

bq24080 1-A, Single-Cell Li-Ion and Li-Polymer Charge Management IC EVM

1 Introduction

This user's guide describes the bq24080 evaluation module (EVM). The EVM provides a convenient method for evaluating the performance of a charge management solution for portable applications. A complete designed and tested charger is presented. The charger is designed to deliver up to 1 A of continuous charge current for single-cell Li-ion or Li-polymer applications using a dc power supply. The charger is programmed from the factory to deliver 0.7 A of charging current.

1.1 Background

The bq24080 is a highly integrated and flexible Li-ion linear charge and system power management device targeted at space-limited charger applications. The bq24080 IC offers integrated power FET and current sensor, high-accuracy current and voltage regulation, charge status, and charge termination, in a single monolithic device. An external resistor sets the magnitude of the charge current. The bq24080 charges the battery in three phases: conditioning, constant current, and constant voltage. Charge is terminated based on minimum current. An internal charge timer provides a backup safety for charge termination. The bq24080 automatically restarts the charge if the battery voltage falls below an internal threshold. The bq24080 automatically enters sleep mode when the input is removed.

1.2 Performance Specification Summary

Table 1. Performance Specification Summary⁽¹⁾

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input dc voltage, $V_{I(DC)}$		$V_{(REG)} + 0.5$	5	5.5	V
Battery charge current, $I_{O(CHG)}$			0.7	1	A
Power dissipation				1.5	W

⁽¹⁾ This input voltage maximum is a function of the maximum allowable power dissipation on the device. The current level is programmed for 0.7 A. If the programmed charge is changed, then the maximum input voltage needs to be adjusted.
 $P_{MAX(IC)} = 1.5 \text{ W} = I_{CHG} (V_{(DC+)} - V_{(BAT+)})$. The device has a maximum recommended operation of 6.5 Vdc.

2 Test Summary

This section shows the test setups used and the tests performed in evaluating the EVM. See the bq24080 data sheet ([SLUS698](#)) for complete details regarding the operation and specifications.

2.1 Test Setup

The bq24080EVM board requires a regulated 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.

Table 2. I/O and Jumper Connections⁽¹⁾

JACK	CONNECTION
J1-DC+	Power supply positive connection, preset to 5 Vdc, 1.0-A current limit.
J1-DC-	Power supply return connection, ground
J2-BAT+	Positive battery pack terminal
J2-BAT-	Negative battery pack terminal, BAT- is common with DC-
JMP4- $\overline{CE}$	Charge Enable-active low. Place shunt on JUMP4 to pull $\overline{CE}$ Hi. Remove shunt for $\overline{CE}$ = Low
JMP1-STAT1	JMP1-2 STAT 1 signal. Place shunt on JMP1 for LED, indication.
JMP2-STAT2	JMP2-2 STAT2 signal. Place shunt on JMP2 for LED indication.
JMP3- $\overline{PG}$	JMP3-2 $\overline{PG}$ signal. Place shunt on JMP3 for LED indication.

(1) Factory jumper selections are shown in BOLD

2.2 Test Procedures

Set up the evaluation board as previously described by making the necessary I/O connections and jumper selections. Prior to test and evaluation, it is important to verify that the maximum power dissipation on the device is not exceeded: $P_{MAX} = 1.5 \text{ W}$.

$$P_{MAX} = (V_{(DC+)} - V_{(BAT+)}) \times I_{(CHG)} \quad (1)$$

1. Turn on the power supply, which is preset to 5 Vdc, and 1 A for the current limit setting.
2. The bq24080 enters preconditioning mode if the battery is below the $V_{(LOWV)}$ threshold. In this mode, the bq24080 precharges the battery with a low current, typically

$$\frac{I_{O(CHG)}}{10} = \frac{0.7 \text{ A}}{10} = 70 \text{ mA} \quad (2)$$

until the battery voltage reaches the $V_{(LOWV)}$ threshold or until the precharge timer expires. If the timer expires, then the charge current is terminated and the bq24080 enters fault mode. Both LEDs turn off when in fault mode. Toggling input power or battery replacement resets fault mode. Note that there are several fault conditions. They are described in the data sheet ([SLUS698](#)).

