Functional Safety Information

LM26420-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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Table of Contents

1 Overview

This document contains information for LM26420-Q1 (HTSSOP-20 and WQFN-16 packages) to aid in a functional safety system design. Information provided are:

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- 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 and Figure 1-2 show the device functional block diagram for reference.

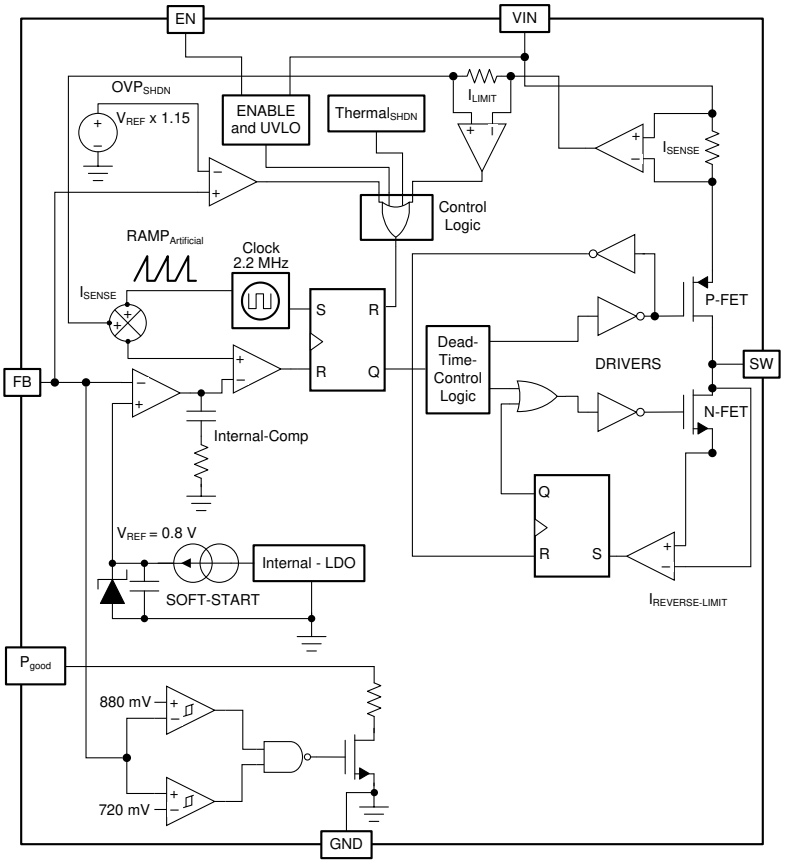

Figure 1-1. Functional Block Diagram HTSSOP-20 Package

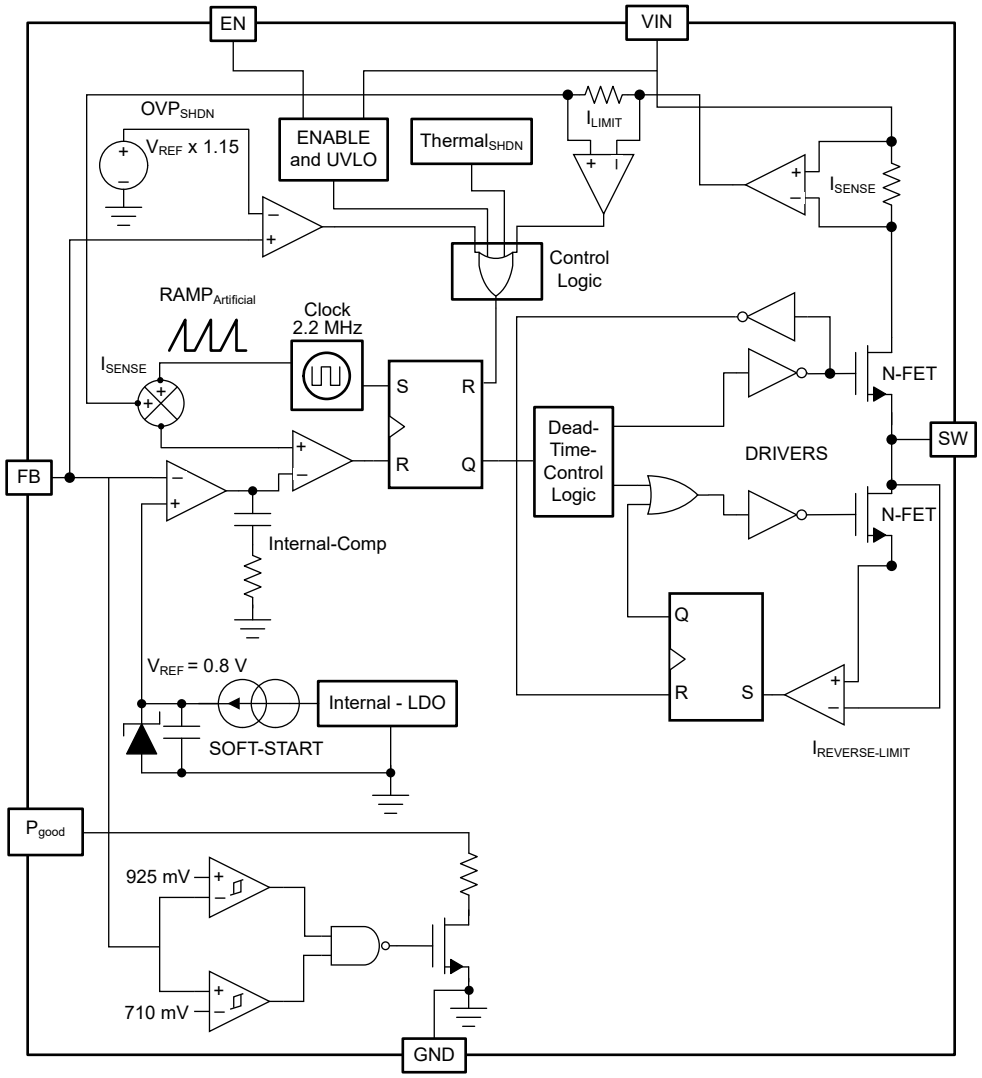

Figure 1-2. Functional Block Diagram WQFN-16 Package

LM26420-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 HTSSOP-20 Package

This section provides functional safety failure in time (FIT) rates for the HTSSOP-20 package of LM26420-Q1 based on an industry-wide used reliability standard:

- 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 10^9 Hours)
Total component FIT rate	16
Die FIT rate	4
Package FIT rate	12

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: Automotive control from table 11
- Power dissipation: 750mW
- Climate type: World-wide table 8
- Package factor (lambda 3): Table 17b
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

2.2 WQFN-16 Package

This section provides functional safety failure in time (FIT) rates for the LM26420-Q1 package of WQFN-16 based on an industry-wide used reliability standard:

- 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 10^9 Hours)
Total component FIT rate	15
Die FIT rate	4
Package FIT rate	11

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: Automotive control from table 11
- Power dissipation: 750mW
- Climate type: World-wide table 8
- Package factor (lambda 3): Table 17b
- Substrate material: FR4
- EOS FIT rate assumed: 0 FIT

3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for LM26420-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 (%)
SW1 and SW2 no output	45
SW1 and SW2 output not in specification – voltage or timing	40
SW1 and SW2 power FET stuck on	5
PG1 and PG2 false trip, fails to trip	5
Short circuit any two pins	5

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the LM26420-Q1 (HTSSOP-20 and WQFN-16 package). 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:

- Assumes the device is running in the typical application. Refer to the *Typical Application Circuit* section in the LM26420-Q1 data sheet.

4.1 HTSSOP-20 Package

Figure 4-1 shows the HTSSOP-20 pin diagram for the LM26420-Q1 package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the LM26420-Q1 data sheet.

