Functional Safety Information

TCAN1473A-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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Trademarks

1 Overview

This document contains information for TCAN1473A-Q1 to aid in a functional safety system design. The TCAN1473A-Q1 comes in the SOIC (D), VSON (DMT) and SOT (DYY) packages. 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 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.

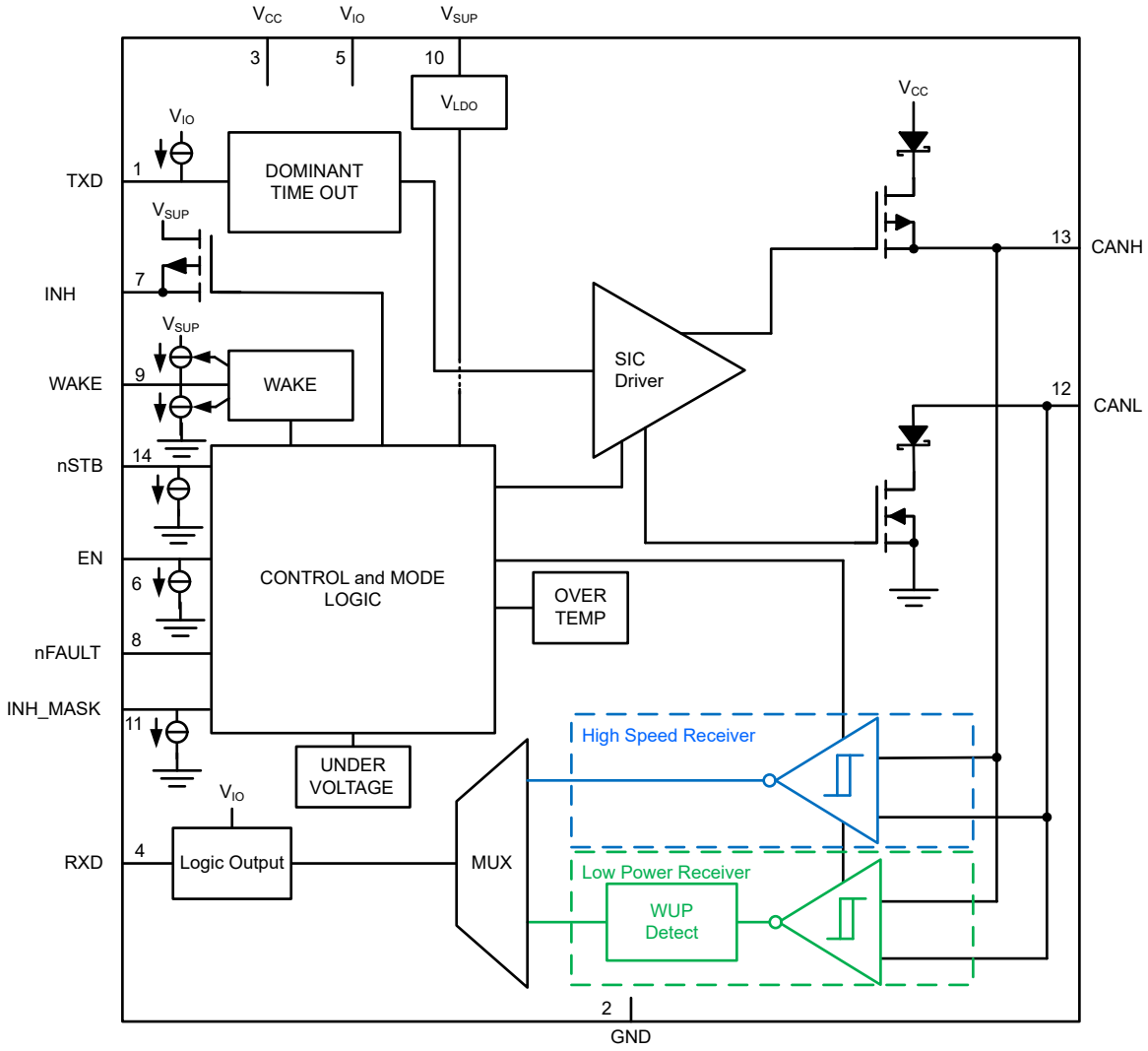

Figure 1-1. Functional Block Diagram

TCAN1473A-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 TCAN1473A-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) 14-pin SOIC (D)	FIT (Failures Per 10^9 Hours) 14-pin VSON (DMT)	FIT (Failures Per 10^9 Hours) 14-pin SOT (DYY)
Total component FIT rate	22	10	11
Die FIT rate	6	4	7
Package FIT rate	16	6	4

