

# ***bq24081EVM 1-A Single-Chip Li-Ion and Li-Pol Charge Management IC Evaluation Module***

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This user's guide describes the bq24081 evaluation module. The EVM provides a convenient method for evaluating the performance of a charge management solution for portable applications

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## **1 Introduction**

### **1.1 Description**

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-Pol applications using a dc power supply. The charger is programmed from the factory to deliver 0.7 A of charging current.

## 1.2 Background

The bq24081 is a highly integrated and flexible Li-Ion linear charge device targeted at space-limited charger applications. It offers an 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 bq24081 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 bq24081 automatically restarts the charge if the battery voltage falls below an internal threshold. The bq24081 automatically enters sleep mode when the input supply is removed.

## 1.3 Performance Specification Summary

	SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{I(DC)}$	Supply voltage range		$V_{(REG)} + 0.5$	5	5.5	V
$I_{O(CHG)}$	Battery charge current <sup>(1)</sup>			0.7	1	A
	Power dissipation	$I_{(CHG)} \times (V_{(DC+)} - V_{(BAT+)})$			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.  $P_{MAX(IC)} = 1.5 W = I_{(CHG)} (V_{(DC+)} - V_{(BAT+)})$ . 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 bq24081 datasheet ([SLUS687](#)) for complete details on operation and specifications for the charger device.

### 2.1 Test Setup

The bq24081 EVM board requires a regulated 5-Vdc, 1-A power source, to provide input power and a single-cell Li-Ion or Li-Pol 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 1. I/O and Jumper Connections<sup>(1)</sup>**

Jack	CONNECTION
J1-DC+	Power supply positive connection, preset to 5.0-VDC, 1.2-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-
J2-TS	No connection – R4 is set to 10 kΩ to bias the TS signal in a charging state (bq24081). See datasheet ( <a href="#">SLUS687</a> ) to activate TS for bq24081. Connector provides for optional external control.
J2-BAT-	Return for thermistor (when used)
JMP1-STAT1	Monitor JMP1-2 for STAT1, or apply a shunt across <b>JMP1</b> for LED status.
JMP2-STAT2	Monitor JMP2-2 for STAT2, or apply a shunt across <b>JMP2</b> for LED status.
JMP3-TE	No jumper => Termination Enabled. Place a shunt on JMP3 to disable termination.

(1) Factory jumper selections are shown in **BOLD**.

### 2.2 Test Procedure

Setup the evaluation board as described above, 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:  $P_{MAX} = 1.5 W$ .

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

1. Turn on the power supply, which is preset to 5 Vdc, and 1 A for the current limit setting.
2. The bq24081 enters preconditioning mode if the battery is below the  $V_{(LOWV)}$  threshold. In this mode, the bq24081 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 bq24081 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 ([SLUS687](#)).

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 termination threshold, the charge is terminated.
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.

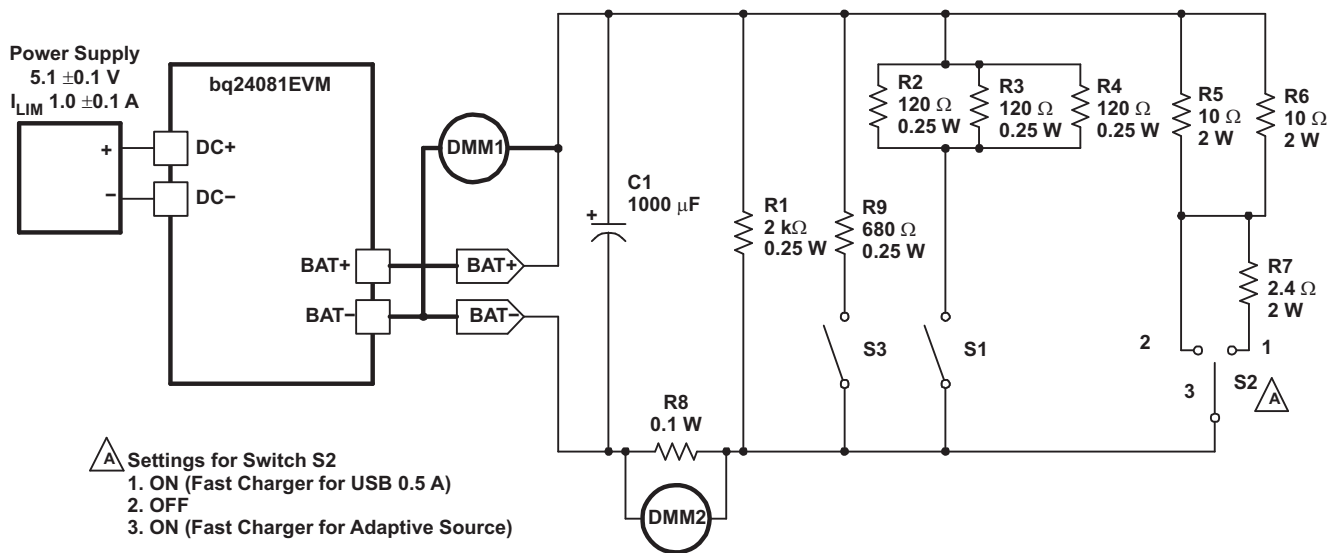
Another alternative to briefly view each mode, on a scope, is to connect a 1-mF or larger capacitor and a parallel 10-k $\Omega$  resistor on the output in place of a battery to observe the charging cycling.

