

General Description

The MAX77787 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that demonstrates the MAX77787, standalone 3.15A USB Type-C® autonomous charger with JEITA.

The MAX77787 can operate from 4.5V to 13.7V input, with a fast charge current up to 3.15A and a maximum input current limit of 3A. The MAX77787 is offered to support Li-ion batteries with JEITA compliance. It also has another option that supports LiFePO4 batteries with non-JEITA compliance.

The EV kit features USB Type-C CC detection, battery charging compliant with the USB Battery Charging Specification Revision 1.2 (BC1.2), proprietary adapter detection upon input insertion, and automatic configuration of the charger input current limit to the maximum allowable current from the input source.

The MAX77787 has the reverse-boost capability, which is enabled by the ENBST pin to allow the 5.1V/1.5A output to CHGIN. The EV kit includes the variable resistor and thermistor to demonstrate the JEITA compliance.

EV Kit Photo

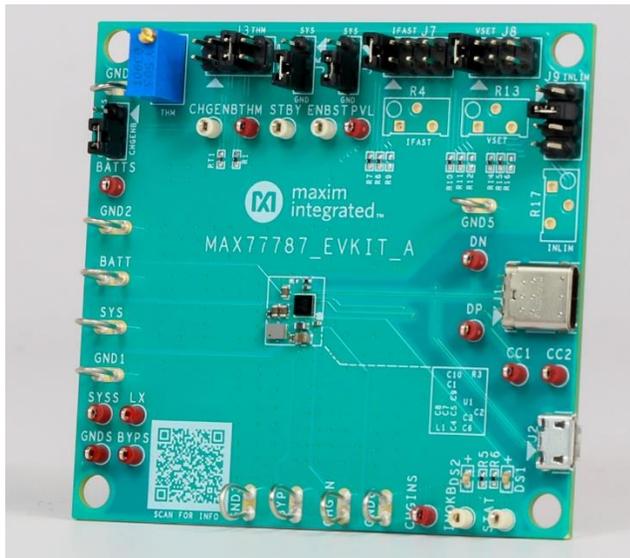


Figure 1. MAX77787 EV Kit

Benefits and Features

- Up to 16V Protection
- 13.7V Maximum Input Operating Voltage
- 3.15A Maximum Charging Current
- 6A Discharge Current Protection
- No Firmware or Communication Required
- Integrated USB Detection
 - Integrated CC Detection for USB Type-C
 - Integrated BC1.2 Detection for Legacy SDP, DCP, and CDP
 - Automatic Input Current Limit Configuration
- Input Voltage Regulation with Adaptive Input Current Limit (AICL)
- 5.1V, 1.5A OTG Mode and BYP Reverse Boost
- Termination Voltage
 - 4.1V to 4.55V for Li-ion and Li-poly Batteries
 - 3.6V/3.7V for LiFePO4 Battery
- Safety
 - Charge Safety Timer
 - JEITA Compliance with NTC Thermistor (MAX77787J)
 - HOT/COLD Stop Charging with NTC Thermistor (MAX77787H)
 - Thermal Shutdown
- Pin Control of all Functions
 - Resistor-Configurable Fast-Charge Current, Termination Voltage, and Input Current Limit
 - ENBST Pin to Enable and Disable Reverse Boost
 - STAT Pin to Indicate Charging Status
 - INOKB Pin to Indicate Input Power-OK (POK)
 - CHGENB Pin to Enable and Disable Charging
 - STBY Pin to Support Suspend Mode
 - THM Pin to Monitor Thermistor
- Fixed Resistor Options to Easily set Fast-Charge Current, Termination Voltage, and Input Current Limit
- Integrated Power Path
- Integrated Battery True-Disconnect FET
- Proven PCB Layout
- Fully Assembled and Tested

Ordering Information appears at end of data sheet.