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 or figure 16
- Power dissipation: 353mW
- Climate type: World-wide table 8 or figure 13
- Package factor (lambda 3): Table 17b or figure 15
- 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 and mixed ≤ 50V supply	25 FIT	55°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 TCAN1473A-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 resulting from misuse or overstress.

Table 3-1. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
Receiver fail	35
Transmitter fail	35
System stuck in sleep mode	15
Control and mode logic failure	10
CANL or CANH driver stuck dominant	5

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the TCAN1473A-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 V_{SUP} (see Table 4-5)
- Pin short-circuited to V_{CC} (see Table 4-6)
- Pin short-circuited to V_{IO} (see Table 4-7)

Table 4-2 through Table 4-7 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 TCAN1473A-Q1 pin diagram for the 14-pin SOIC (D) and 14-pin SOT (DYY) packages. Figure 4-2 shows the TCAN1473A-Q1 pin diagram for the 14-pin VSON (DMT) package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TCAN1473A-Q1 data sheet.

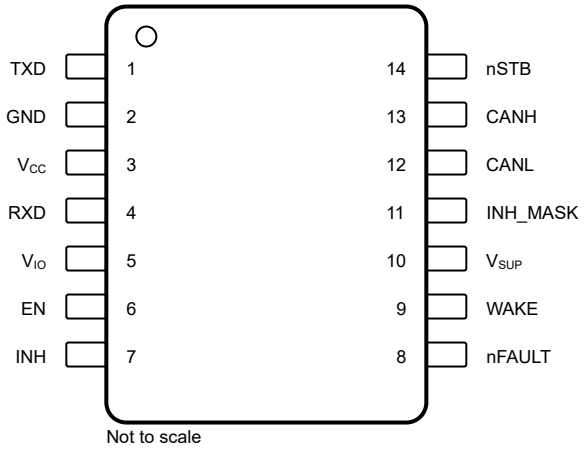

Figure 4-1. TCAN1473A-Q1 Pin Diagram (14-pin SOIC (D) and 14-pin SOT (DYY) Packages)

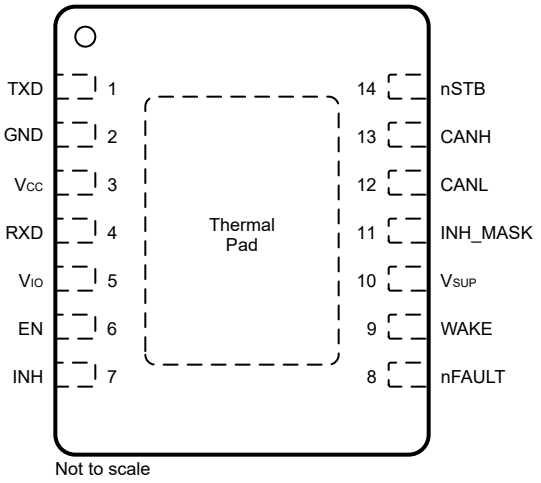

Figure 4-2. TCAN1473A-Q1 Pin Diagram (14-pin VSON (DMT) Package)

