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1 Overview

This document contains information for the TLC69624-Q1 and TLC69634-Q1 (WQFN (32) Wettable flank and HTSSOP (32) packages) 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 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.

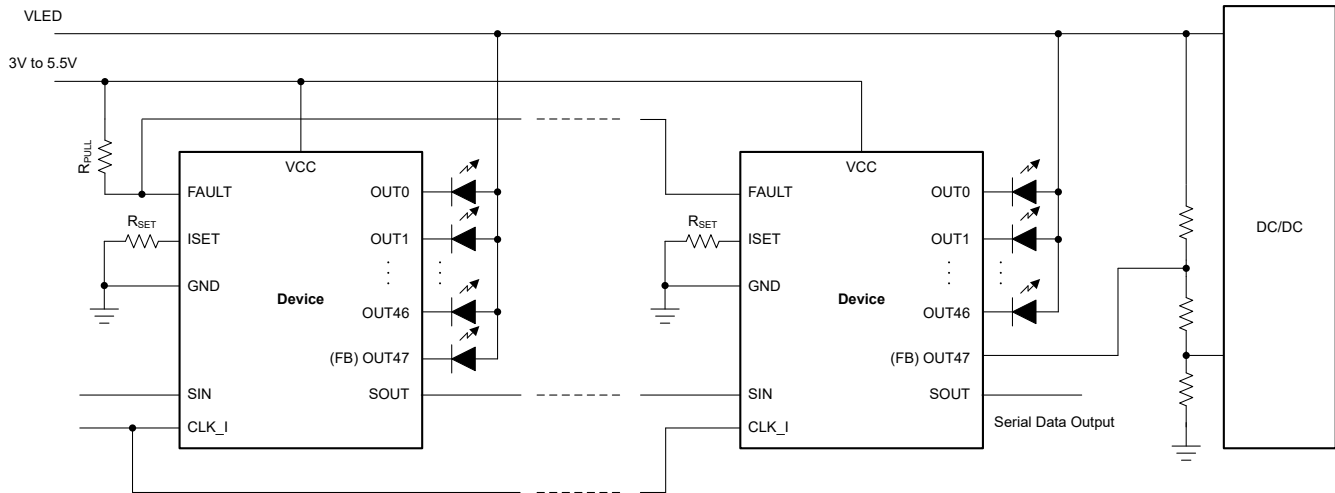


Figure 1-1. Functional Block Diagram

The TLC69624-Q1 and TLC69634-Q1 were developed using a quality-managed development process, but were not developed in accordance with the IEC 61508 or ISO 26262 standards.

2 Functional Safety Failure In Time (FIT) Rates

2.1 WQFN (32) Wettable flank Package

This section provides functional safety failure in time (FIT) rates for the WQFN (32) Wettable flank package of the TLC69624-Q1 and TLC69634-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 2-3](#) 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)
Total component FIT rate	12.63
Die FIT rate	2.16
Package FIT rate	10.47

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:
 - 10,000 power-on-hours | 300,000km driving
 - 15 year lifetime
 -

Table 2-2. Temperature and Distribution Assumptions

Temperature [°C]	Distribution [%]
–40	1
–20	5
43	20
60	65
95	8
105	1

- Power dissipation: 500mW
- Climate type: World-wide table 8 or figure 13
- Package factor (lambda 3): From table 17b or figure 15
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

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

Table	Category	Reference FIT Rate	Reference Virtual T _J
5	CMOS, BICMOS Digital, analog, or mixed	60 FIT	70°C

The reference FIT rate and reference virtual T_J (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.