3. Once the battery voltage is above the $V_{(LOWV)}$ threshold, the battery enters fast-charge mode. This EVM is programmed for 0.7 A of fast-charging current.
4. Once the battery reaches voltage regulation (4.2 V), the current tapers down as the battery reaches its full capacity.
5. When the current reaches the taper termination threshold, the charge current terminates.
6. After termination, if the battery discharges down to the recharge threshold, the charger starts fast charging.

An alternative method of testing the EVM is with a source meter, that can sink or source current. This can be adjusted to test each mode, in place of a battery.

Another alternative to view each mode, on a scope, is to connect a 1000- μF or larger capacitor and a parallel 10-k Ω resistor on the output in place of a battery to observe the charging cycling.

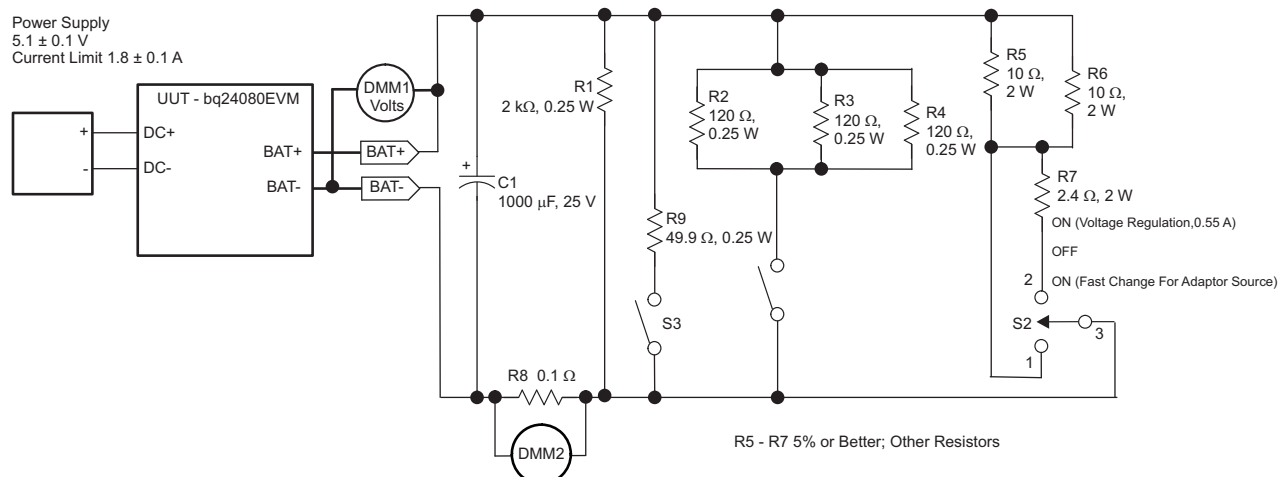
2.3 Alternative Test Procedure

The following is a test procedure to verify charging states without the need for a battery or expensive test equipment.

2.3.1 Equipment

The procedure used to evaluate the EVM assembly with a few basic functions of the device is as follows:

1. Power source: current limited 5-V laboratory supply with its current limit set to 1 A $\pm$ 0.1 A
2. Two Fluke 75 multimeters, equivalent or better.
3. Load test board as shown in [Figure 1](#).



NOTE: R5, R6, and R7 are 5% or better. All other resistors are 1% or better.