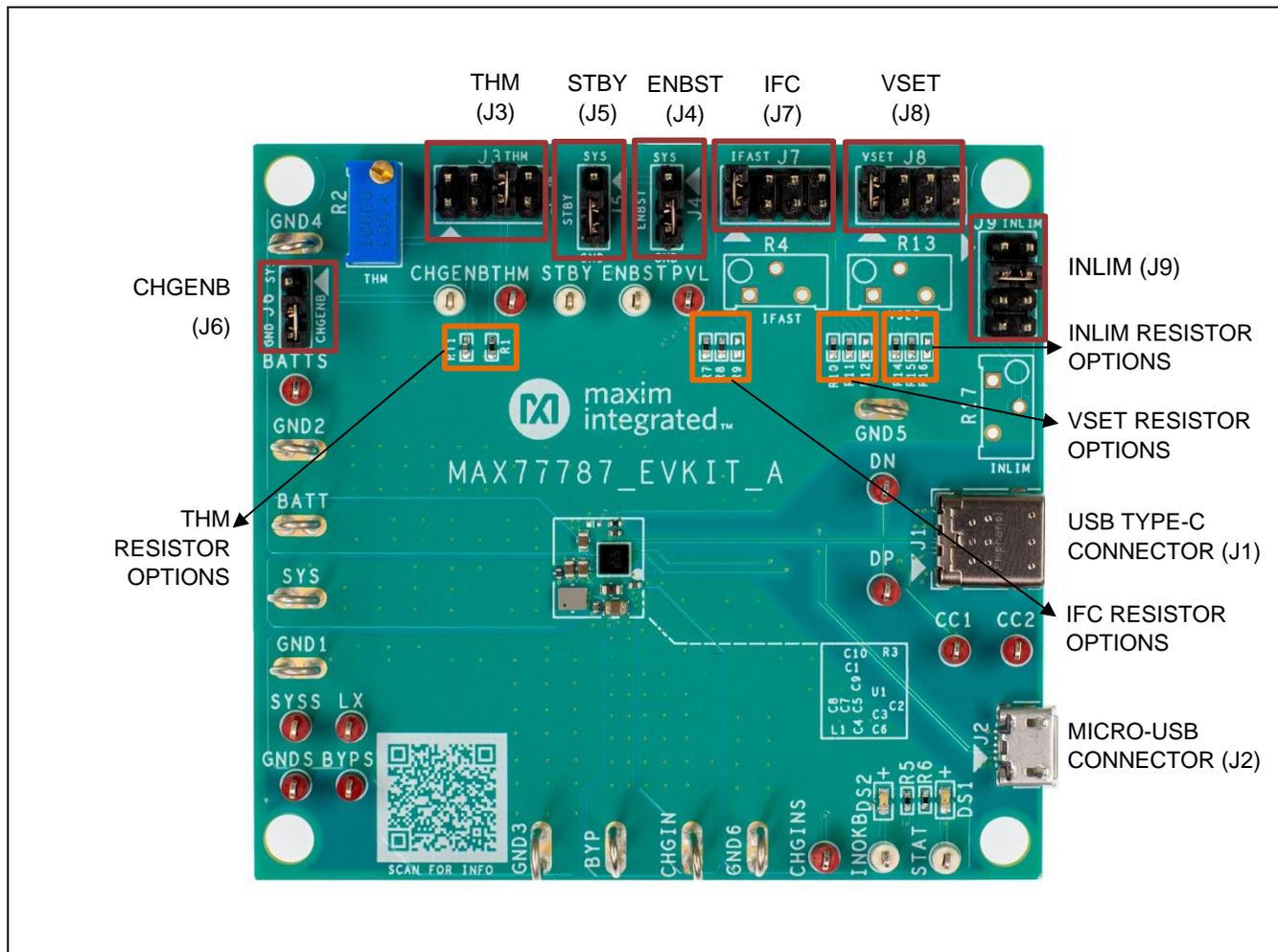


Figure 2. Jumper and Resistor Options Location

Quick Start

EV Kit Default Setting

INPUT CURRENT LIMIT	FAST-CHARGE CURRENT	TERMINATION VOLTAGE	CHARGER	REVERSE BOOST MODE	SUSPEND MODE
3A	500mA	3.6V	ON	OFF	OFF

Note: To change the setting, see [Table 1](#) for jumper positions.

Required Equipment

- MAX77787 evaluation kit
- USB Type-C travel adapter and cable
- Power supply
- Battery, battery simulator, or power supply with electronic load
- Oscilloscope
- Multimeters

Initial Test Setup

The EV kit is fully assembled and tested. Follow the steps to verify board operation:

1. Do not turn on the DC power supply until all connections are made.
2. Confirm that all jumpers are at their default positions as indicated in [Table 1](#).
3. Connect the battery, battery simulator, or power supply to the loop labeled BATT and GND.
4. Connect the power supply to the loop labeled CHGIN. Note that CHGIN can come from three sources (Micro-USB connector, USB TYPE-C Connector, or CHGIN loop), only one of these sources should be connected at any time.
5. The EV kit is now ready for use.