2.2 HTSSOP (32) Package

This section provides functional safety failure in time (FIT) rates for the HTSSOP (32) package of the TLC69624-Q1 and TLC69634-Q1 based on two different industry-wide used reliability standards:

- [Table 2-4](#) provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- [Table 2-6](#) provides FIT rates based on the Siemens Norm SN 29500-2

Table 2-4. 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	23.73
Die FIT rate	1.97
Package FIT rate	21.76

The failure rate and mission profile information in [Table 2-4](#) comes from the reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission profile:
 - 10,000 power-on-hours | 300,000km driving
 - 15 year lifetime
 -

Table 2-5. Temperature and Distribution Assumptions

Temperature [°C]	Distribution [%]
–40	1
–20	5
43	20
60	65
95	8
105	1

- Power dissipation: 500mW
- Climate type: World-wide table 8 and figure 13
- Package factor (lambda 3): From table 17b and figure 15
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2-6. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T _J
5	CMOS, BICMOS Digital, analog, or mixed	60 FIT	70°C

The reference FIT rate and reference virtual T_J (junction temperature) in [Table 2-6](#) 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 the TLC69624-Q1 and TLC69634-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 (%)
All constant-current outputs are out of specification	20.3
All constant-current outputs are stuck high	3.1
All constant-current outputs are stuck low	3.7
One of the constant-current outputs is out of specification	2.6
One of the constant-current outputs is stuck high	0.4
One of the constant-current outputs is stuck low	0.4
Fault fails to trigger	8.9
Fault is falsely triggered	17.2
Communication failure	43.4

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the TLC69624-Q1 and TLC69634-Q1 (WQFN (32) Wettable flank and HTSSOP (32) 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](#) and [Table 4-6](#))
- Pin open-circuited (see [Table 4-3](#) and [Table 4-7](#))
- Pin short-circuited to an adjacent pin (see [Table 4-4](#) and [Table 4-8](#))
- Pin short-circuited to supply (see [Table 4-5](#) and [Table 4-9](#))

[Table 4-2](#) through [Table 4-9](#) 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:

- Special considerations on pin level tailoring: The OUT23 pin can be selected as either the constant-current sink channel or the FB function.

4.1 WQFN (32) Wettable flank Package

[Figure 4-1](#) shows the TLC69624-Q1 and TLC69634-Q1 pin diagram for the WQFN (32) Wettable flank package. For a detailed description of the device pins, see the *Pin Configuration and Functions* section in the TLC69624-Q1 and TLC69634-Q1 datasheet.

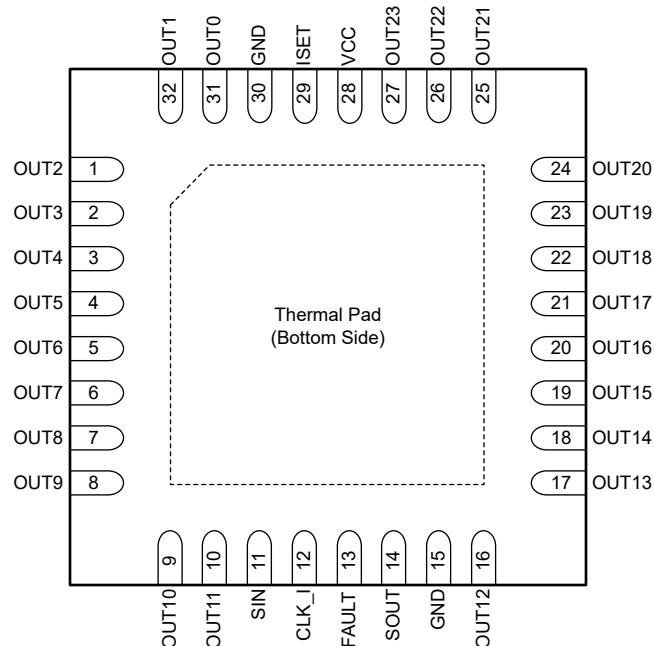


Figure 4-1. Pin Diagram (WQFN (32) Wettable flank) Package

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
OUT2–OUT11	1–10	The device reports LED open.	B
SIN	11	There is a communication failure.	B
CLK_I	12	There is a communication failure.	B
FAULT	13	A fault is falsely triggered on the device.	B
SOUT	14	There is a communication failure.	B
GND	15, 30	There is no effect on the device. The device operates as normal.	D
OUT12–OUT23	16–27	The device reports LED open.	B
VCC	28	The device cannot start up.	B
ISET	29	The device reports an error on the ISET pin.	B
OUT0–OUT1	31–32	The device reports LED open.	B