Figure 1. bq24080 Testing Setup

2.3.2 Equipment Setup

1. Connect the load board to the BAT+ and BAT-. Set switches SW1 to Closed, SW3 to Open, and SW2 to Off (center).
2. Connect a voltage meter, DMM1, to the J5-BAT+/BAT- output to monitor the output voltage (range is 0 V to 5 V).
3. Set the laboratory supply for 5.1 V $\pm$ 0.1 Vdc, 1 A $\pm$ 0.1 A current limit, and then turn off supply. Connect the laboratory supply to J1.
4. Connect DVM2 across R8 to monitor the current (R8 should be a 1% or better resistor if it is used for current measurements.)
5. Shunt jumpers should be installed on the LED header pins, JMP1-1/2, JMP2-1/2, and JMP3-1/2. For the $\overline{CE}$ header pins, JMP4 should have the shunt on just one pin (not shorted).

2.3.3 Procedure

1. Ensure that *Equipment Setup* steps are followed (SW1—closed, SW2 and SW3—Open, shunts installed as per the preceding step 5, test board connected, and power source set to 5.1 V $\pm$ 0.1 Vdc). Turn on the power source.
2. Verify output voltage, BAT+, is between 2.5 Vdc to 2.95 Vdc, and the red LED (D1) and green LEDs (D2 and D3) are lit.
3. Place shunt jumper on JMP3-1/2, and verify that charging stops (DMM2 < 0.5 mV). Remove the shunt short (place on one pin), and verify that the output voltage, BAT+, is between 2.5 Vdc and 2.95 Vdc.
4. Close switch SW3 and open switch SW1. Verify LED (D2) is off and the output voltage, BAT+, regulates between 4.16 Vdc and 4.24 Vdc.
5. Close switch SW2 (to position 1 Ω –5 Ω), and verify that output voltage, BAT+, is between 3.1 Vdc and 3.5 Vdc. Note: If output drops below 3 V and remains there, the input may be dropping below 4.9 V momentarily. Add the input capacitance necessary to the source, to keep the input in compliance.
6. Verify that the charging current is between 0.6 A and 0.8 A (DMM2 is between 60 mVdc and 80 mVdc).
7. Open switch SW3, set switch SW2 to Off, and verify that the LEDs, D1 and D2, alternate being lit.
8. If all tests pass, EVM has been assembled correctly.
9. Turn off the J1 power source and disconnect UUT.

2.4 Ordering Information

Table 3. Ordering Information

EVM Part Number	Additional Devices	Chemistry	Pack Voltage	Capacity
bq24080EVM	None	Li-Ion / Li-Poly	2.5 V to 4.2 V	Any

3 Schematic

Figure 2 shows the schematic diagram for the bq24080EVM.