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

- V_{CC} = 4.5V to 5.5V
- V_{SUP} = 4.5V to 40V
- V_{IO} = 1.7V to 5.5V

Table 4-2. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
TXD	1	The TXD pin is biased dominant indefinitely. The device enters dominant time-out mode. The device is unable to transmit data.	B
GND	2	None	D
V_{CC}	3	The device enters sleep mode. There is a high current draw from the external regulator supplying the V_{CC} pin.	B
RXD	4	The output of the receiver is biased recessive indefinitely. The host is unable to receive data from the bus.	B
V_{IO}	5	The device enters sleep mode. The transceiver is passive on the bus. There is a high current draw from the external regulator supplying the V_{IO} pin.	B
EN	6	The EN pin is biased low. The device is unable to enter normal mode. The device is unable to communicate.	B
INH	7	The I_{SUP} current is high. The INH pin is potentially damaged and indication from the transition to sleep mode is not available.	A
nFAULT	8	The nFAULT pin is biased low indefinitely, which indicates a fault indefinitely.	B
WAKE	9	The WAKE pin is biased low indefinitely and is unable to utilize the local wake-up function.	B
V_{SUP}	10	The device is not powered. There is a high current flowing from the source supplying V_{SUP} flowing to GND.	B
INH_MASK	11	The inhibit mask function cannot be used as intended.	B
CANL	12	There is a violation of the $V_{O(REC)}$ specification. EMC performance is degraded.	C
CANH	13	The device cannot drive the dominant bit to the bus, communication is not possible.	B
nSTB	14	The nSTB pin is biased low indefinitely. The transceiver is unable to enter normal mode. The device is unable to communicate.	B
Thermal Pad	-	None	D

Note

The 14-pin VSON (DMT) package includes a thermal pad.

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
TXD	1	The TXD pin defaults to a recessive bias. The device is always recessive and unable to transmit data.	B
GND	2	The device is not powered.	B
V_{CC}	3	The device in protected mode.	B
RXD	4	There is no RXD output, the device is unable to receive data.	B
V_{IO}	5	The device in protected mode.	B
EN	6	The EN pin defaults to a logic-low bias. The device is unable to enter normal mode. The device is unable to communicate.	B
INH	7	None	D
nFAULT	8	There is no effect on performance, but the device is unable to monitor system faults.	B
WAKE	9	There is no effect on performance, but the device is unable to utilize the local wake-up function.	B
V_{SUP}	10	The device is not powered.	B
INH_MASK	11	The inhibit mask function cannot be used as intended.	B
CANL	12	The device cannot drive dominant on the bus. The device is unable to communicate.	B
CANH	13	The device cannot drive dominant on the bus. The device is unable to communicate.	B
nSTB	14	The nSTB pin defaults to a logic-low bias. The device is unable to enter normal mode. The device is unable to communicate.	B
Thermal Pad	-	None	D

Note

The 14-pin VSON (DMT) package includes a thermal pad.

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effects	Failure Effect Class
TXD	1	GND	The TXD pin is biased dominant indefinitely and the device enters dominant time-out mode. The device is unable to transmit data.	B
GND	2	V_{CC}	The device is in protected mode, the I_{CC} current is high.	B
V_{CC}	3	RXD	The output of the RXD pin is biased recessive indefinitely. The controller is unable to receive data from the CAN bus.	B
RXD	4	VIO	The output of the RXD pin is biased recessive indefinitely. The controller is unable to receive data from the CAN bus.	B
V_{IO}	5	EN	The EN pin is biased high indefinitely. The device is unable to enter the standby and silent modes.	B
EN	6	INH	There is a violation of the absolute maximum rating on the EN pin (except in sleep mode). The transceiver is potentially damaged.	A
nFAULT	8	WAKE	There is a potential violation of the absolute maximum rating on the nFAULT pin if WAKE is biased high. The transceiver is potentially damaged.	A
WAKE	9	V_{SUP}	The WAKE pin is biased high indefinitely, the device is unable to utilize local wake-up function.	B
V_{SUP}	10	INH_MASK	There is a violation of the absolute maximum rating on the INH_MASK pin. The transceiver is potentially damaged.	A
INH_MASK	11	CANL	If the INH_MASK pin is at V_{IO} level, the I_{OS} current is potentially reached; RXD is always recessive. If the INH_MASK pin is at logic low, the $_{O(REC)}$ specifications are violated. EMC performance is degraded.	B
CANL	12	CANH	The bus is biased recessive. Communication is not possible. The I_{OS} current is potentially reached on the CANH or CANL pin.	B

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

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effects	Failure Effect Class
CANH	13	nSTB	The driver and receiver turn off when the CAN bus is recessive. The device potentially does not enter normal mode.	B

Note

The 14-pin VSON (DMT) package includes a thermal pad. All devices pins are adjacent to the thermal pad. The behavior of the device when pins are shorted to the thermal pad depends on the net that is connected to the thermal pad.