Detailed Description of Hardware

Follow the initial test setup procedure.

Battery Charger Test Setup

The battery charger can be tested in three different ways; with a battery, battery simulator, or power supply with an electronic load. Typical bench setups for MAX77787 the EV kit with different configurations are shown in [Figure 3](#), [Figure 4](#) and [Figure 5](#).

Battery

- 1) Connect the 1 cell battery pack and current meter between BATT and GND. **Note:** Only use a battery with a charge termination voltage that matches that of the jumper setting on the board.
- 2) Connect the 5.0V/5.0A current-limited DC power supply between CHGIN and GND and turn it on.
- 3) Observe the current reading from the current meter. If the battery is discharged, the fast-charging current should match the setting with the external IFAST resistor (R7/R8/R9). If the battery is not discharged, it could be in a top-off state or done state. The current reading could be top-off current (match the jumper setting on the board) or done state (~0A).

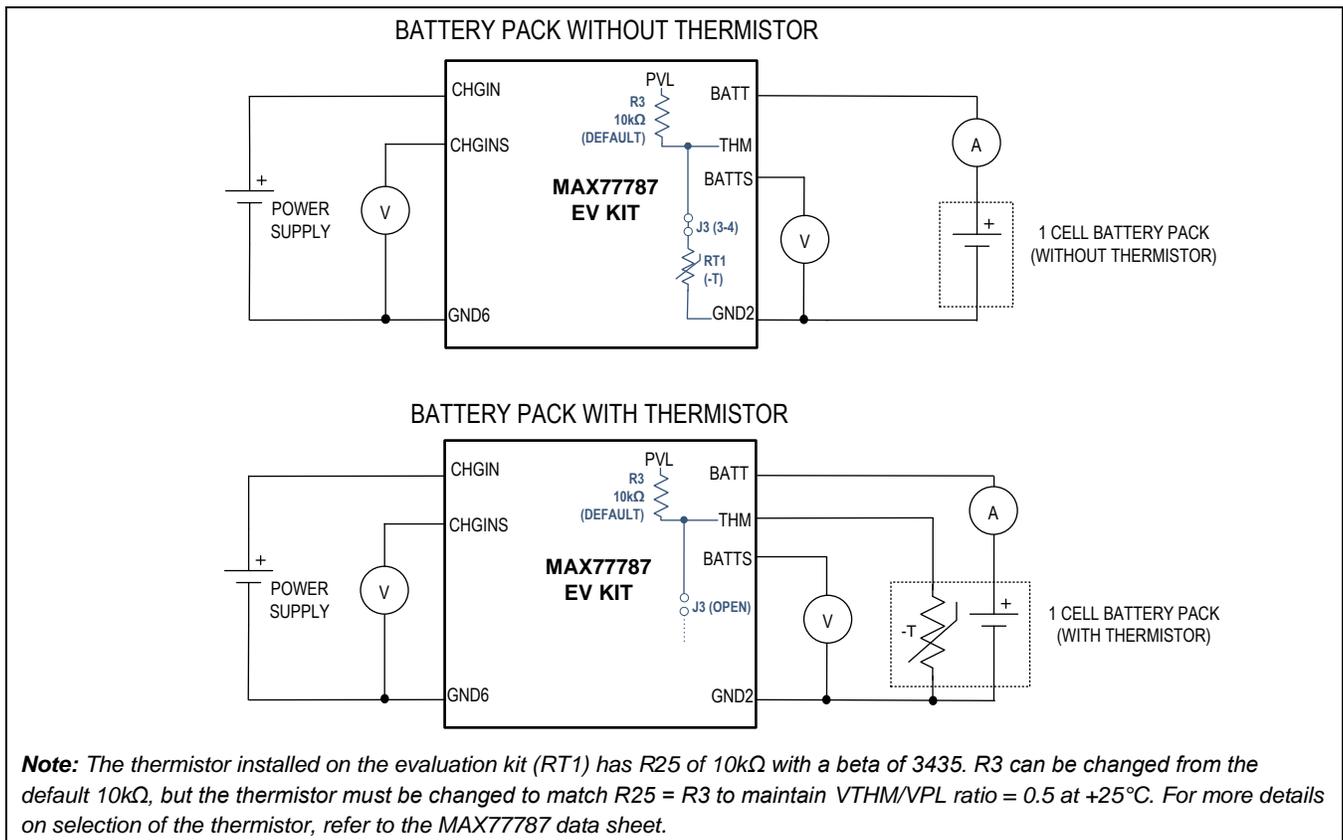