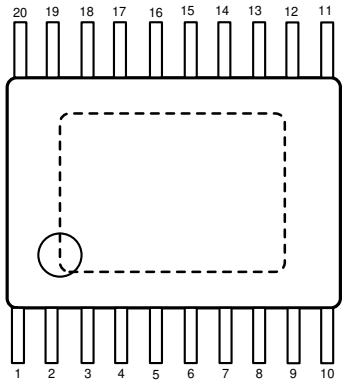

Figure 4-1. Pin Diagram (HTSSOP-20 Package)

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
VINC	1	Device does not power up.	B
EN1	2	Intended functionality if converter 1 is shutdown.	D
VIND1	3	Device does not power up.	B
VIND1	4	Device does not power up.	B
SW1	5	Potential device damage.	A
PGND1	6	No effect.	D
PGND1	7	No effect.	D
FB1	8	Output voltage regulated to VIN (100% mode).	B
PG1	9	Intended functionality if PG1 is not used.	D

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
DAP	10	No effect.	D
DAP	11	No effect.	D
PG2	12	Intended functionality if PG2 is not used.	D
FB2	13	Output voltage regulated to VIN (100% mode).	B
PGND2	14	No effect.	D
PGND2	15	No effect.	D
SW2	16	Potential device damage.	A
VIND2	17	Device does not power up.	B
VIND2	18	Device does not power up.	B
EN2	19	Intended functionality if converter 2 is shutdown.	D
AGND	20	No effect.	D
DAP	-	No effect.	D

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
VINC	1	Device is not functional.	B
EN1	2	Undetermined device status, device potentially does not power up.	B
VIND1	3	Device does not power up.	B
VIND1	4	Device does not power up.	B
SW1	5	Converter 1 is not functional, open loop operation.	B
PGND1	6	Device is not functional.	B
PGND1	7	Device is not functional.	B
FB1	8	Undetermined converter 1 output voltage.	B
PG1	9	Intended functionality if PG1 is not used.	D
DAP	10	Functional but impact on thermal behavior and reliability.	C
DAP	11	Functional but impact on thermal behavior and reliability.	C
PG2	12	Intended functionality if PG2 is not used.	D
FB2	13	Undetermined converter 2 output voltage.	B
PGND2	14	Device is not functional.	B
PGND2	15	Device is not functional.	B
SW2	16	Converter 2 is not functional, open loop operation.	B
VIND2	17	Device does not power up.	B
VIND2	18	Device does not power up.	B
EN2	19	Undetermined device status, device potentially does not power up.	B
AGND	20	Device is not functional.	B
DAP	-	Functional but impact on thermal behavior and reliability.	C

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

Pin Name	Shorted to	Description of Potential Failure Effects	Failure Effect Class
VINC	EN1	Intended functionality.	D
EN1	VIND1	Intended functionality.	D
VIND1	VIND1	Redundant pin.	D
VIND1	SW1	Potential device damage.	A

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

Pin Name	Shorted to	Description of Potential Failure Effects	Failure Effect Class
SW1	PGND1	Potential device damage.	A
PGND1	PGND1	Redundant pin.	D
PGND1	FB1	Output voltage regulated to VIN (100% mode).	B
FB1	PG1	Potential device damage.	A
PG1	DAP	Intended functionality if PG1 is not used.	D
DAP	PG2	Intended functionality if PG2 is not used.	D
PG2	FB2	Potential device damage.	A
FB2	PGND2	Output voltage regulated to VIN (100% mode).	B
PGND2	PGND2	Redundant pin.	D
PGND2	SW2	Potential device damage.	A
SW2	VIND2	Potential device damage.	A
VIND2	VIND2	Redundant pin.	D
VIND2	EN2	Intended functionality.	D
EN2	AGND	Intended functionality if converter 2 is shutdown.	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
VINC	1	Intended functionality.	D
EN1	2	Intended functionality.	D
VIND1	3	Intended functionality.	D
VIND1	4	Intended functionality.	D
SW1	5	Potential device damage.	A
PGND1	6	Device does not power up.	B
PGND1	7	Device does not power up.	B
FB1	8	Potential device damage.	A
PG1	9	PG does not indicate the status.	B
DAP	10	Device does not power up.	B
DAP	11	Device does not power up.	B
PG2	12	PG does not indicate the status.	B
FB2	13	Potential device damage.	A
PGND2	14	Device does not power up.	B
PGND2	15	Device does not power up.	B
SW2	16	Potential device damage.	A
VIND2	17	Intended functionality.	D
VIND2	18	Intended functionality.	D
EN2	19	Intended functionality.	D
AGND	20	Device does not power up.	B
DAP	-	Device does not power up.	B

4.2 WQFN-16 Package

Figure 4-2 shows the LM26420-Q1 pin diagram for the WQFN-16 package. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the LM26420-Q1 data sheet.