### 2.3 Alternative Test Procedure

The procedure in [Section 2.3.1](#) describes a quick test to verify charging states without the need for a battery or expensive test equipment.

#### 2.3.1 Equipment

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



Note: R5, R6, and R7—5% or better. All other resistors—1% or better

**Figure 1. bq24081EVM Testing Setup**

### 2.3.2 Equipment Setup

1. Connect the load board to the BAT+ and BAT-. Set switches SW1 and SW3 to closed and switch SW2 to off (center).
2. Connect a voltage meter, DMM1, to the BAT+/BAT- output to monitor the output voltage (range is 0 V to 5 V).
3. Set the lab supply for 5.1 V  $\pm$ 0.1 Vdc, 1 A  $\pm$ 0.1 A current limit and then turn off supply. Connect DMM2 across R8 to monitor the current (R8 should be a 1% or better resistor if it is used for current measurements).
4. Shunt jumpers should be installed on JPM1 and JPM2.

### 2.3.3 Procedure

1. Make sure the steps described in [Section 2.3.2 Equipment Setup](#) are followed (SW1 and SW3 are set to closed, and SW2 is set to off, shunts installed as shown in step 4, 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 and 2.9 Vdc and the red LED (D1) and green LEDs (D2) are illuminated.
3. Momentarily short J5-2 to J1-1 (TS to DC+), and verify that charging stops (DMM2 < 0.5 mV). Remove short and verify output voltage, BAT+, is between 2.5 Vdc and 2.9 Vdc.
4. 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) and verify output voltage, BAT+, is between 3.4 Vdc and 3.8 Vdc.
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, D2), alternate being illuminated.
8. Turn off power. Remove UUT from test apparatus. Repeat setup and test procedures for other untested EVMs.