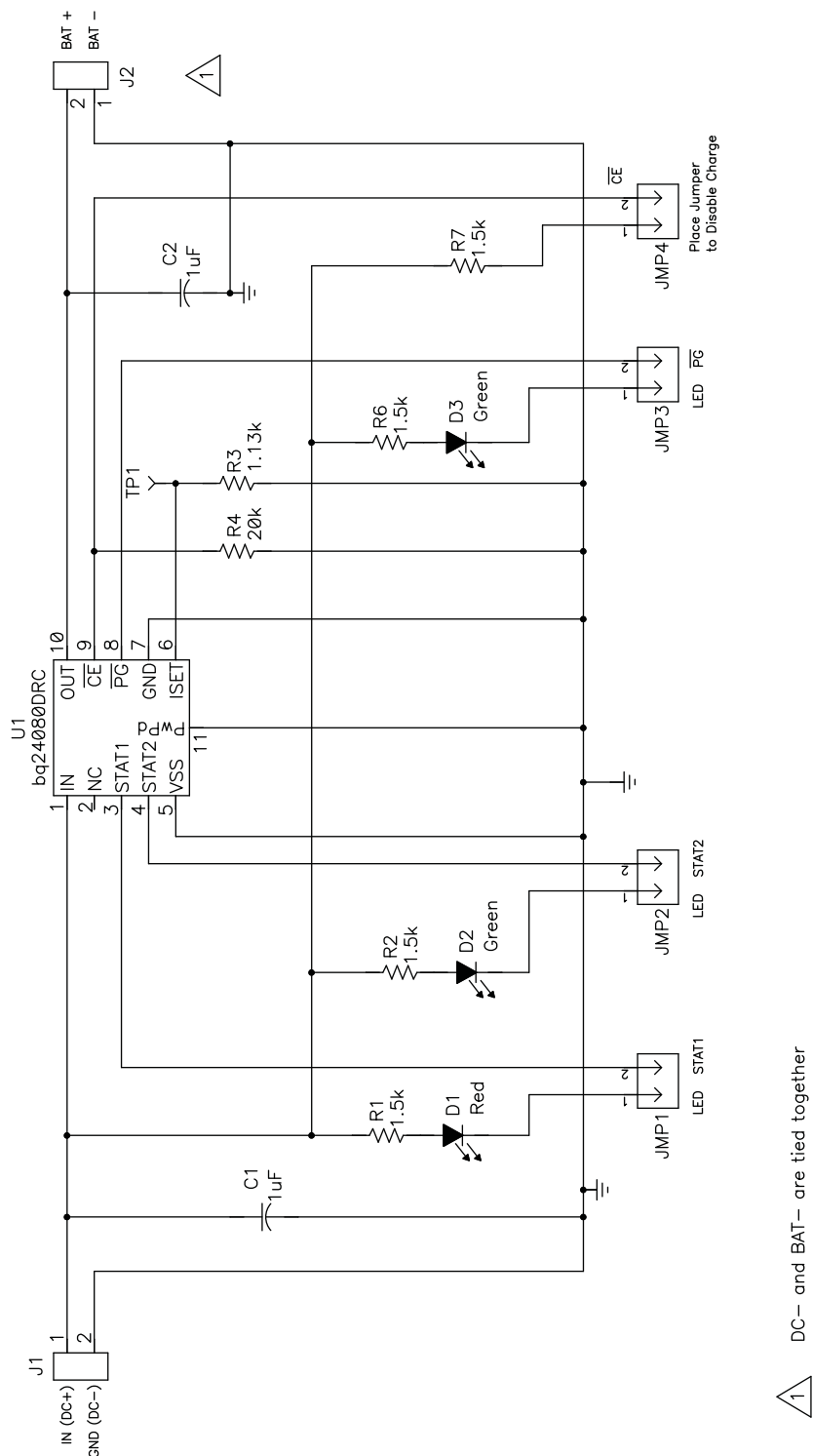


Figure 2. bq24080 Schematic

4 Physical Layouts

Figure 3 and Figure 4 show the top layer and bottom layer of the EVM, respectively. Figure 5 shows the top assembly view.