Figure 3. Battery Charger Test with Real Battery Pack

Battery Simulator

- 1) Connect the battery simulator between BATT and GND, adjust the voltage to 3.8V with 3.5A current limit, and turn it on.
- 2) Connect the 5.0V/5.0A current-limited DC power supply between CHGIN and GND and turn it on.
- 3) Observe the current reading from the battery simulator and see if the fast-charging current matches with the external IFAST resistor.

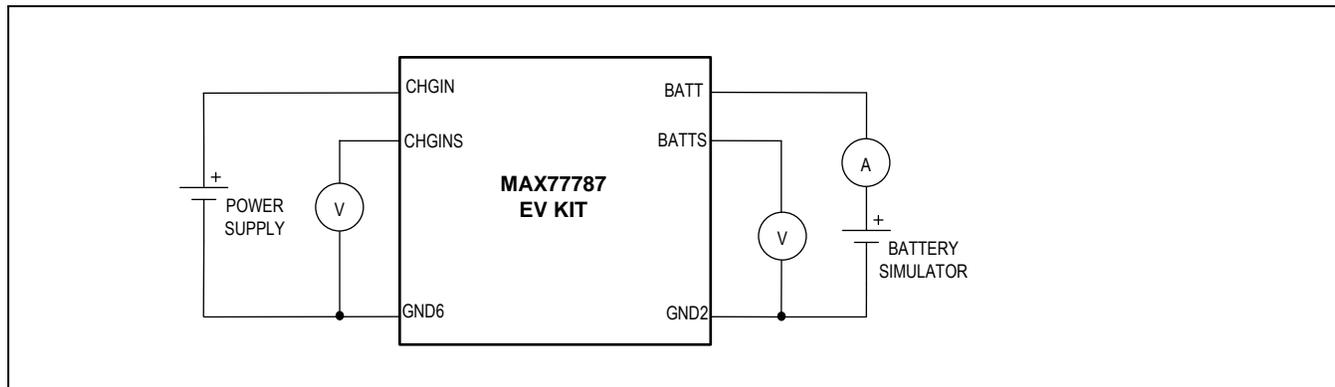


Figure 4. Battery Charger Test with Battery Simulator

Power Supply with Electronic Load

- 1) Connect the power supply between BATT and GND and adjust the voltage to 3.8V with 3.5A current limit.
- 2) Connect the electronic load between BATT and GND and set the load current to 3.5A.
- 3) Turn on the power supply and electronic load.
- 4) Connect the 5.0V/5.0A current-limited DC power supply between CHGIN and GND and turn it on.
- 5) Observe the current reading from the current meter 1 and 2 (the fast-charging current equals $I_2 - I_1$) and see if this value matches with the external IFAST resistor.

