Functional Safety Information

LM74930-Q1
Functional Safety FIT Rate, FMD and Pin FMA

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Trademarks

1 Overview

This document contains information for LM74930-Q1 (VQFN (24)) 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.

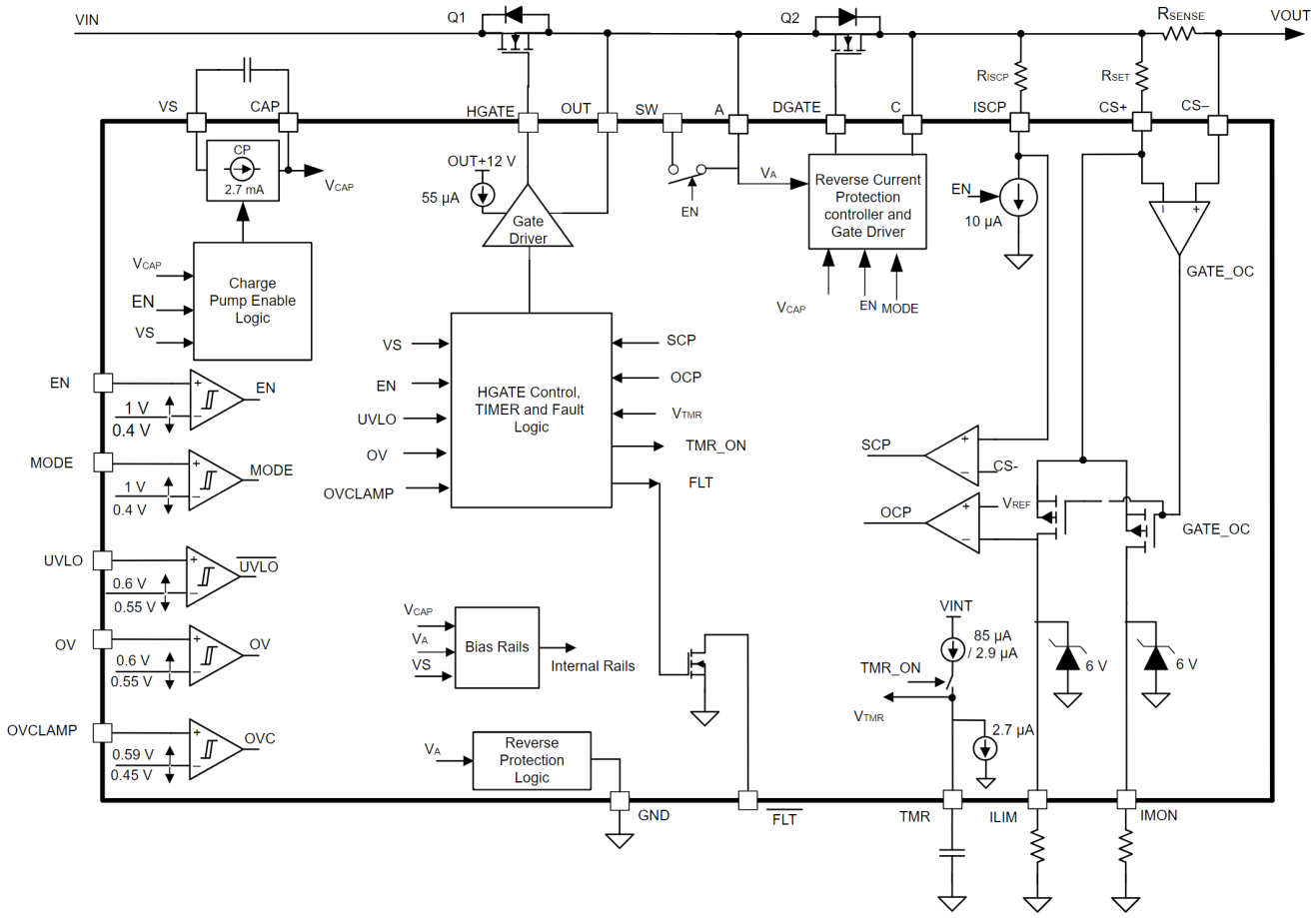

Figure 1-1. Functional Block Diagram

LM74930-Q1 is 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 LM74930-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)
Total component FIT rate	14
Die FIT rate	3
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: Motor control from table 11
- Power dissipation: 42mW
- Climate type: World-wide table 8
- Package factor (lambda 3): Table 17b
- 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 logic	25	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 LM74930-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 (%)
DGATE output functional, not in specification voltage or timing	14
DGATE stuck at high	11
DGATE stuck at low	15
HGATE output functional, not in specification voltage or timing	9
HGATE stuck at high	5
HGATE stuck at low	17
IMON not in specification - current or timing	5
Overcurrent protection fails to trip or false trip	6
Short circuit protection fails to trip or false trip	5
UVLO, OV fails to trip or false trip	8
Pin-to-pin short	5

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a failure mode analysis (FMA) for the pins of the LM74930-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 supply (see Table 4-5)

Table 4-2 through Table 4-5 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 LM74930-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the LM74930-Q1 data sheet.

