BQ24074 Pin FMA

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1 Pin FMA Description

This document provides a Failure Modes Analysis (FMA) for the device pins of BQ24074 Standalone 1-Cell 1.5-A Linear Battery Charger with PowerPath. The failure conditions covered in this document are circuit board level problems that impact the BQ24074 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 BQ24074 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 BQ24074 does not have a negative rail voltage to analyze.

In summary, the BQ24074 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 BQ24074 may be found within the datasheet published at:

http://www.ti.com/lit/ds/symlink/bq24074.pdf

3 Pin FMA Analysis

Table 1. Pin FMA Analysis for Pin Floating

Pin		Open		
Number	Name	Damage	Functionality	Comments
1	TS	No	Yes	Charging disabled. TS voltage pulls high due to 75uA current source which puts TS voltage outside charge range.
2,3	BAT	No	Yes	Charging stops. Charger goes into battery detect mode. Out is powered by VIN.
4	/CE	No	Yes	285kΩ internal pulldown on /CE. Device is enabled and charging occurs.
5	EN2	No	Yes	285kΩ internal pulldown on EN2. Input current limit dependent on EN1 and EN2 according to Table 1 in datasheet.
6	EN1	No	Yes	285kΩ internal pulldown on EN1. Input current limit dependent on EN1 and EN2 according to Table 1 in datasheet.
7	/PGOOD	No	Yes	Open drain output. No power good indication. Charger functions normally.
8	VSS	No	No	Device will be off and inactive.
9	/CHG	No	Yes	Open drain output. No charge status indication. Charger functions normally.
10,11	OUT	No	Yes	No load on OUT. Charger functions normally.
12	ILIM	No	Yes	Input FET turned off. OUT powered by BAT.
13	IN	No	Yes	No input. OUT will be powered by battery.
14	TMR	No	Yes	Safety timer sets to default values. Charging stops after timer expires.
15	ITERM	No	Yes	Termination current set to default 10%.
16	ISET	No	Yes	Charging current set to 0mA. OUT powered by input or battery.

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	TS	2,3	BAT	No	Yes	Charging stops. TS voltage outside charging range.
2,3	BAT	4	/CE	No	Yes	/CE is pulled high. Charging is disabled.
5	EN2	6	EN1	No	Yes	Input current limit set to either USB100 mode if both pins are pulled low or USB suspend mode if both pins are pulled high as stated in Table 1 in the datasheet.
6	EN1	7	/PGOOD	No	Yes	EN1 will be pulled low when VIN is present. Table 1 in datasheet states input current limit state. ILIM setting could be affected.
7	/PGOOD	8	VSS	No	Yes	/PGOOD LED will always be on. Incorrect power good

						status will be reported. Charging still functional.
9	/CHG	10,11	OUT	No	Yes	Increase in input current observed when OUT is shorted to /CHG with VIN present. Charger still functional. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
10,11	OUT	12	ILIM	No	Yes	Input FET is turned off and charging stops until short to OUT is removed. Battery powers the output.
13	IN	14	TMR	No	Yes	Charging stops after default timer limit is reached. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
14	TMR	15	ITERM	No	Yes	Timer duration is reduced. ITERM is 10% of ICHARGE
15	ITERM	16	ISET	No	Yes	Charge current and termination current will be incorrect.

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

Pin		Short to GND		
Number	Name	Damage	Functionality	Comments
1	TS	No	Yes	Charging stops. Charger in TS Hot region
2,3	BAT	No	Yes	Charging stops when battery voltage below VBAT(SC) short circuit protection. Uncontrolled current from battery to ground.
4	/CE	No	Yes	Charger is active
5	EN2	No	Yes	Input current limit set to either USB100 or USB500 mode. Refer to table 1 in the datasheet.
6	EN1	No	Yes	Input current limit set to either USB100 or ILIM mode. Refer to table 1 in the datasheet.
7	/PGOOD	No	Yes	/PGOOD LED will always be on. Incorrect power good status will be reported. Charging still functional.
8	VSS	No	Yes	VSS is GND
9	/CHG	No	Yes	/CHG LED will always be on. Incorrect charger status will be reported. Charger still functional
10,11	OUT	No	Yes	OUT short circuit recovery active when VOUT < Vo(sc1). Input current limited to 100mA.
12	ILIM	Yes	Yes	Input current not limited when ILIM is shorted to ground after startup. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet. When short is removed, normal operation begins. When short occurs before startup, charging does not occur.
13	IN	No	Yes	Input FET turned off. Output powered by battery. Uncontrolled current from input supply.
14	TMR	No	Yes	Safety timer is disabled. Charger still functional.
15	ITERM	No	Yes	Termination occurs at lowest setting. Charger still functional.
16	ISET	No	Yes	Charging is disabled. Charging resumes when short is removed.

Table 4. Pin FMA Analysis for Pin short circuit to Supply

Pin		Short to Supply		
Number	Name	Damage	Functionality	Comments
1	TS	No	No	Charging stops. TS in cool region. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
2,3	BAT	No	Yes	Possible damage to battery and BAT pin due to unregulated current path and Abs max of pin exceeded. Charging resumes when short is removed. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
4	/CE	No	No	Charging is disabled. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
5	EN2	No	Yes	INLIM will be in either ILIM mode or standby

				mode. Refer to table 1 in the datasheet. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
6	EN1	No	Yes	EN1 will be high. Device will either be in USB500 mode or standby mode. Refer to table 1 in the datasheet. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
7	/PGOOD	No	Yes	Input current increases. No /PGOOD indicator function. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
8	VSS	No	Yes	Input supply will be shorted to ground with possible damage to input if no short protection is present. System current will be supplied by the battery but no charging will occur.
9	/CHG	No	Yes	Input current increases. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
10,11	OUT	No	Yes	Unregulated current from supply to output. Pin damage. Possible damage to downstream devices. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
12	ILIM	No	Yes	Input FET is turned off and charging stops until short to supply is removed. Battery powers the output. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
13	IN	N/A	N/A	N/A
14	TMR	No	Yes	Charging stops after default timer limit is reached. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
15	ITERM	No	Yes	Termination occurs at default (10%) of ISET. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.
16	ISET	No	Yes	Charging stops. Pin damage may occur if fault conditions exceed Absolute Maximum Rating table in the device datasheet.

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