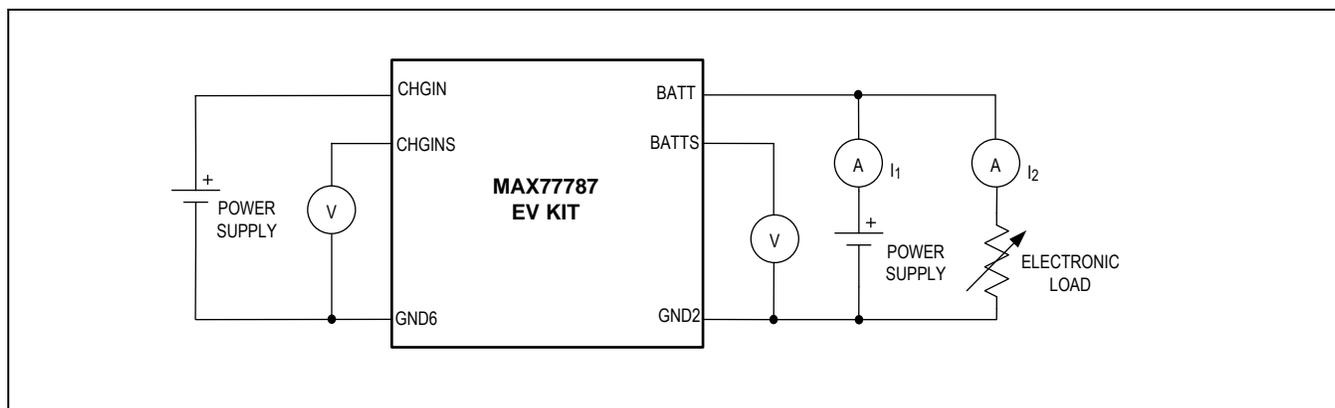


Figure 5. Battery Charger Test with Power Supply and Electronic Load

Table 1. Default Shunt Positions and Jumper Descriptions

JUMPER #	DEFAULT POSITION	FUNCTION
J3	Short 5-6	Short 1-2: Connect THM pin to a variable resistor
		Short 3-4: Connect THM pin to a thermistor
		Short 5-6: Connect THM pin to a fixed value resistor 10K
		Short 7-8: Connect THM pin to GND
J4	Short 2-3	Short 1-2: Enable OTG Reverse Boost
		Short 2-3: Connect ENBST pin to GND
J5	Short 2-3	Short 1-2: Enable USB Suspend Mode
		Short 2-3: Connect STBY pin to GND
J6	Short 2-3	Short 1-2: Disable Charging
		Short 2-3: Connect CHGENB to GND
J7	Short 3-4	Short 1-2: Connect IFAST pin to a fixed value resistor 24.9K (IFAST = 3.15A)
		Short 3-4: Connect IFAST pin to a fixed value resistor 2.43K (IFAST = 0.5A)
		Short 5-6: Connect IFAST pin to a fixed value resistor (open for user's choice of resistor value)
		7-8: Not in use
J8	Short 1-2	Short 1-2: Connect VSET pin to a fixed value resistor 24.9K (VSET = 3.6V)
		Short 3-4: Connect VSET pin to a fixed value resistor 2.43K (VSET = 4.55V)
		Short 5-6: Connect VSET pin to a fixed value resistor (open for user's choice of resistor value)
		7-8: Not in use
J9	Short 3-4	Short 1-2: Connect INLIM pin to a fixed value resistor 24.9K (INLIM = 0.5A)
		Short 3-4: Connect INLIM pin to a fixed value resistor 2.43K (INLIM = 3A)
		Short 5-6: Connect INLIM pin to a fixed value resistor (open for user's choice of resistor value)
		7-8: Not in use

Table 2. Mode Configuration by External Pins

CHGENB	ENBST	STBY	CHGIN FET	QBAT	MODE
J6 (1-2)	J4 (2-3)	J5 (2-3)	ON	OFF	Buck = ON, Charging = OFF
J6 (1-2)	J4 (2-3)	J5 (1-2)	OFF	OFF	Invalid
J6 (1-2)	J4 (1-2)	J5 (2-3)	ON	OFF	Invalid
J6 (1-2)	J4 (1-2)	J5 (1-2)	OFF	OFF	Invalid
J6 (2-3)	J4 (2-3)	J5 (2-3)	ON	ON	Buck = ON, Charging = ON
J6 (2-3)	J4 (2-3)	J5 (1-2)	OFF	ON	Suspend Mode
J6 (2-3)	J4 (1-2)	J5 (2-3)	ON	ON	OTG Reverse-Boost Mode
J6 (2-3)	J4 (1-2)	J5 (1-2)	OFF	ON	BYP Reverse-Boost Mode

BC1.2 and CC Detection Test Setup

- 1) Connect the battery/battery simulator/power supply with an electronic load between BATT and GND. See the [Battery Charger Test Setup](#) section for details.
- 2) Plug in the USB Type-C cable from the PC or AC adaptor.
- 3) MAX77787 automatically sets the CHGIN input current limit based on the charger type detection results. If the input source is not a standard power source described by BC1.2, USB Type-C or proprietary charger type that the MAX77787 can detect, the MAX77787 sets the input current limit according to RINLIM. In the case of floating RINLIM, the MAX77787 input current limit is set to 0.5A when an unknown proprietary charger is detected.