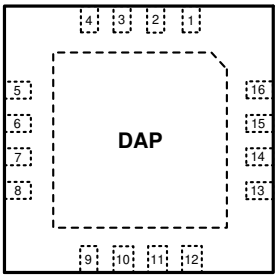

Figure 4-2. Pin Diagram (WQFN-16 Package)

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
VIND1	1	Device does not power up.	B
VIND1	2	Device does not power up.	B
SW1	3	Potential device damage.	A
PGND1	4	No effect.	D
FB1	5	Output voltage regulated to VIN (100% mode).	B
PG1	6	Intended functionality if PG1 is not used.	D
PG2	7	Intended functionality if PG2 is not used.	D
FB2	8	Output voltage regulated to VIN (100% mode).	B
PGND2	9	No effect.	D
SW2	10	Potential device damage.	A
VIND2	11	Device does not power up.	B
VIND2	12	Device does not power up.	B
EN2	13	Intended functionality if converter 2 is shutdown.	D
AGND	14	No effect.	D
VINC	15	Device does not power up.	B
EN1	16	Intended functionality if converter 1 is shutdown.	D
DAP	-	No effect.	D

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
VIND1	1	Device does not power up.	B
VIND1	2	Device does not power up.	B
SW1	3	Converter 1 not functional, open loop operation.	B
PGND1	4	Device is not functional.	B
FB1	5	Undetermined converter 1 output voltage.	B
PG1	6	Intended functionality if PG1 is not used.	D
PG2	7	Intended functionality if PG2 is not used.	D
FB2	8	Undetermined converter 2 output voltage.	B
PGND2	9	Device is not functional.	B
SW2	10	Converter 2 not functional, open loop operation.	B
VIND2	11	Device does not power up.	B

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
VIND2	12	Device does not power up.	B
EN2	13	Undetermined device status, device potentially does not power up.	B
AGND	14	Device is not functional.	B
VINC	15	Device is not functional.	B
EN1	16	Undetermined device status, device potentially does not power up.	B
DAP	-	Functional but impact on thermal behavior and reliability.	C

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

Pin Name	Shorted to	Description of Potential Failure Effects	Failure Effect Class
VIND1	VIND1	Redundant pin.	D
VIND1	SW1	Potential device damage.	A
SW1	PGND1	Potential device damage.	A
FB1	PG1	Potential device damage.	A
PG1	PG2	PG output can be wrong.	C
PG2	FB2	Potential device damage.	A
PGND2	SW2	Potential device damage.	A
SW2	VIND2	Potential device damage.	A
VIND2	VIND2	Redundant pin.	D
EN2	AGND	Intended functionality if converter 2 is shutdown.	D
AGND	VINC	Device does not power up.	B
VINC	EN1	Intended functionality.	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
VIND1	1	Intended functionality.	D
VIND1	2	Intended functionality.	D
SW1	3	Potential device damage.	A
PGND1	4	Device does not power up.	B
FB1	5	Potential device damage.	A
PG1	6	PG does not indicate the status.	B
PG2	7	PG does not indicate the status.	B
FB2	8	Potential device damage.	A
PGND2	9	Device does not power up.	B
SW2	10	Potential device damage.	A
VIND2	11	Intended functionality.	D
VIND2	12	Intended functionality.	D
EN2	13	Intended functionality.	D
AGND	14	Device does not power up.	B
VINC	15	Intended functionality.	D
EN1	16	Intended functionality.	D
DAP	-	Device does not power up.	B

5 Revision History

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

Changes from Revision * (May 2020) to Revision A (November 2024)	Page
• Updated document for HTSSOP-20 package information	2
• Updated document for WQFN-16 package information	2

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