Table 4-5. Pin FMA for Device Pins Short-Circuited to V_{SUP}

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
TXD	1	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
GND	2	The device is not powered. The I_{SUP} current is high.	B
V_{CC}	3	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
RXD	4	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
V_{IO}	5	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
EN	6	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
INH	7	Minimal current is driven into the INH pin.	D
nFAULT	8	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
WAKE	9	The WAKE pin is biased high. The device is unable to utilize the local wake-up function.	B
V_{SUP}	10	None	D
INH_MASK	11	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A
CANL	12	The I_{OS} current is potentially reached. The RXD pin is always recessive.	B
CANH	13	The $V_{O(REC)}$ specification is violated. EMC performance is degraded and communication errors potentially result.	C
nSTB	14	There is a violation of the absolute maximum rating. The transceiver is potentially damaged.	A

Note

The 14-pin VSON (DMT) package includes a thermal pad.

Table 4-6. Pin FMA for Device Pins Short-Circuited to V_{CC}

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
TXD	1	The TXD pin is biased recessive indefinitely. The device is unable to transmit data.	B
GND	2	The CAN transmitter is not powered and the device enters sleep mode. There is a high current draw from the external regulator supplying the VCC pin.	B
V_{CC}	3	None	D
RXD	4	The output of the receiver is biased recessive indefinitely. The host is unable to receive data from the bus.	B
V_{IO}	5	The I/O pins operate as 5V input and output pins. The microcontroller is potentially damaged if $V_{CC} > V_{IO}$.	C
EN	6	The EN pin is biased high indefinitely. The device is unable to enter the standby and silent modes.	B
INH	7	There is a violation of the absolute maximum rating on the V_{CC} pin. The INH pin is biased at the V_{CC} voltage. The system potentially does not wakeup.	A
nFAULT	8	The nFAULT pin is biased high indefinitely. The transceiver is unable to report faults.	B
WAKE	9	None	D
V_{SUP}	10	There is a violation of the absolute maximum rating on the V_{CC} pin.	A

Table 4-6. Pin FMA for Device Pins Short-Circuited to V_{CC} (continued)

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
INH_MASK	11	The inhibit mask function is activated when the device enters silent mode. The microcontroller is potentially damaged if $V_{CC} > V_{IO}$.	B
CANL	12	The I_{OS} current is potentially reached. The RXD pin is always recessive.	B
CANH	13	The $V_{O(REC)}$ specification is violated. EMC performance is degraded.	C
nSTB	14	The nSTB pin is biased high indefinitely. The transceiver is unable to enter the standby and sleep modes.	B

Note

The 14-pin VSON (DMT) package includes a thermal pad.

Table 4-7. Pin FMA for Device Pins Short-Circuited to V_{IO}

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
TXD	1	The TXD pin is biased recessive indefinitely. The device is unable to transmit data.	B
GND	2	The device is not powered. There is a high current draw from the external regulator supplying to the VIO pin.	B
V_{CC}	3	The I/O pins operate as 5V input and outputs pins. The microcontroller is potentially damaged if $V_{CC} > V_{IO}$.	C
RXD	4	The output of the receiver is biased recessive indefinitely. The host is unable to receive data from bus.	B
V_{IO}	5	None	D
EN	6	The EN pin is biased high indefinitely. The device is unable to enter the standby and silent modes.	B
INH	7	There is a violation of the absolute maximum rating on the V_{IO} pin. The INH pin is biased at the V_{IO} voltage. The system potentially does not wakeup.	B
nFAULT	8	The nFAULT pin is biased high indefinitely. The transceiver is unable to report faults.	B
WAKE	9	None	D
V_{SUP}	10	There is a violation of the absolute maximum rating on the V_{IO} pin.	A
INH_MASK	11	The inhibit mask function is activated when the device enters silent mode.	D
CANL	12	The I_{OS} current is potentially reached. The RXD pin is always recessive.	B
CANH	13	The $V_{O(REC)}$ specification is violated. EMC performance is degraded.	C
nSTB	14	The nSTB pin is biased high indefinitely. The transceiver is unable to enter the standby and sleep modes.	B

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
October 2024	*	Initial Release

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