OTG Reverse Boost Test Setup

- 1) Connect the power supply between BATT and GND, adjust the voltage to 3.8V with 3.5A current limit, and turn it on.
- 2) Apply the Jumper 4 to enable the OTG reverse-boost mode.
- 3) Monitor the voltage of CHGIN at CHGINS test point and see whether it equals 5.1V. Note that VCHGIN must be lower than 0.7V before ENBST is enabled. Otherwise, CHGIN does not supply current when ENBST is enabled.

BYP Reverse Boost Test Setup

- 1) Connect the power supply between BATT and GND, adjust the voltage to 3.8V with 3.5A current limit, and turn it on.
- 2) Apply the Jumper 4 and Jumper 5 to enable the BYP reverse-boost mode.
- 3) Monitor the voltage of BYP at BYPS test point and see whether it equals 5.1V.

LED Indicator

- 1) Two LED indicators are installed on the EV kit: DS1 (green) is for the STAT pin and DS2 (red) is for INOKB.
- 2) The STAT pin is an open-drain and active-low output that indicates charge status. See [Table 3](#) for details.
- 3) INOKB is an open-drain and active-low output that indicates the input status. If a valid input source is inserted and the buck converter starts switching, INOKB pulls low. When the reverse boost is enabled, INOKB pulls low to indicate the 5V output from CHGIN.

Table 3. STAT Output with Charging Status

CHARGING STATUS	STAT	LOGIC STATE	CHARGE STATUS LED
No Input	High Impedance	High	Off
Trickle, Pre-charge, Fast Charge	Repeat Low and High Impedance with 1Hz, 50% duty cycle	After an external diode and a capacitor rectifier, High	Blinking with 1Hz, 50% duty cycle
Top-Off and Done	Low	Low	Solid On
Faults	High Impedance	High	Off

Component Suppliers

SUPPLIER	PHONE	WEBSITE
MURATA	770-436-1300	www.murata-northamerica.com
SAMTEC	800-726-8329	www.samtec.com
TAIYO-YUDEN	603-669-7587	www.t-yuden.com
TDK	847-803-6100	www.tdk.com
VISHAY	408-970-5852	www.vishay.com
CYNTEC	510-668-5167	www.cyntec.com
PANASONIC	800-344-2112	www.panasonic.com

Note: Indicate that you are using MAX77787 when contacting these component suppliers.

Ordering Information

PART NUMBER	IC	TYPE	THERMAL PROTECTION	BATTERY CHEMISTRY
MAX77787JEVKIT#	MAX77787JEWX+	EV Kit	JEITA	Li-ion Li-polymer
MAX77787HEVKIT#	MAX77787HEWX+	EV Kit	HOT/COLD STOP	LiFePO4

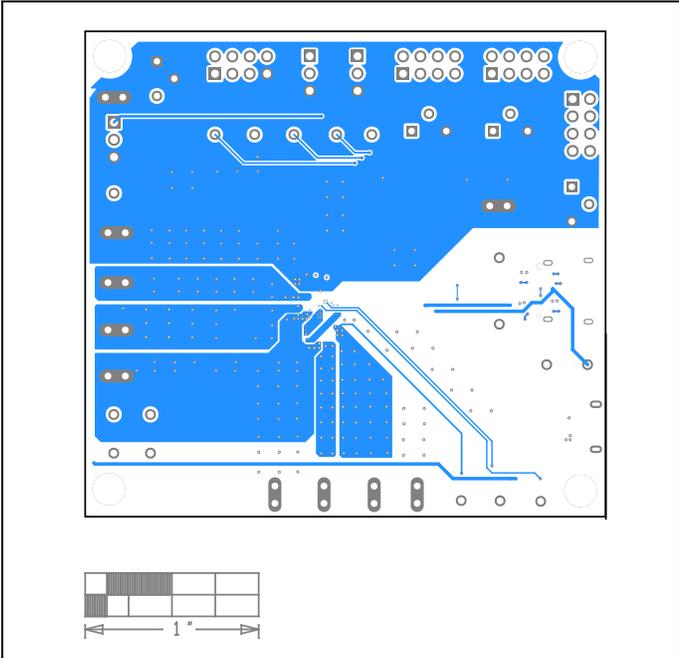
#Denotes RoHS-compliant.

