per Siemens Norm SN 29500-2**

Table	Category	Reference FIT Rate	Reference Virtual T <sub>J</sub>
5	CMOS Analog switch, Bus Interface	5 FIT	55°C

The Reference FIT Rate and Reference Virtual T<sub>J</sub> (junction temperature) in [Table 2-3](#) 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 TXU0104-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 (%)
Driver HIZ no output	23%
Functional fail (voltage, timing, out of specification)	26%
Driver stuck at fault high	16%
Driver stuck at fault low	15%
Driver stuck at undetermined state	20%

## 4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TXU0104-Q1 (TSSOP-14 and VQFN-14 packages). 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](#) and [Table 4-6](#))

[Table 4-2](#) through [Table 4-6](#) 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

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

- 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](#) and [Table 4-6](#))

### 4.1 TSSOP-14 and VQFN-14 Package

Figure 4-1 shows the TXU0104-Q1 pin diagram for the TSSOP-14 package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TXU0104-Q1 data sheet.

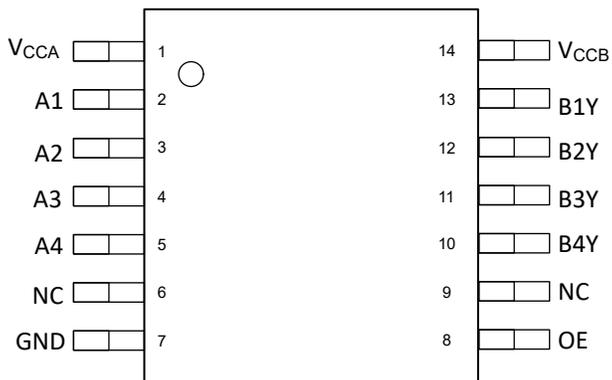


Figure 4-1. Pin Diagram (TSSOP-14) Package

Figure 4-2 shows the TXU0104-Q1 pin diagram for the VQFN-14 package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TXU0104-Q1 data sheet.

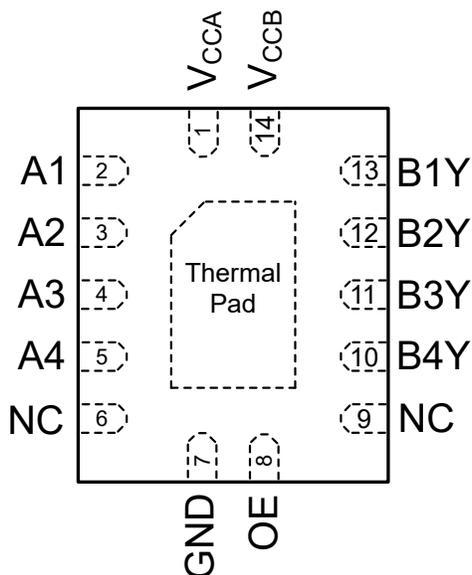


Figure 4-2. Pin Diagram (VQFN-14 Package)

**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
VCCA	1	Device will not be powered or damaged, because short is external to device. System level damage can occur in this scenario.	B
A1	2	Ax will be LOW, if corresponding Bx is HIGH, there will be potential damage to the device if the current is not limited. If corresponding Bx is LOW, then nothing will occur, no damage.	B
A2	3		B
A3	4		B
A4	5		B
NC	6		Normal operation.
GND	7	Normal operation.	D
OE	8	All I/Os will be fixed into high impedance (tri-state).	B
NC	9	Normal operation.	D
B4Y	10	Bx will be LOW, if corresponding Ax is HIGH, there will be potential damage to the device if the current is not limited. If corresponding Ax is LOW, then nothing will occur, no damage.	B
B3Y	11		B
B2Y	12		B
B1Y	13		B
VCCB	14		Device will not be powered or damaged, because the short is external to device. System level damage can occur in this scenario.

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VCCA	1	Device will not be powered.	B
A1	2	Ax pin will be grounded internally.	D
A2	3		D
A3	4		D
A4	5		D
NC	6		Normal operation.
GND	7	Device will not be powered.	B
OE	8	I/Os can be high impedance or active, unknown input state.	A
NC	9	Normal operation.	D
B4Y	10	Bx pin will be in HiZ if device is disabled. If device is enabled, it will be HIGH or LOW depending upon the input.	D
B3Y	11		D
B2Y	12		D
B1Y	13		D
VCCB	14		Device will not be powered.

**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
VCCA	1	A1	Ax will be HIGH, if corresponding Bx is LOW, there will be potential damage to the device if the current is not limited. If corresponding Bx is HIGH, then nothing will occur, no damage.	B
A1	2	A2	Two inputs shorted together will not cause damage unless there is external bus contention that drives the input such that $V_{IL} < \text{Input Voltage} < V_{IH}$ in which case excessive supply current to GND can cause damage.	B
A2	3	A3		B
A3	4	A4		B
A4	5	NC		D
NC	6	GND	Normal operation.	D
GND	7	OE	All I/Os will be fixed into high impedance (tri-state).	B
OE	8	NC	Normal operation.	D
NC	9	B4Y	Normal operation.	D
B4Y	10	B3Y	Two outputs shorted together can cause damage if there is external bus contention that drives one output LOW while driving the other output HIGH.	A
B3Y	11	B2Y		A
B2Y	12	B1Y		A
B1Y	13	VCCB	Bx will be HIGH, if corresponding Ax is LOW, there will be potential damage to the device if the current is not limited. If corresponding Ax is HIGH, then nothing will occur, no damage.	B
VCCB	14	VCCA	Device will not be powered or damaged, because short is external to device System level damage can occur in this scenario.	B

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VCCA	1	Normal operation.	D
A1	2	Ax will be HIGH, if corresponding Bx is LOW, there will be potential damage to the device if the current is not limited. If corresponding Bx is HIGH, then nothing will occur, no damage.	B
A2	3		B
A3	4		B
A4	5		B
NC	6	Normal operation.	D
GND	7	Device will not be powered or damaged, because short is external to device. System level damage can occur in this scenario.	B
OE	8	All I/Os will be active, device cannot be disabled.	B
NC	9	Normal operation.	D
B4Y	10	Bx will be HIGH, if corresponding Ax is LOW, there will be potential damage to the device if the current is not limited. If corresponding Ax is HIGH, then nothing will occur, no damage.	B
B3Y	11		B
B2Y	12		B
B1Y	13		B
VCCB	14	Device will not be powered or damaged, because short is external to device. System level damage can occur in this scenario.	B

**Table 4-6. Pin FMA for Device Pins Short-Circuited to supply VCCB**

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VCCA	1	Device will not be powered or damaged, because short is external to device. System level damage can occur in this scenario.	B
A1	2	Ax will be HIGH, if corresponding Bx is LOW, there will be potential damage to the device if the current is not limited. If corresponding Bx is HIGH, then nothing will occur, no damage.	B
A2	3		B
A3	4		B
A4	5		B
NC	6	Normal operation.	D
GND	7	Device will not be powered or damaged, because short is external to device. System level damage can occur in this scenario.	B
OE	8	All I/Os will be active, device cannot be disabled.	B
NC	9	Normal operation.	D
B4	10	Bx will be HIGH, if corresponding Ax is LOW, there will be potential damage to the device if the current is not limited. If corresponding Ax is HIGH, then nothing will occur, no damage.	B
B3	11		B
B2	12		B
B1	13		B
VCCB	14	Normal operation.	D

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