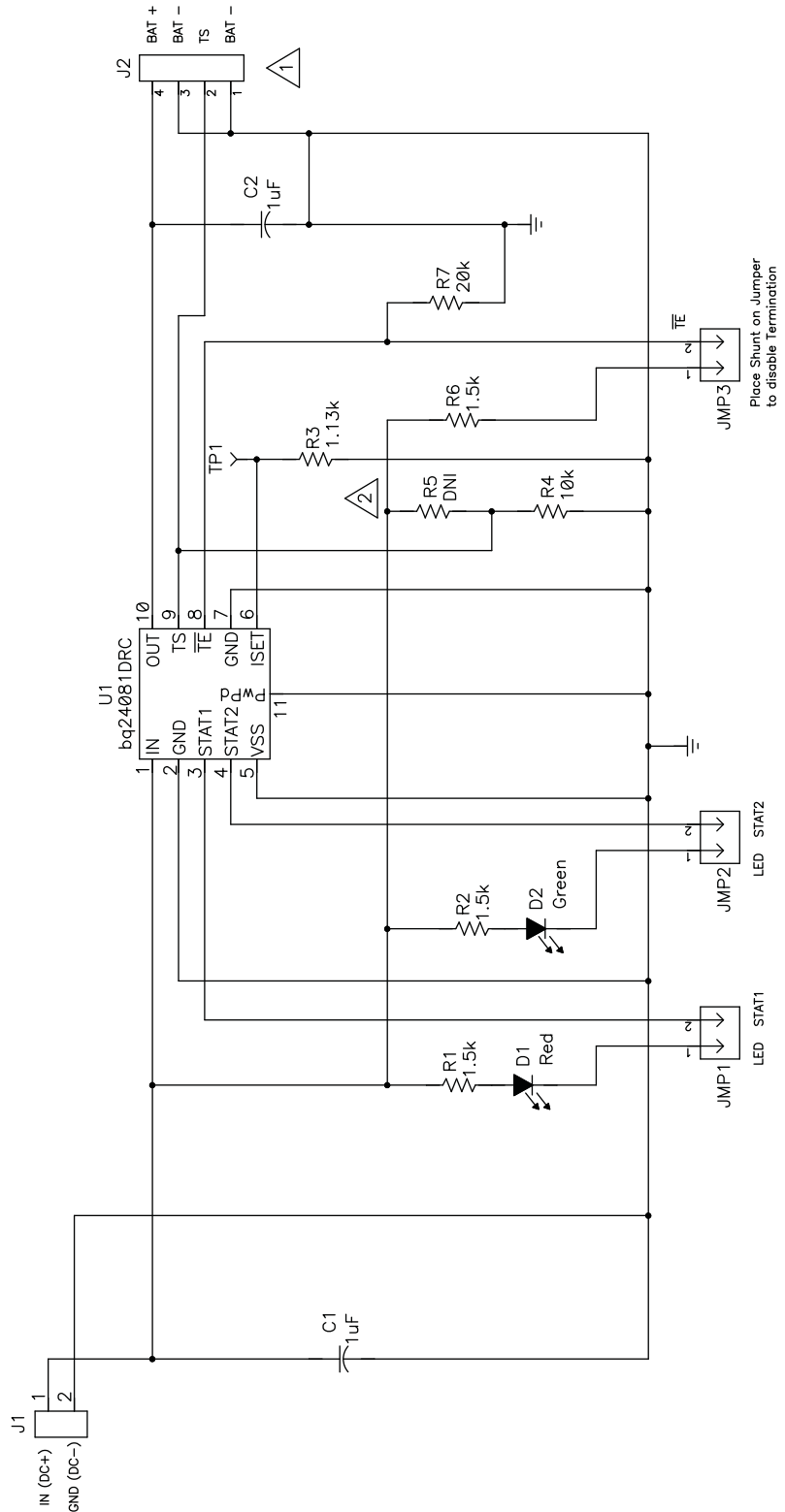
## 2.4 Ordering Information

**Table 2. Ordering Information**

EVM Part Number	Additional Devices	Chemistry	Pack Voltage	Capacity
bq24081EVM	None	Li-Ion/Li-Poly	2.5 V to 4.2 V	Any

### 3 Schematic

Figure 2 shows the schematic diagram for the bq24081EVM.



1 DC-, BAT-, GND, Pwr Pad, and Vss are tied together to a single ground plane.

2 Do not install. Option for future IC.

Figure 2. bq24081 EVM Schematic

#### 4 Physical Layouts

Figure 3 shows the top layer of the EVM. Figure 4 shows the bottom layer. Figure 5 shows the top assemble view.