MAX77787 EV Kit Bill of Materials

QTY	REF DES	MFG PART#	MANUFACTURER	VALUE
MINIMAL BILL OF MATERIALS FOR MAX77787 AUTONOMOUS CHARGER WITH JEITA				
2	C1, C8	C1005X5R1A225K050BC	TDK	2.2µF; 10%; 10V; X5R; SMT (0402); CERAMIC
1	C2	EMK105ABJ225MV; GRM155R61C225ME11	TAIYO YUDEN; KEMET	2.2µF; 20%; 16V; X5R; SMT (0402); CERAMIC
1	C3	C1608JB1C106M080AB	TDK	10µF; 20%; 16V; JB; SMT (0603); CERAMIC
1	C4	GRM155R61C104KA88	MURATA	0.1µF; 10%; 16V; X5R; SMT (0402); CERAMIC
3	C5, C7, C9	C1608X5R1A106K080AC	TDK	10µF; 10%; 10V; X5R; SMT (0603); CERAMIC
1	C6	ANY	ANY	22µF; 16V; 10%; X5R; SMT (0805); CERAMIC
1	L1	HTEH25201T-R47MSR-63	CYNTEC	0.47µH; ±20%; 5.6A
1	RT1	NCP15XH103F03	MURATA	10KΩ; ±1%; SMT (0402); THERMISTOR; THICK FILM
1	R3	CRCW040210K0FK; RC0402FR-0710KL	VISHAY DALE; YAGEO PHICOMP	10KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
3	R7, R10, R14	ERJ-2RKF2492	PANASONIC	24.9KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
1	U1	MAX77787	MAXIM	MAX77787JEWX+
OTHER COMPONENTS FOR EVALUATION KIT				

QTY	REF DES	MFG PART#	MANUFACTURER	VALUE
0	C10	N/A	N/A	NOT INSTALLED
1	R1	CRCW040210K0FK; RC0402FR-0710KL	VISHAY DALE; YAGEO PHICOMP	10KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
1	R2	3296Y-1-503LF	BOURNS	50KΩ; 10%; THROUGH-HOLE-RADIAL LEAD; 0.5W
3	R4, R13, R17	N/A	N/A	NOT INSTALLED
2	R5, R6	CR0402-16W-1651FT; CRCW04021K65FK	VENKEL LTD.; VISHAY DALE	1.65KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
3	R8, R11, R15	ERJ-2RKF2431	PANASONIC	2.43KΩ; 1%; SMT (0402); ±100PPM/°C; 0.1W
0	R9, R12, R16	N/A	N/A	NOT INSTALLED
1	J1	12401832E402A	AMPHENOL	FEMALE; USB TYPE C CONNECTOR
1	J2	10118193-0001LF	FCI CONNECT	FEMALE; MICRO USB B TYPE RECEPTACLE
4	J3, J7-J9	PEC04DAAN	SULLINSELECTRONICS CORP.	CONNECTOR; MALE; THROUGH-HOLE; STRAIGHT; 8 PINS
3	J4-J6	TSW-103-07-T-S	SAMTEC	CONNECTOR; THROUGH-HOLE; SINGLE ROW; STRAIGHT; 3 PINS
10	BATT, BYP, CHGIN, GND1-GND6, SYS	9020 BUSS	WEICO WIRE	MAXIM PAD; WIRE; SOLID; 20AWG
12	BATTS, BYPS, CC1, CC2, CHGINS, DN, DP, GNDS, LX, PVL, SYSS, THM	5000	KEYSTONE	TEST POINT; RED
5	CHGENB, ENBST, INOKB, STAT, STBY	5002	KEYSTONE	TEST POINT; WHITE
1	DS1	SML-311YTT86	ROHM	LED; SMT (0603); YELLOW; VF = 1.8V; IF = 0.02A; -30°C TO +85°C
1	DS2	SML-311UT	ROHM	LED; SMT (0603); RED; VF = 1.8V; IF = 0.02A; -30°C TO +85°C
4	MH1-MH4	9032	KEYSTONE	ROUND-THRU HOLE SPACER; NYLON
1	MISC1	AK67421-1-R	ASSMANN	USB2.0 MICRO CONNECTION CABLE
6	SU4-SU9	S1100-B; SX1100-B; STC02SYAN	KYCON; KYCON; SULLINS ELECTRONICS CORP.	JUMPER; BLACK; TOTAL LENGTH = 0.24IN
1	PCB	MAX77787	MAXIM	MAX77787JEVKIT#

MAX77787 EV Kit PCB Layout (continued)



MAX77787 EV Kit PCB Layout—Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/21	Initial release	—



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