

BQ24040 Pin FMA

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1 Pin FMA Description

This document provides a Failure Modes Analysis (FMA) for the device pins of BQ24040 Single-Input, Single Cell Li-Ion and Li-Pol Battery Charger With Auto Start. The failure conditions covered in this document are circuit board level problems that impact the BQ24040 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 BQ24040 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 BQ24040 does not have a negative rail voltage to analyze.

In summary, the BQ24040 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 (+5V)

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 the device operation?

2 Pin Configurations and Functions

Pin configuration, functions and package information for BQ24040 may be found within the datasheet published at:

<http://www.ti.com/lit/ds/symlink/bq24040.pdf>

3 Pin FMA Analysis

Table 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 0A)
3	VSS	No	No	Device is not operational and fails to charge battery despite /CHG LED on.
4	PRETERM	No	Yes	Normal charging operation with $I_{PreChg} = 20\%$ and $I_{TERM} = 10\%$
5	/PG	No	Yes	Normal charging operation but PG indicator will not notify of power good
6	NC	No	Yes	Normal charging operation
7	ISET2	No	Yes	Normal charging operation with I_{CHG} maximum = 100mA
8	/CHG	No	Yes	Normal charging operation but CHG indicator will not show charging status
9	TS	No	Yes	Device will enter TTDM mode: charge without timer or termination
10	OUT	No	Yes	Battery detect sequence runs until battery is connected

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

Pin		Shorted To		Short to Next Pin		
Number	Name	Number	Name	Damage	Functionality	Comments
1	IN	2	ISET	No	No	No charge current (ISET pulled high, configured for 0A)
2	ISET	3	VSS	No	No	No charge current (device latches off due to ISET OCP protection). Input toggle required to restart operation
3	VSS	4	PRETERM	No	No	Normal charging operation with I_{PRECHG} and $I_{TERM} = 0$ mA
4	PRETERM	5	/PG	No	No	Normal charging operation with I_{PRECHG} and $I_{TERM} = 0$ mA
6	NC	7	ISET2	No	Yes	Normal charging operation
7	ISET2	8	/CHG	No	Yes	Normal charging operation with max $I_{CHG} = I_{SET}$
8	/CHG	9	TS	No	No	Battery charge current fluctuates periodically based on battery voltage, TS thresholds, and deglitch times. Device enters in and out of TS faults
9	TS	10	OUT	No	Yes	Device will enter TTDM mode: charge without timer or termination

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

Pin		Short to GND		
Number	Name	Damage	Functionality	Comments
1	IN	No	No	Uncontrolled current flows out of main power supply. No power to part resulting in no startup
2	ISET	No	No	No charge current (device latches off due to ISET OCP protection). Input toggle required to restart operation
3	VSS	No	Yes	Normal charging operation
4	PRETERM	No	No	Normal charging operation with I_{PRECHG} and $I_{TERM} = 0$ mA
5	/PG	No	Yes	Normal charging operation but will always indicate power good
6	NC	No	Yes	Normal charging operation
7	ISET2	No	Yes	Normal charging operation with max $I_{CHG} = I_{SET}$
8	/CHG	No	Yes	Normal charging operation but will always indicate charging
9	TS	No	No	Device will not charge due to TS disable threshold ($V_{TS-DIS_HYS-10k}$)
10	OUT	No	No	Uncontrolled current flows out of back-up battery

Table 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 0A)
3	VSS	No	No	Uncontrolled current flows out of main power supply. No power to part resulting in no startup
4	PRETERM	No	Yes	Normal charging operation
5	/PG	No	Yes	Normal charging operation
6	NC	No	Yes	Normal charging operation
7	ISET2	No	Yes	Normal charging operation with max $I_{CHG} = 500$ mA
8	/CHG	No	Yes	Normal charging operation
9	TS	No	Yes	Device will enter TTDM mode: charge without timer or termination
10	OUT	No	No	Uncontrolled current flows into battery

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