Functional Safety Information

BQ25170
Pin FMA

![Texas Instruments logo]

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1 Pin FMA Description

This document gives a Failure Mode Analysis (FMA) for the pins of the BQ25170 device. This IC targeted at space-limited applications supports 1-cell Li-Ion, Li-Polymer, and LiFePO$_4$ batteries. The various failure conditions outlined in this document are circuit board level issues that impact the BQ25170 device pins.

There are several circuit board level problems that can impact the device pins. Board manufacturing defects can leave a device pin open circuited when it fails to solder to its board pad. A pin can also be open circuited if the circuit board is stressed to the point where the device pin breaks off its board pad. Manufacturing defects can short-circuit adjacent pins on a device when solder reflows between the pins. Both pin open circuit and adjacent pin short-circuit conditions are analyzed in this document.

Foreign objects on circuit boards can cause short-circuit problems when they short board traces. If any of these traces connect to the device, it will cause a short-circuit event on the corresponding device pin. An analysis of board level shorts impacting the BQ25170 is circuit board dependent. However, it is useful to analyze device pin shorts to the ground rail and to the highest magnitude positive and negative device power rails. First, these rails are usually the largest traces on a circuit board and therefore more prone to short-circuit events. Second, these rails represent the voltage and current-carrying extremes on the circuit board and are more liable to cause device issues when shorted to a device pin. Pin shorts to ground and pin shorts to the highest positive rail voltage are analyzed in the document. The BQ25170 does not have a negative rail voltage to analyze.

In summary, the BQ25170 pin affecting failure scenarios analyzed in this document are:
- Pin is open circuited
- Pin is short circuited to the next pin (if possible)
- Pin is short circuited to ground
- Pin is short circuited to input supply (+5 V)

This document also details how these pin conditions affect the device:
- Does the pin condition cause permanent damage?
- Is the device functional under the pin condition?
- How does the particular pin condition affect device operation?

2 Pin Configurations and Functions

Pin configuration, functions, and package information for the BQ25170 may be found within the BQ25170 data sheet.

3 Pin Failure Mode Analysis (Pin FMA)

Table 3-1. Pin FMA Analysis for Pin Floating

Pin		Open		
Number	Name	Damage	Functionality	Comments
1	IN	NO	NO	No power to part
2	ISET	NO	NO	No charge current (ISET configured for 0 ma) - STAT ON.
3	TS	NO	NO	Device will enter cold fault shutdown - STAT Blink.
4	GND	NO	NO	No return path for input voltage, not operational.
5	STAT	NO	YES	Normal charging operation but no status indication.
6	/PG	NO	YES	Normal charging operation but no power good indication.
7	VSET	NO	NO	Open is fault condition
8	OUT	NO	NO	Device will cycle between charge complete and recharge - STAT Blink.

Table 3-2. Pin FMA Analysis for Pin Short Circuit to Next Pin

Pin		Shorted to Next Pin				
Number	Name	Number	Name	Damage	Functionality	Comments
1	IN	2	ISET	NO	NO	No charge current (ISET configured for 0 mA) - STAT ON.
2	ISET	3	TS	NO	NO	TS low shutdown or temp fault
3	TS	4	GND	NO	NO	Shutdown condition
5	STAT	6	/PG	NO	YES	Normal charging operation but /PG and STAT not functional.
6	/PG	7	VSET	NO	NO	Low /PG will trip VSET fault
7	VSET	8	OUT	NO	NO	Hi will trip VSET fault

Table 3-3. Pin FMA Analysis for Pin Short Circuit to Ground

Pin		Short to GND		
Number	Name	Damage	Functionality	Comments
1	IN	NO	NO	No power to part. Main supply shorted.
2	ISET	NO	NO	Fault condition
3	TS	NO	NO	Shutdown condition
4	GND	NO	YES	Normal operation
5	STAT	NO	YES	Normal charging operation but no status indication.
6	/PG	NO	YES	Normal charging operation but no power good indication.
7	VSET	NO	NO	No change during current charging cycle. Upon starting next charge cycle, configuration pin will detect fault and prevent charging. Nonrecoverable fault signaled through STAT pin.
8	OUT	NO	NO	OUT current limited to 16 mA - Short on battery.

Table 3-4. Pin FMA Analysis for Pin Short Circuit to Supply

Pin		Short to Supply		
Number	Name	Damage	Functionality	Comments
1	IN	NO	YES	Normal charging operation
2	ISET	NO	NO	No charge current (ISET configured for 0 ma) - STAT ON, potential for damage[1].
3	TS	NO	NO	Device will enter cold fault shutdown, potential for damage[1].
4	GND	NO	NO	No power to part. Main power supply shorted.
5	STAT	YES	NO	Normal charging STAT, potential for damage[1].
6	/PG	YES	NO	Normal charging /PG, potential for damage[1].
7	VSET	NO	NO	Fault condition, potential for damage[1].
8	OUT	NO	NO	Fault contition - Vout OVP, potential for damage[1].

(1)   Test conditons with supply at 5 V (typical value). Voltage above pin absolute maximum (5.5 V) can damage device.

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