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
OUT2–OUT11	1–10	The device reports LED open.	B
SIN	11	There is a communication failure.	B
CLK_I	12	There is a communication failure.	B
FAULT	13	A fault fails to trigger on the device.	B
SOUT	14	There is a communication failure.	B
GND	15, 30	There is no effect on the device. There are multiple GND pins.	D
OUT12–OUT23	16–27	The device reports LED open.	B
VCC	28	The device cannot start up.	B
ISET	29	The device reports an error on the ISET pin.	B
OUT0–OUT1	31–32	The device reports LED open.	B

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
OUT2	1	OUT3	The LEDs connected to the OUT2 and OUT3 pin cannot perform the correct brightness.	B
OUT3	2	OUT4	The LEDs connected to the OUT3 and OUT4 pin cannot perform the correct brightness.	B
OUT4	3	OUT5	The LEDs connected to the OUT4 and OUT5 pin cannot perform the correct brightness.	B
OUT5	4	OUT6	The LEDs connected to the OUT5 and OUT6 pin cannot perform the correct brightness.	B
OUT6	5	OUT7	The LEDs connected to the OUT6 and OUT7 pin cannot perform the correct brightness.	B
OUT7	6	OUT8	The LEDs connected to the OUT7 and OUT8 pin cannot perform the correct brightness.	B
OUT8	7	OUT9	The LEDs connected to the OUT8 and OUT9 pin cannot perform the correct brightness.	B
OUT9	8	OUT10	The OUT9 and OUT10 pin are both corner pins, the adjacent-pin short is not applicable.	D
OUT10	9	OUT11	The LEDs connected to the OUT10 and OUT11 pin cannot perform the correct brightness.	B
OUT11	10	SIN	There is a communication failure.	B
SIN	11	CLK_I	There is a communication failure.	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
CLK_I	12	FAULT	The device reports fault falsely.	B
FAULT	13	SOUT	The device reports fault falsely.	B
SOUT	14	GND	There is a communication failure.	B
GND	15	OUT12	The device reports LED open.	B
OUT12	16	OUT13	The OUT12 and OUT13 pin are both corner pins, the adjacent-pin short is not applicable.	D
OUT13	17	OUT14	The LEDs connected to the OUT13 and OUT14 pin cannot perform the correct brightness.	B
OUT14	18	OUT15	The LEDs connected to the OUT14 and OUT15 pin cannot perform the correct brightness.	B
OUT15	19	OUT16	The LEDs connected to the OUT15 and OUT16 pin cannot perform the correct brightness.	B
OUT16	20	OUT17	The LEDs connected to the OUT16 and OUT17 pin cannot perform the correct brightness.	B
OUT17	21	OUT18	The LEDs connected to the OUT17 and OUT18 pin cannot perform the correct brightness.	B
OUT18	22	OUT19	The LEDs connected to the OUT18 and OUT19 pin cannot perform the correct brightness.	B
OUT19	23	OUT20	The LEDs connected to the OUT19 and OUT20 pin cannot perform the correct brightness.	B
OUT20	24	OUT21	The OUT20 and OUT21 pin are both corner pins, the adjacent-pin short is not applicable.	D
OUT21	25	OUT22	The LEDs connected to the OUT21 and OUT22 pin cannot perform the correct brightness.	B
OUT22	26	OUT23	The LEDs connected to the OUT22 and OUT23 pin cannot perform the correct brightness.	B
OUT23	27	VCC	The device reports LED short.	B
VCC	28	ISET	The device reports an error on the ISET pin.	B
ISET	29	GND	The device reports an error on the ISET pin.	B
GND	30	OUT0	The device reports LED open.	B
OUT0	31	OUT1	The LEDs connected to the OUT0 and OUT1 pin cannot perform the correct brightness.	B
OUT1	32	OUT2	The OUT1 and OUT2 pin are both corner pins, the adjacent-pin short is not applicable.	D

