User's Guide
SLUUBF6–April 2016

bq21040 0.8-A Single-Input, Single-Cell Li-Ion Battery Charger Evaluation Module

This user's guide describes the bq21040 evaluation module (EVM), how to perform a stand-alone evaluation or interface with a host or system. The charger is designed to deliver up to 800 mA of continuous current to the battery output when programmed with a resistor on the ISET pin and is programmed at the factory for approximately 540 mA. The charge status is indicated by the /CHG pin.

Contents

List of Figures

1 Introduction

The bq21040 series of devices are highly integrated Li-ion linear charger devices targeted at space-limited portable applications. The devices operate from either a USB port or AC adapter.

The bq21040 has a single power output that charges the battery. A system load can be placed in parallel with the battery as long as the average system load does not keep the battery from charging fully during the 10 hour safety timer.

The battery is charged in three phases: conditioning, constant current, and constant voltage. In all charge phases, an internal control loop monitors the IC junction temperature and reduces the charge current if an internal temperature threshold is exceeded.

The charger power stage and charge current sense functions are fully integrated. The charger function has high-accuracy current and voltage regulation loops, charge status display, and charge termination. The pre-charge current and termination current threshold are set to 20% and 10% of the fast charge current internally on the bq21040. The fast charge current value is programmable via an external resistor.

2 Considerations With Evaluating the bq21040

Refer to the bq21040 data sheet (SLUSCE2) for specific details on the charger ICs.

The ISET current control loop sets the maximum charge current. A system load may be connected to the OUT pin, which takes away some of the charge current. Normally it is not recommended to operate the device in pre-charge since the system load keeps the battery from recovering; but, since the precharge current is fixed to 20% of its fast charge current, this restriction is not necessary.

3 Performance Specification Summary

Specification	Test Conditions	MIN	TYP	MAX	UNIT
Input DC voltage, Vin	Recommended input voltage range	4.45		6.45	V
Reduced Performance, Vin(1)	Will not charge with Over Voltage input condition. Limited charging with under voltage input.	3.5		28	V
Power Dissipation(2)	$P_{DISS} = (V_{IN} – V_{OUT}) \times I_{OUT}$			1.5	W
I_{OUT}	R_{ISET} = 1 kΩ		0.54	0.8	A

(1) Input voltage range is specified for normal operation. Input voltage between UVLO and 4.75 V has limited functionality, but does not damage the IC nor present any safety issue with the battery. Input voltage above OVP and less than 30 Vdc has no operation and will not damage the IC. Lower input voltage (closer to dropout operation) produces less heat dissipation and potentially better performance.

(2) The junction temperature rise above ambient is proportional to the power dissipation. Once the junction temperature reaches approximately 125°C, thermal regulations reduces the programmed charge current.

4 Test Summary

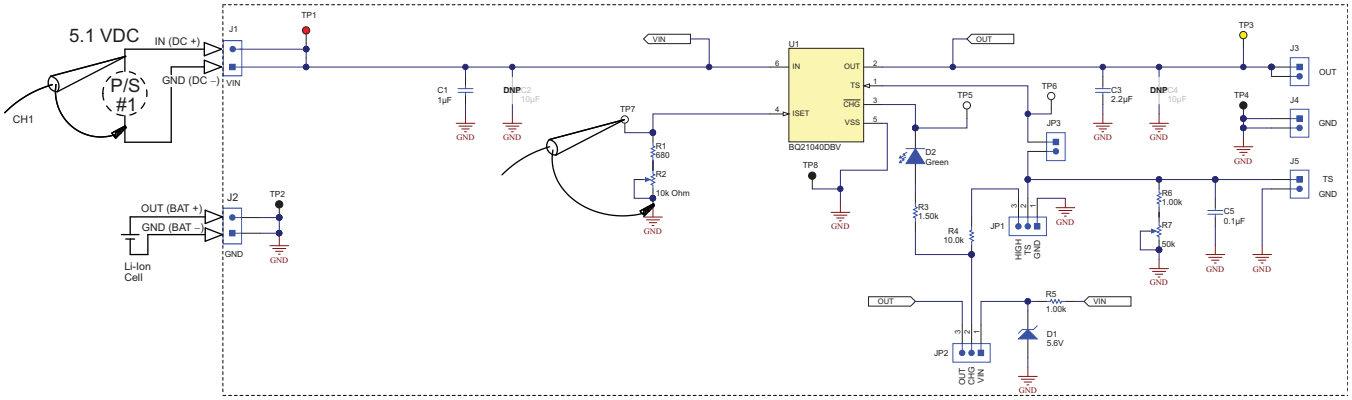
The bq21040 EVM board requires a 5-VDC, 1-A power source to provide input power and a single-cell Li-ion or Li-polymer battery pack. The test setup connections and jumper setting selections are configured for a stand-alone evaluation; but, can be changed to interface with external hardware such as a microcontroller.

