Application Report

BQ29209-Q1 Functional Safety FIT Rate, FMD, and Pin FMA

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Table of Contents

1 Overview

This document contains information for BQ29209-Q1 (VSON package) to aid in a functional safety system design. Information provided is as follows:

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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 shows the device functional block diagram for reference.

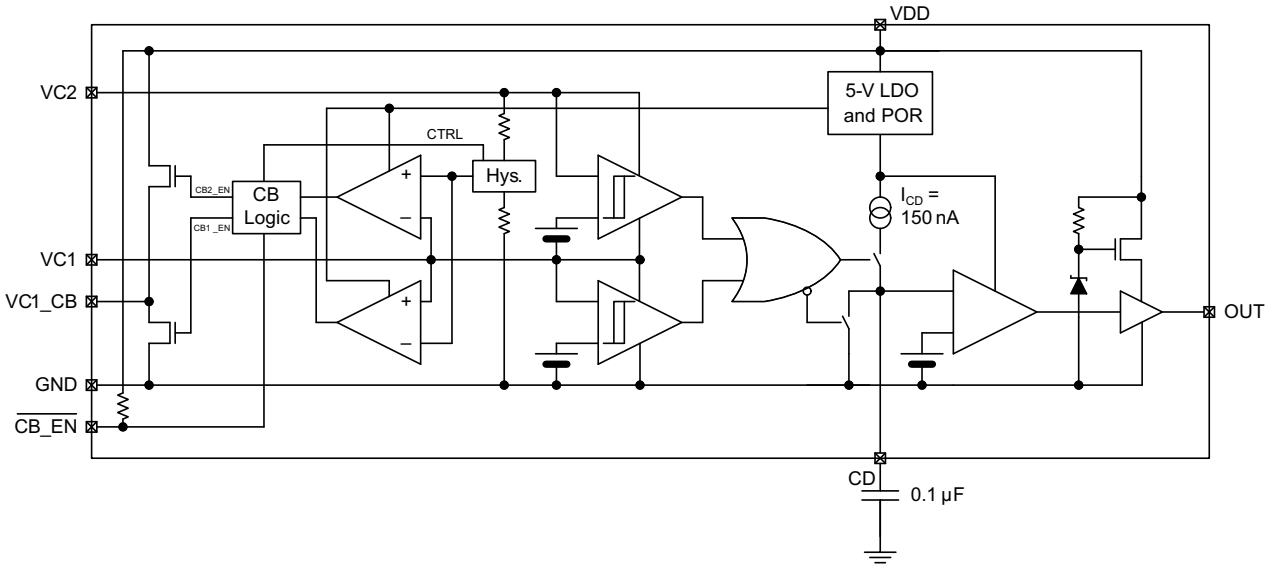

Figure 1-1. Functional Block Diagram

BQ29209-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 VSON Package

This section provides Functional Safety Failure In Time (FIT) rates for the VSON package of BQ29209-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	7
Die FIT Rate	3
Package FIT Rate	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
- Power dissipation: TBD mW
- 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
5	CMOS/BICMOS ASICs Analog & Mixed =<50V supply	20 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 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 (%)
OUT - OVT fails to trip	15%
OUT - OVT functional, trips out of spec timing or voltage	30%
OUT - OVT false trip	15%
Cell Balance - fails to enable	5%
Cell Balance - functional, incorrect balance threshold	30%
Cell Balance - false enable	5%

The FMD in Table 3-1 excludes short circuit faults across the isolation barrier. Faults for short circuit across the isolation barrier can be excluded according to ISO 61800-5-2:2016 if the following requirements are fulfilled:

1. The signal isolation component is OVC III according to IEC 61800-5-1. If a SELV/PELV power supply is used, pollution degree 2/OVC II applies. All requirements of IEC 61800-5-1:2007, 4.3.6 apply.
2. Measures are taken to ensure that an internal failure of the signal isolation component cannot result in excessive temperature of its insulating material.

Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed-circuit board do not reduce this distance.

4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the BQ29209-Q1 (VSON 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)
- 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

4.1 VSON Package

Figure 4-1 shows the BQ29209-Q1 pin diagram for the VSON package. For a detailed description of the device pins please refer to the '*Pin Configuration and Functions*' section in the *BQ29209-Q1 Voltage Protection with Automatic Cell Balance for 2-Series Cell Li-Ion Batteries* data sheet (SLUSC62).

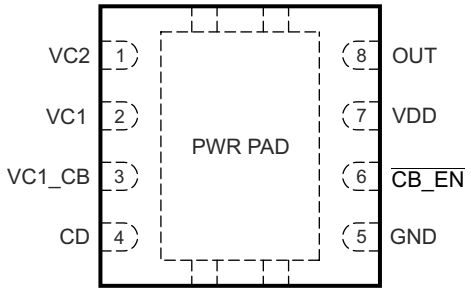

Figure 4-1. Pin Diagram VSON (Package)

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
VC2	1	No OV detection on cell 2	B
VC1	2	Automatic OV detection	D
VC1_CB	3	Automatic OV detection	D
CD	4	No OV detection	B
GND	5	Function as normal	D
CB_EN	6	Automatic cell balance enable	B
VDD	7	No power to part	B
OUT	8	No output signal to system	B

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VC2	1	No OV detection on cell 2	B

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VC1	2	Automatic OV detection	D
VC1_CB	3	Automatic OV detection	D
CD	4	Automatic OV detection	D
GND	5	No power to part	B
CB_EN	6	No cell balancing function	B
VDD	7	No power to part	B
OUT	8	No output signal to system	B

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
VC2	1	VC1	No OV detection on cell 2	B
VC1	2	VC1_CB	Cell balancing performance degradation	C
C1_CB	3	CD	Automatic OV detection	D
CD	4	GND	No OV detection	B
GND	5	CB_EN	Automatic cell balance enable	B
CB_EN	6	VDD	No cell balancing function	B
VDD	7	OUT	Automatic OV detection	D
OUT	8	VC2	Automatic OV detection	D

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

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
VC2	1	Performance degradation	C
VC1	2	Automatic OV detection	D
VC1_CB	3	Automatic OV detection	D
CD	4	Automatic OV detection	D
GND	5	No power to part	B
CB_EN	6	No cell balancing function	B
VDD	7	Function as normal	D
OUT	8	Automatic OV detection	D

5 Revision History

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

Date	Revision	Notes
August 2020	*	Initial Release

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