Table 4-5. Pin FMA for Device Pins Short-Circuited to Supply

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
OUT2–OUT11	1–10	No adjacent pin.	D
SIN	11	No adjacent pin.	D
CLK_I	12	No adjacent pin.	D
FAULT	13	No adjacent pin.	D
SOUT	14	No adjacent pin.	D
GND	15, 30	No adjacent pin.	D
OUT12–OUT22	16–26	No adjacent pin.	D
OUT23	27	The device reports LED short.	B
VCC	28	The device operates as normal.	D
ISET	29	The device reports an error on the ISET pin.	B
OUT0–OUT1	31–32	No adjacent pin.	D

4.2 HTSSOP (32) Package

Figure 4-2 shows the TLC69624-Q1 and TLC69634-Q1 pin diagram for the HTSSOP (32) package. For a detailed description of the device pins, see the *Pin Configuration and Functions* section in the TLC69624-Q1 and TLC69634-Q1 datasheet.

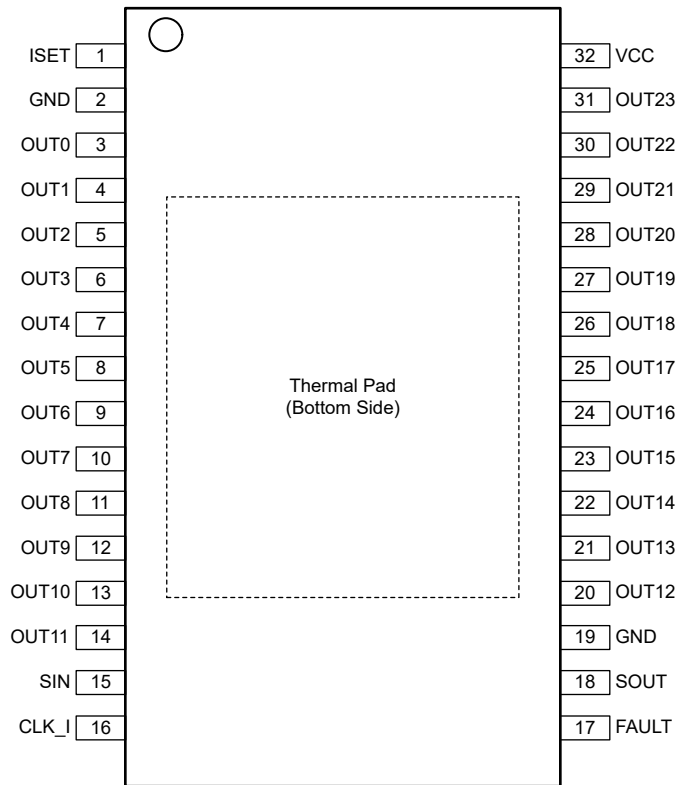


Figure 4-2. Pin Diagram (HTSSOP (32) Package)

Table 4-6. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
ISET	1	The device reports an error on the ISET pin.	B
GND	2, 19	There is no effect on the device. The device operates as normal.	D
OUT0–OUT11	3–14	The device reports LED open.	B
SIN	11	There is a communication failure.	B
CLK_I	12	There is a communication failure.	B
FAULT	13	A fault is falsely triggered on the device.	B
SOUT	14	There is a communication failure.	B
OUT12–OUT23	20–31	The device reports LED open.	B
VCC	32	The device cannot start up.	B

Table 4-7. Pin FMA for Device Pins Open-Circuited

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
ISET	1	The device reports an error on the ISET pin.	B
GND	2, 19	There is no effect on the device. There are multiple GND pins.	D
OUT0–OUT11	3–14	The device reports LED open.	B
SIN	11	There is a communication failure.	B
CLK_I	12	There is a communication failure.	B
FAULT	13	A fault fails to trigger on the device.	B
SOUT	14	There is a communication failure.	B
OUT12–OUT23	20–31	The device reports LED open.	B
VCC	32	The device cannot start up.	B
ISET	1	The device reports an error on the ISET pin.	B