4.1 Equipment

- Power supply +5.1 ±0.1 V, current limit set to 1.5 ±0.1 A
- Battery: 4.2-V LiCoO2 or equivalent
- Three Fluke 75 DMMs (equivalent or better)
- Oscilloscope, model TDS220 (equivalent or better)

4.2 Equipment and EVM Setup

Jack or Component	Connect or Adjustment To:
J1 – VIN	Power supply positive, preset to 5 VDC, 1-A current limit
J2 – GND	Power supply ground
J3 – OUT	Positive Battery Pack Terminal
J4 – GND	Negative Battery Pack Terminal
J5 - TS	No shunt
JP1	No shunt
JP2	Apply shunt for CHG LED connection, CHG = OUT
JP3	Apply shunt for TS connection
R2 (R_{ISET})	Adjust R2 for 1 kΩ between TP2 and GND
R11 (R_{TS})	Adjust R11 for 10 kΩ between TP9 and GND



Dashed Line Represents EVM Board

Figure 1. EVM Setup

4.3 Test Procedure Using a Single Cell Li-Ion Battery

1. Verify that the setup is correct and turn on the power supply, which was preset to 5 VDC, and 1 A for the current-limit setting.
2. The bq21040 enters preconditioning mode if the battery is below the $V_{(LOWV)}$ threshold. In this mode, the bq21040 pre-charges the battery with a low current (internally set to 20% of fast charge) until the battery voltage reaches the $V_{(LOWV)}$ threshold or until the pre-charge timer expires. If the timer expires, then the charge current is terminated and the bq21040 enters fault mode. The CHG LED turns off when in timer fault mode. Toggling input power, toggling TS (BAT_EN) or battery replacement resets fault mode.
3. When the battery voltage rises above the $V_{(LOWV)}$ threshold, the battery enters fast-charge constant current mode. This EVM is programmed for 0.54 A of fast-charging current.
4. Once the battery reaches the voltage regulation threshold (4.2 V), the voltage control loop takes over and the current tapers down as the battery reaches its full capacity.
5. The battery remains at the fast-charge mode until either the charge timer expires or the charge termination current threshold is reached.
6. When the charge terminates, the CHG LED turns off.
7. Remove JMP3 (TS) and the charger turns on. This mode is Termination and Timer Disable Mode (TTDM). This allows continuous power applied from the input to the output, regulated to 4.2 V with a maximum current programmed by the ISET resistor. The system can operate without a battery in this mode as long as the system does not exceed the supplied input current.
8. If the battery discharges to the recharge threshold, the charger starts fast charging, but the CHG LED will not come on for the subsequent charges. Cycling the input power, replacing the battery, or toggling the TS pin low starts a new charge with the CHG LED on.
9. Install the jumper on JP3 (TS) adjust R7 until VTS (voltage between TPS and GND) is around 1.23 V. Charging should be suspended. Reduce voltage on TS pin by adjust R7 until charging resumes. Further reduce the voltage on TS until VTS is around 278 mV and charging should be suspended.

NOTE: Loads across the battery can affect termination. The pre-term pin can be adjusted to offset the system current. See data sheet for more details.

4.4 Alternate Test Methods

A 4-quadrant power supply that can source and sink current can be used in place of the battery pack to evaluate the charger. It allows each transfer between pre-charge, constant-current and constant voltage fast charge. Keep leads short to avoid adding too much inductance which may cause an interaction between the power supply and charger. A large capacitor across the output helps cancel the inductance if long leads are necessary.