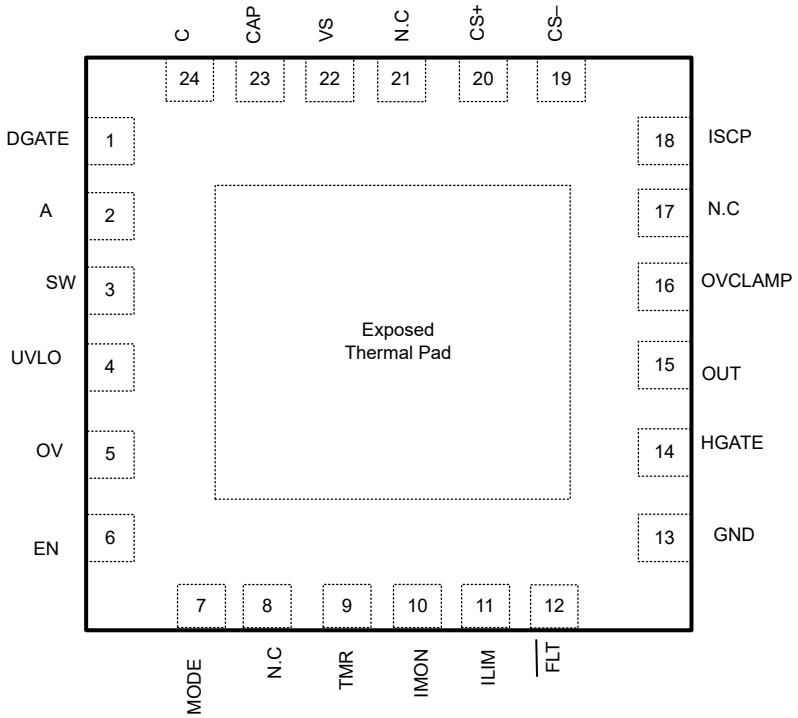

Figure 4-1. Pin Diagram

The pin FMA is provided under the assumption that the device is operating under the specified ranges within the Recommended Operating Conditions section of the data sheet.

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
DGATE	1	Device is damaged due to internal conduction. External DGATE FET can also be damaged due to maximum VGS rating violation.	A
A	2	Input supply shorted to ground. Device is not functional.	B
SW	3	Device is damaged if enabled.	A
UVLO	4	Device HGATE drive is off.	B
OV	5	Overvoltage protection functionality is disabled.	B
EN	6	Device is in shutdown mode.	B
MODE	7	Device disables reverse-current blocking feature.	B
NC	8, 17, 21	No effect on device operation.	D
TMR	9	Timer functionality is not available.	B
IMON	10	Current monitoring output is not available.	B
ILIM	11	Overcurrent protection, with circuit breaker feature, is not be available.	B
$\overline{\text{FLT}}$	12	Fault indication functionality is not be available.	B
GND	13	No impact on the device functionality.	D
HGATE	14	Device is damaged.	A
OUT	15	External FET VGS(max) rating can be exceeded and damage the external FET. Device can experience an increase in quiescent current.	D
OVCLAMP	16	Overvoltage clamp, with circuit breaker timer functionality, is disabled.	B
ISCP	18	Device damage is expected due to internal current flow.	A
CS-	19	Device damage is expected due to internal current flow.	A
CS+	20	Device damage is expected due to internal current flow.	A
VS	22	Device does not power up.	B
CAP	23	Device is damaged due to internal conduction between VS and CAP.	A
C	24	Linear regulation and reverse current blocking functionality is not available. Device quiescent current can increase.	B
RTN	—	Input reverse-polarity protection feature is not available.	B