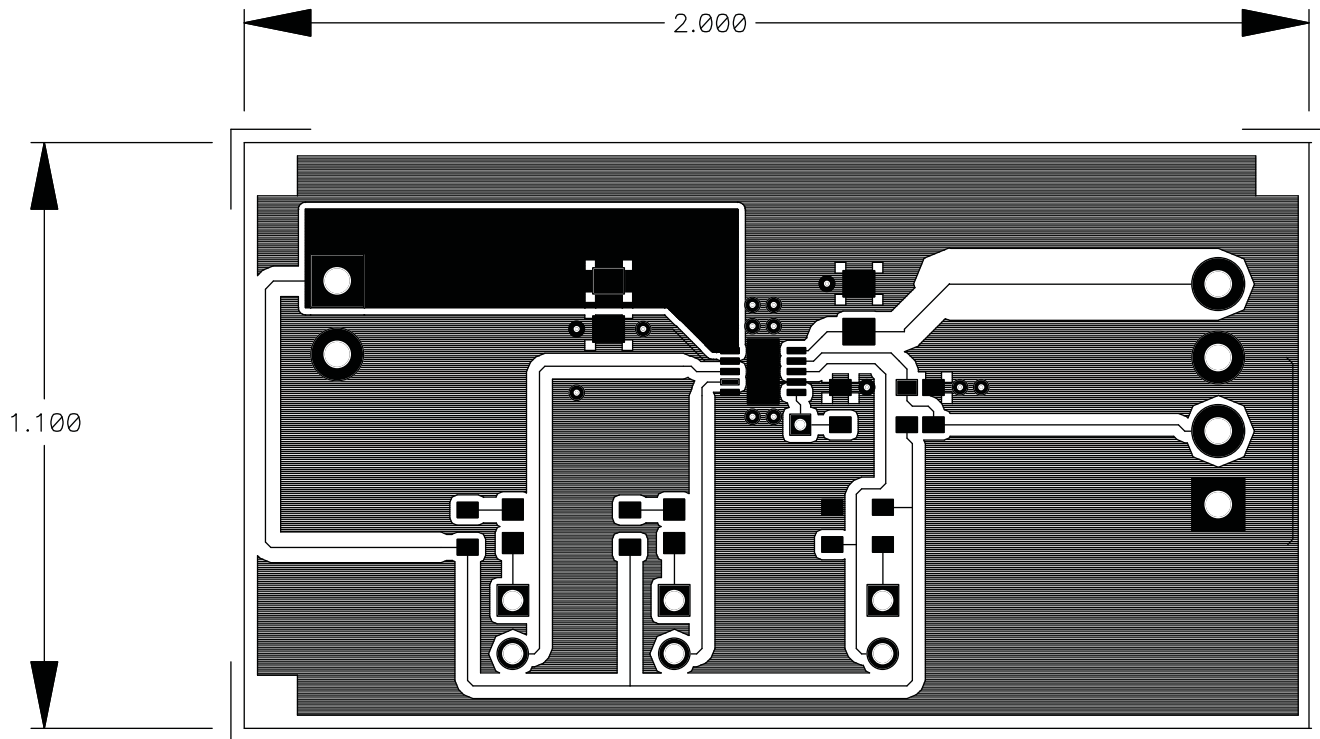


Figure 3. bq24081 EVM – Top Layer

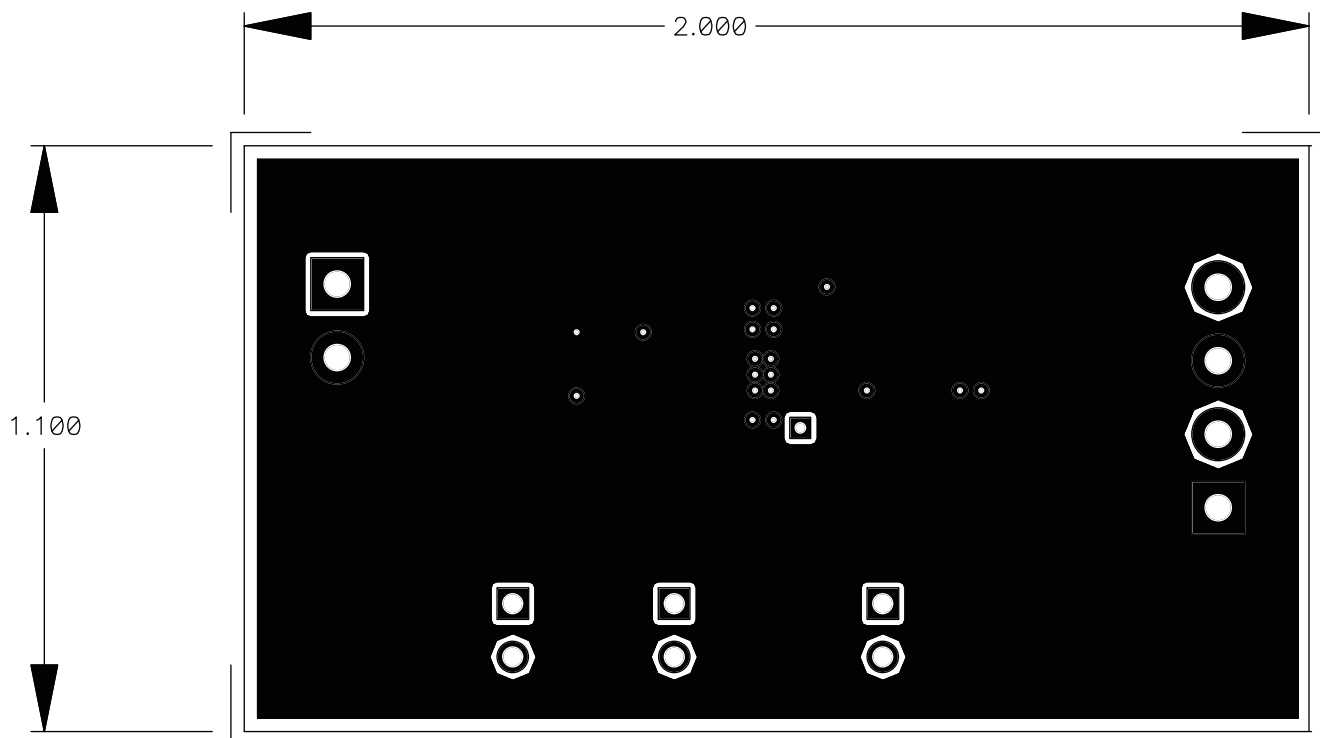