5 Schematic, Physical Layouts and Bill of Materials

5.1 Schematic

Figure 2 illustrates the EVM schematic.

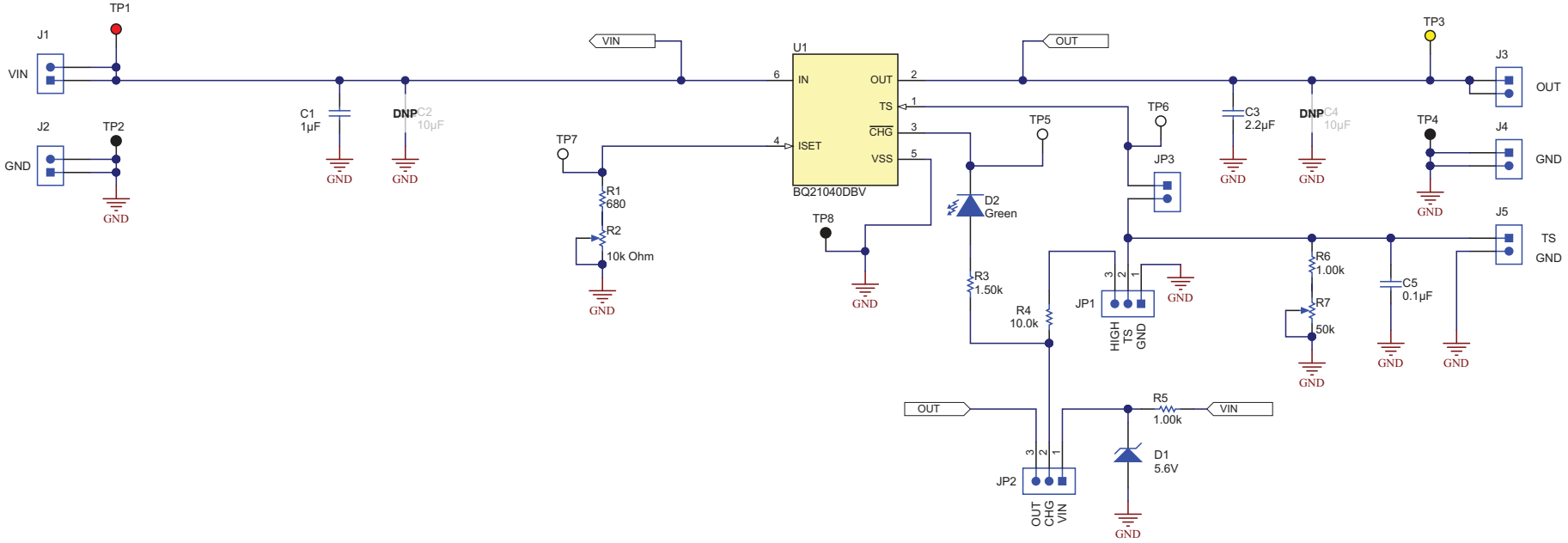


Figure 2. bq21040 EVM Board Schematic

5.2 Physical Layouts

Figure 3 through Figure 5 illustrate the EVM PCB layouts.