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
DGATE	1	Preferred diode FET can not be controlled. Reverse-current blocking feature is not available. Load current flows through body diode of the FET.	B
A	2	Preferred diode FET is turned off due to linear regulation sink current. Load current flows through body diode of the FET.	B
SW	3	Battery voltage monitoring feature is not available.	B
UVLO	4	Device HGATE drive is off due to internal pull down on UVLO pin.	B
OV	5	Overvoltage protection functionality is disabled as OV pin is internally pulled low.	B
EN	6	Device is in shutdown mode as EN pin is internally pulled low.	B
MODE	7	Device enables reverse-current blocking feature.	B
NC	8, 17, 21	No effect on device operation.	D
TMR	9	Device operation with default timer operation. Auto retry timer can not be set using external timer capacitor.	B
IMON	10	Current monitoring output is not available.	B
ILIM	11	ILIM pin is pulled high and device is in overcurrent protection mode.	B
$\overline{\text{FLT}}$	12	Fault indication functionality is not available.	B
GND	13	Device does not power up.	D
HGATE	14	HGATE control to turn on or turn off the external FET is not available.	B
OUT	15	HGATE control to turn on or turn off the external FET is not available.	D
OVCLAMP	16	Overvoltage clamp with circuit breaker timer functionality disabled.	B
ISCP	18	Short circuit protection feature is not available.	B
CS-	19	Device is in overcurrent protection mode and HGATE drive is turned off.	B
CS+	20	Overcurrent protection and current monitoring output is not available.	B
VS	22	Device does not power up.	B
CAP	23	Charge pump does not build up and gate drives DGATE and HGATE are disabled.	B
C	24	DGATE drive remains off.	B
RTN	—	No effect on device operation.	D

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

Pin Name	Pin No.	Description of Potential Failure Effects	Failure Effect Class
DGATE	1	Preferred diode FET is off. Load current flows through body diode of the FET.	B
A	2	No effect on device operation.	D
SW	3	UVLO feature is not available.	B
UVLO	4	Either OV or UVLO comparator trigger and HGATE is off.	B
OV	5	HGATE drive is off in case device is enabled (EN = High).	B
EN	6	No effect on device operation.	D
MODE	7	Reverse-current blocking feature is enabled if adjacent pin voltage is high and feature is disabled if adjacent pin voltage is low.	D
NC	8, 17, 21	No effect on device operation.	D
TMR	9	Timer (TMR) and current monitoring (IMON) functionality are out of data sheet specification.	B
IMON	10	Current monitoring output is out of data sheet specification.	B
ILIM	11	Device is in overcurrent protection mode based on $\overline{FLT}$ voltage level.	B
$\overline{FLT}$	12	No effect on device operation.	D
GND	13	GND shorted to HGATE can cause device damage.	A
HGATE	14	HGATE FET is off as HGATE is shorted to OUT causing VGS short condition.	B
OUT	15	No effect on device operation. Device supports only overvoltage clamp operation during SLEEP mode.	B
OVCLAMP	16	OVCLAMP shorted to OUT results in TIMER start when OUT pin voltage rises above $V_{(OVCLAMPR)}$ and HGATE turns off when TIMER expires.	B
ISCP	18	No effect on device operation.	D
CS-	19	Short circuit and overcurrent protection is not available.	B
CS+	20	Overcurrent limit, current monitoring output parameters are out of specification.	B
VS	22	Device charge pump does not come up. DGATE and HGATE drive are off.	B
CAP	23	Device charge pump does not come up. DGATE and HGATE drive are off.	B
C	24	No effect on device operation.	B
RTN	—	No effect on device operation.	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
DGATE	1	DGATE is shorted to supply. Preferred diode FET remains off.	B
A	2	No effect on device operation.	D
SW	3	Battery voltage monitoring feature is available, irrespective of EN pin status.	B
UVLO	4	UVLO functionality is not available.	B
OV	5	HGATE is turned off due to OV comparator input going high.	B
EN	6	Device is always on as EN is pulled to supply.	B
MODE	7	Reverse-current blocking feature is enabled.	B
NC	8, 17, 21	No effect on device operation.	D
TMR	9	Device is damaged if supply voltage level is >5.5V.	A
IMON	10	Device is damaged if supply voltage level is >5.5V.	A
ILIM	11	Device is damaged if supply voltage level is >5.5V.	A
$\overline{FLT}$	12	Fault indication functionality is not available.	B
GND	13	Device does not power up due to supply shorted to GND.	D
HGATE	14	HGATE control to turn on or turn off the external FET is not available. Device quiescent current can increase.	B
OUT	15	Supply is shorted to output. Preferred diode (DGATE), load disconnect (HGATE) features are not functional as supply is shorted to output.	B
OVCLAMP	16	Timer starts as supply rises above $V_{(OVCLAMPR)}$ and HGATE turns OFF after timer expires.	B
ISCP	18	Device has default short circuit protection threshold of 20mV.	B
CS-	19	Overcurrent protection functionality is not available.	B
CS+	20	Device is in overcurrent protection mode.	B
VS	22	No effect on device operation.	B
CAP	23	Charge pump does not build up and gate drives DGATE and HGATE are disabled.	B
C	24	Preferred diode functionality is not available (reverse-current blocking).	B
RTN	—	No effect on device operation.	D

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265