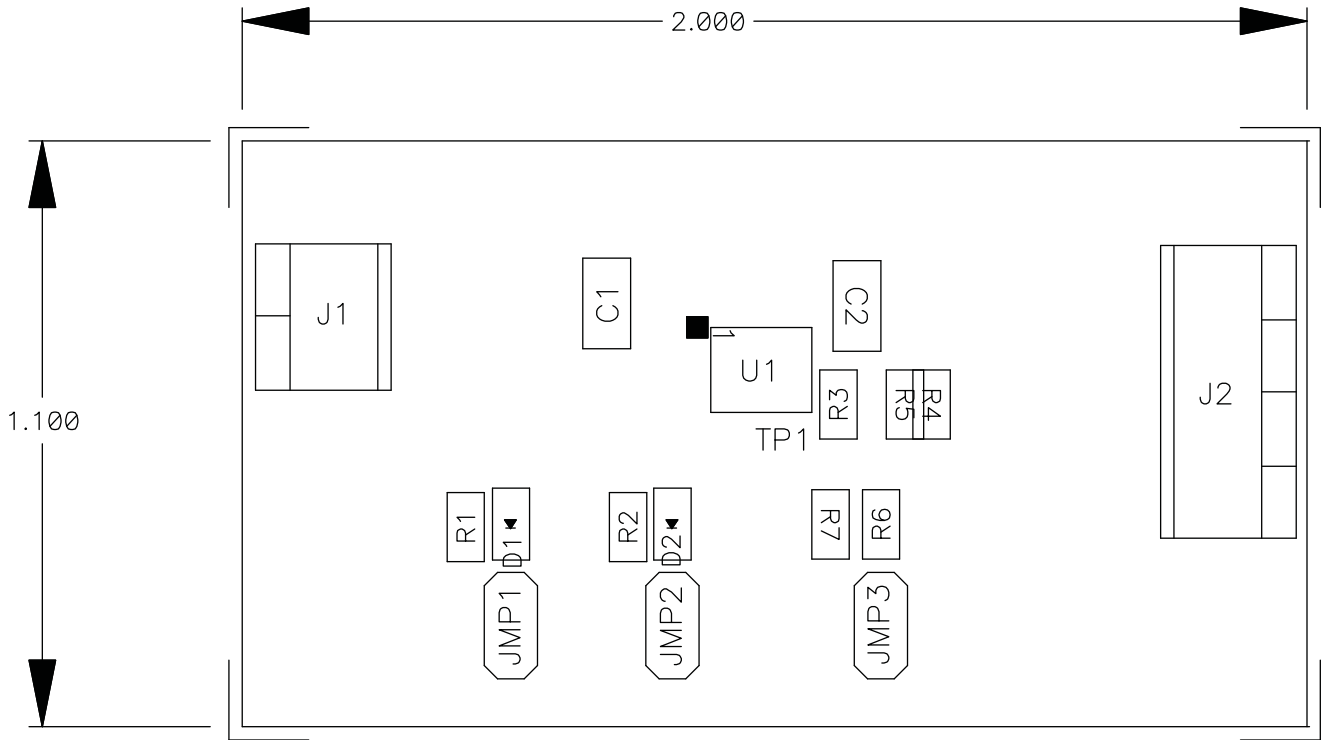
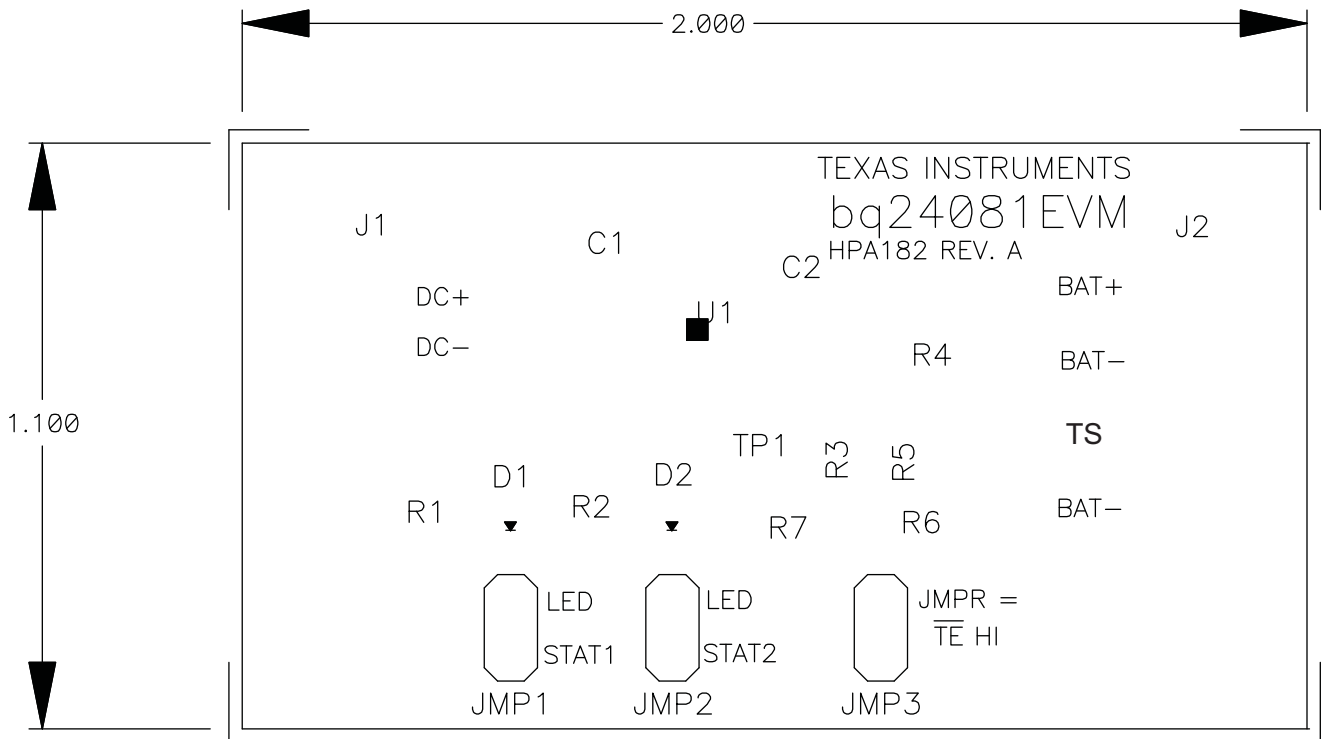