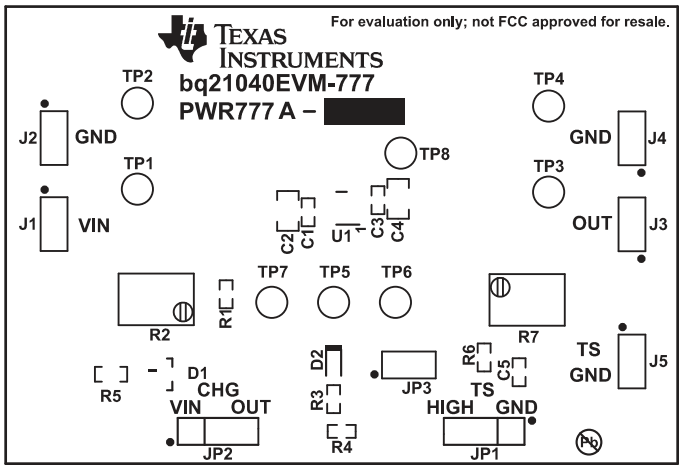


Figure 3. Assembly Layer

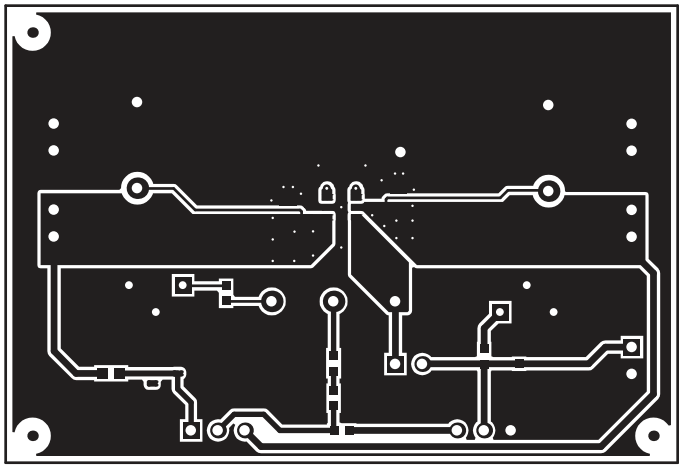


Figure 4. Top Layer

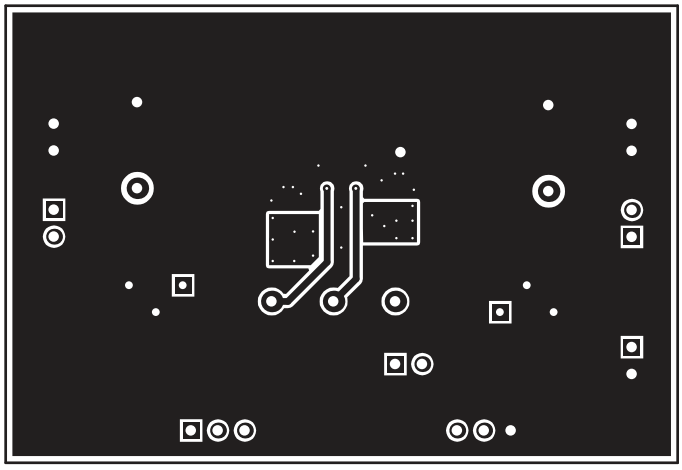


Figure 5. Bottom Layer

5.3 Bill of Materials

Table 1 lists the EVM BOM.

Table 1. bq21040EVM Bill of Materials

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
!PCB	1		Printed Circuit Board		PWR777	Any	-	-
C1	1	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X5R, 0603	0603	C1608X5R1E105K080AC	TDK		
C3	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, +/- 10%, X7R, 0603	0603	GRM188R71A225KE15D	Murata		
C5	1	0.1uF	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 0603	0603	GCM188R71H104KA57B	Murata		
D1	1	5.6V	Diode, Zener, 5.6 V, 225 mW, SOT-23	SOT-23	BZX84C5V6LT1G	ON Semiconductor		
D2	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
J1, J2, J3, J4, J5, JP3	6		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
JP1, JP2	2		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
R1	1	680	RES, 680, 5%, 0.1 W, 0603	0603	CRCW0603680RJNEA	Vishay-Dale		
R2	1	10k Ohm	Trimmer, 10k ohm, 0.25W, TH	4.5x8x6.7mm	3266W-1-103LF	Bourns		
R3	1	1.50k	RES, 1.50k ohm, 1%, 0.1W, 0603	0603	CRCW06031K50FKEA	Vishay-Dale	Equivalent	Any
R4	1	10.0k	RES, 10.0 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0710KL	Yageo America		
R5, R6	2	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale		
R7	1	50k	Trimmer, 50k ohm, 0.25W, TH	4.5x8x6.7mm	3266W-1-503LF	Bourns		
SH-JP1, SH-JP2, SH-JP3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1	1	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP2, TP4, TP8	3	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone		
TP3	1	Yellow	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP5, TP6, TP7	3	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
U1	1		Single-Input, Low Cost Single Cell Li-Ion and Li-Pol Battery Charger, DBV0006A	DBV0006A	BQ21040DBV	Texas Instruments		Texas Instruments
C2, C4	0	10uF	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805	0805	C2012X5R1E106K125AB	TDK		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
		Notes:	Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.					

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