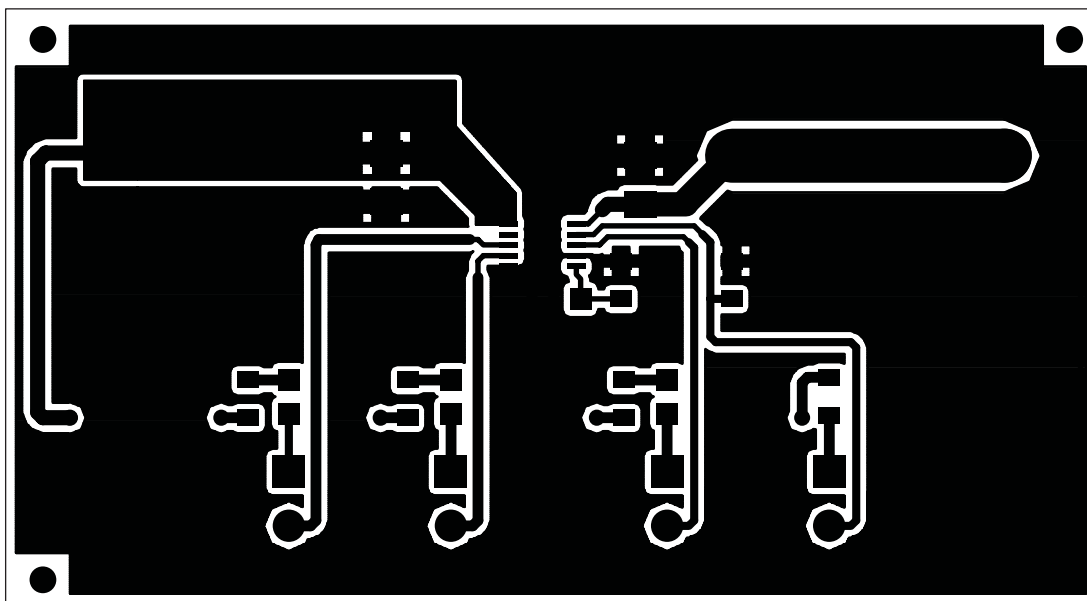


Figure 3. bq24080EVM Top Layer

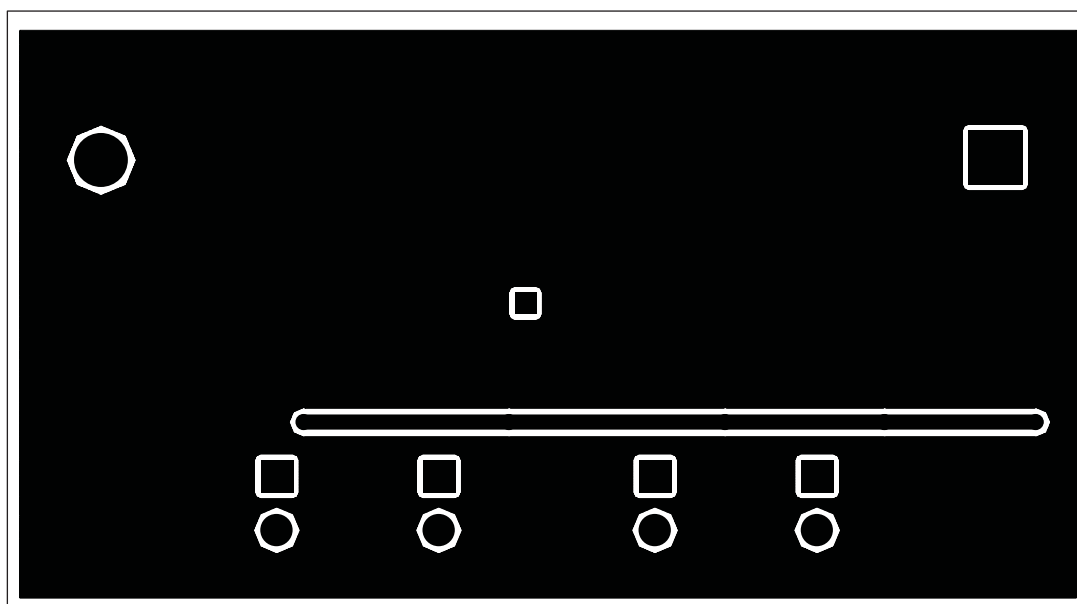


Figure 4. bq24080EVM Bottom Layer

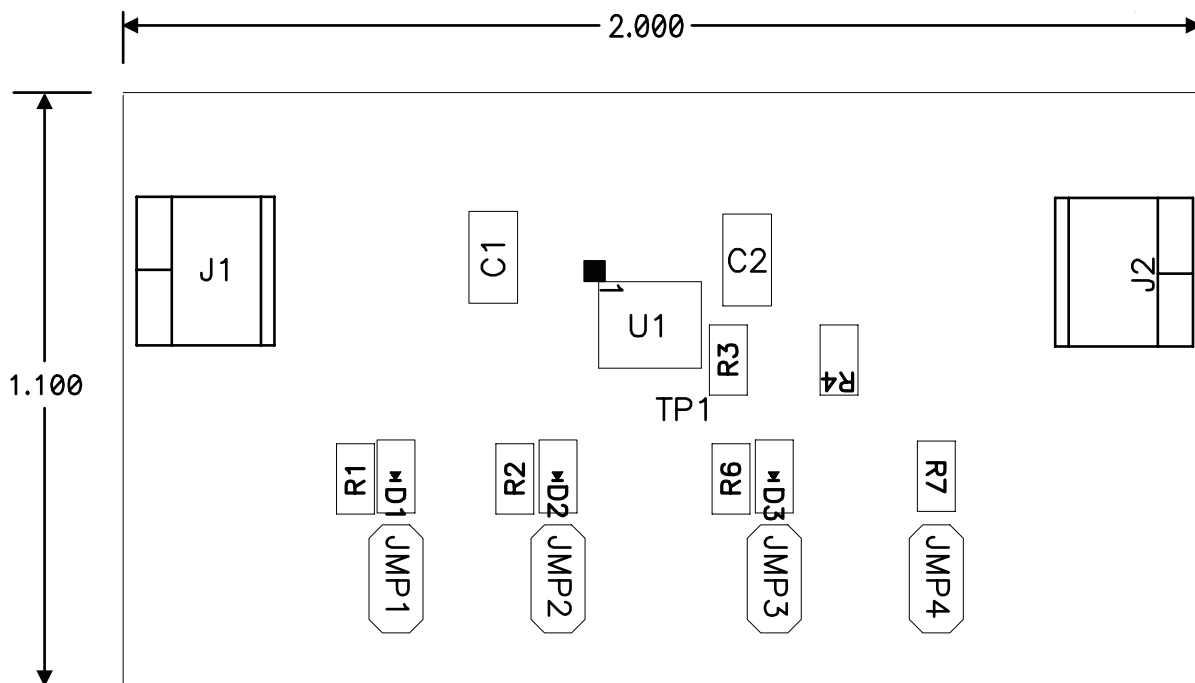


Figure 5. bq24080EVM Component Placement

5 Bill of Materials

Table 4 lists the materials required for the bq24080EVM.

Table 4. Bill of Materials

COUNT	REF DES	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
2	C1, C2	1 μ F	Capacitor, Ceramic, 1- μ F, 16-V, X7R	0805	Std	Std
1	D1	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	0603	160-1181-1-ND	Liteon
2	D2, D3	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	160-1183-1-ND	Liteon
2	J1, J2		Terminal Block, 2-pin, 6-A, 3.5 mm	0.27 x 0.25	ED1514	OST
4	JMP1, JMP2, JMP3, JMP4	PTC36SAAN	Header, 2-pin, 100-mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
4	R1, R2, R6, R7	1.5 k Ω	Resistor, Chip, 1.5-k Ω , 1/16-W, 1%	0603	Std	Std
1	R3	1.13 k Ω	Resistor, Chip, 1.13-k Ω , 1/16-W, 1%	0603	Std	Std
1	R4	20 k Ω	Resistor, Chip, 20-k Ω , 1/16-W, 1%	0603	Std	Std
1	U1	bq24080DR C	IC, Single Chip, Li -Ion/Li-Poly, Charger	DRC10	TI	bq24027DRC
4		NA	Shunt, 100-mill, Black	0.1	3M	929950-00
1			PCB, 2 In x 1 In x 0.31 In		Any	HPA181

6 References

bq24080, Single-Chip, Li-Ion and Li-Pol Charger IC data sheet ([SLUS698](#)).

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of $V_{REG} + 0.5\text{ V}$ to 5.2 V and the output voltage range of 0 V to 4.2 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 70°C . The EVM is designed to operate properly with certain components above 70°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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