Table 4-8. Pin FMA for Device Pins Short-Circuited to Adjacent Pin

Pin Name	Pin No.	Shorted to	Description of Potential Failure Effects	Failure Effect Class
ISET	1	GND	The device reports an error on the ISET pin.	B
GND	2	OUT0	The device reports LED open.	B
OUT0	3	OUT1	The LEDs connected to the OUT0 and OUT1 pin cannot perform the correct brightness.	B
OUT1	4	OUT2	The LEDs connected to the OUT1 and OUT2 pin cannot perform the correct brightness.	B
OUT2	5	OUT3	The LEDs connected to the OUT2 and OUT3 pin cannot perform the correct brightness.	B
OUT3	6	OUT4	The LEDs connected to the OUT3 and OUT4 pin cannot perform the correct brightness.	B
OUT4	7	OUT5	The LEDs connected to the OUT4 and OUT5 pin cannot perform the correct brightness.	B
OUT5	8	OUT6	The LEDs connected to the OUT5 and OUT6 pin cannot perform the correct brightness.	B
OUT6	9	OUT7	The LEDs connected to the OUT6 and OUT7 pin cannot perform the correct brightness.	B
OUT7	10	OUT8	The LEDs connected to the OUT7 and OUT8 pin cannot perform the correct brightness.	B
OUT8	11	OUT9	The LEDs connected to the OUT8 and OUT9 pin cannot perform the correct brightness.	B
OUT9	12	OUT10	The LEDs connected to the OUT9 and OUT10 pin cannot perform the correct brightness.	B

Table 4-8. 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
OUT10	13	OUT11	The LEDs connected to the OUT10 and OUT11 pin cannot perform the correct brightness.	B
OUT11	14	SIN	There is a communication failure.	B
SIN	15	CLK_I	There is a communication failure.	B
CLK_I	16	FAULT	The CLK_I and FAULT pin are both corner pins, the adjacent-pin short is not applicable.	D
FAULT	17	SOUT	The device reports fault falsely.	B
SOUT	18	GND	There is a communication failure.	B
GND	19	OUT12	The device reports LED open.	B
OUT12	20	OUT13	The LEDs connected to the OUT12 and OUT13 pin cannot perform the correct brightness.	B
OUT13	21	OUT14	The LEDs connected to the OUT13 and OUT14 pin cannot perform the correct brightness.	B
OUT14	22	OUT15	The LEDs connected to the OUT14 and OUT15 pin cannot perform the correct brightness.	B
OUT15	23	OUT16	The LEDs connected to the OUT15 and OUT16 pin cannot perform the correct brightness.	B
OUT16	24	OUT17	The LEDs connected to the OUT16 and OUT17 pin cannot perform the correct brightness.	B
OUT17	25	OUT18	The LEDs connected to the OUT17 and OUT18 pin cannot perform the correct brightness.	B
OUT18	26	OUT19	The LEDs connected to the OUT18 and OUT19 pin cannot perform the correct brightness.	B
OUT19	27	OUT20	The LEDs connected to the OUT19 and OUT20 pin cannot perform the correct brightness.	B
OUT20	28	OUT21	The OUT20 and OUT21 pin are both corner pins, the adjacent-pin short is not applicable.	D
OUT21	29	OUT22	The LEDs connected to the OUT21 and OUT22 pin cannot perform the correct brightness.	B
OUT22	30	OUT23	The LEDs connected to the OUT22 and OUT23 pin cannot perform the correct brightness.	B
OUT23	31	VCC	The device reports LED short.	B
VCC	32	ISET	The VCC and ISET pin are both corner pins, the adjacent-pin short is not applicable.	D

Table 4-9. Pin FMA for Device Pins Short-Circuited to Supply

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
ISET	1	No adjacent pin.	D
GND	2, 19	No adjacent pin.	D
OUT0–OUT11	3–14	No adjacent pin.	D
SIN	11	No adjacent pin.	D
CLK_I	12	No adjacent pin.	D
FAULT	13	No adjacent pin.	D
SOUT	14	No adjacent pin.	D
OUT12–OUT22	20–31	No adjacent pin.	D
OUT23	31	The device reports LED short.	B
VCC	32	The device operates as normal.	D

5 Revision History

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

DATE	REVISION	NOTES
June 2026	*	Initial Release

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