Figure 4. bq24081 EVM – Bottom Layer



**Figure 5. bq24081 EVM – Component Placement**



**Figure 6. bq24081 Silkscreen Layer**

## 5 List of Materials

Table 3 lists the materials required for the bq24081EVM.

**Table 3. bq24081 EVM Parts List<sup>(1)</sup>**

Count	Ref. Designator	Value	Description	Size	Part Number	Manufacturer
2	C1, C2	1uF	Capacitor, Ceramic, 1uF, 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
1	D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	160-1183-1-ND	Liteon
1	J1		Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED1514	OST
1	J2		Terminal Block, 4-pin, 6-A, 3.5mm	0.55 x 0.25	ED1516	OST
3	JPM1, JPM2, JPM3	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
3	R1, R2, R6	1.5k	Resistor, Chip, 1.5k-Ohms, 1/16-W, 1%	0603	Std	Std
1	R3	1.13k	Resistor, Chip, 1.13k-Ohms, 1/16-W, 1%	0603	Std	Std
0	R5			0603		
2	R4, R7	10k	Resistor, Chip, 10k-Ohms, 1/16-W, 1%	0603	Std	Std
1	U1	bq24081DRC	IC, Single Chip, Li Ion/Li POL, Charger	DRC10	bq24081DRC	TI
1	--		PCB, 2 In x 1 In x 0.031 In		HPA182	Any

(1) Notes:

1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk (\*\*\*) cannot be substituted. All other components can be substituted with equivalent MFG's components.



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### EVM WARNINGS AND RESTRICTIONS

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

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  $70^\circ\text{C}$ . The EVM is designed to operate properly with certain components above  $70^\circ\text{C}$  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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