Evaluation Board User Guide

# MAX77978 Evaluation Kit

Evaluates: MAX77978

## General Description

The MAX77978 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that evaluates the MAX77978 Standalone USB Type-C® and Power Delivery Controller.

The EV kit contains the MAX77963 charger to demonstrate the MAX77978's I²C controller feature. The MAX77963 is a buck-boost charger designed for 2S/3S Li+ battery applications. It can operate with input voltages ranging from 3.5V to 23V and features a maximum programmable fast-charging current of 3.2A.

The MAX42403 buck converter is installed on the EV kit to provide 5V to the VCIN pin. The MAX77963 uses SYS to enable the buck converter.

The EV kit includes the IC evaluation board, which features an integrated I²C-communication interface and a USB micro-B cable. Windows®-based graphical user interface (GUI) software is available with the EV kit and can be downloaded from the Analog Devices website at *www.analog.com*. The EV kit software requires a Windows 7 or newer operating system.

## Features

- MCU-Based Configuration
  - No Firmware Development Needed in Autonomous Configuration
  - Customizable Firmware Based on End Application Requirements
- RISC-V CPU and 16Kbyte MTP
  - USB Type-C Compliant Default Embedded Firmware
  - Supports Customizable Actions on Events
  - Firmware Updates for Future Specification Revisions
- USB Type-C Support and USB-PD Support
  - USB Type-C Version 2.3 and PD3.2 Compliant
  - Mode Configuration: Sink/Source/Dual Role Port
  - Programmable Power Supply (PPS) Sink Support
  - Fast Role Swap (FRS) Initial Sink Support
  - Alternate Mode Support and integrated SBU Crossbar Mux
  - Integrated $V_{CONN}$ Switch with OCP
  - Support Try.Snk State and Try.Src State
  - Debug Accessory Sink/Source Mode
- Supports BC1.2 Legacy/Proprietary Charger/HVDCP Detection
- Integrated D+/D- Switches for USB2.0 and UART
- Integrated eUSB2-USB 2.0 Repeater
- Liquid Corrosion Mitigation Mode
- VDD Operating Range, 3.1V to 5.5V
- High Voltage VBUS (52V), DP/DN (24V), CC (52V)
- Short-to-VBUS Protection on CC Pins and SBU Pins (50V)
- Dead Battery Support (Sink Mode Support when No VDD Applied)
- I²C Programmable Configuration (Three SIDs)
- I²C Controller-to-Control External Charger or DC-DC Converter
- Five Configurable GPIOs (Including SID)

## MAX77978 EV Kit Files

| FILE | DESCRIPTION |
|---|---|
| MAX77978GUISetup 1.0.0.zip | Installs EV kit files onto computer for Windows 7 or newer |

***Ordering Information* appears at end of data sheet.**

## Quick Start

### Required Equipment

- MAX77978 EV kit
- USB Type-C or PD travel adapter (TA)
- Adjustable DC power supply
- Battery or simulated battery
  - 2- or 3-cell Li-ion protected battery
  - Simulated battery or preloaded power supply
- Oscilloscope to monitor CC pin or other signals
- Multimeters
- USB Micro-B cable
- Windows-based PC

**Note:** In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows operating system.

## Procedure

The EV kit is fully assembled and tested. Follow the steps to install the EV kit software, connect the required hardware, and begin operating the kit. The EV kit software can be run without hardware attached. After establishing



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communication, the IC must still be configured correctly for the desired operation mode. Ensure the PC remains connected to the internet throughout the process so the USB driver installs automatically.

1. Visit *www.analog.com* to download the latest version of the MAX77978 EV kit software. Save the software to a temporary folder and unpack the zip file.
2. Install the EV kit software on the computer by running the MAX77978GUISetup1.0.0.exe program inside the temporary folder. This copies the program files and creates an icon in the **Windows Start** menu. The software requires the .NET Framework 4.5 or later. If connected to the internet, Windows automatically updates the .NET Framework as needed.
3. The EV kit software launches automatically after installation and can be launched by clicking its icon in the **Windows Start** menu.
4. Make jumper connections based on the Default Connection column in *Table 1*. Change it later when evaluating more features.
5. Connect the EV kit to a USB port on the PC using the USB cable provided.
6. Connect a 2- or 3-cell Li-ion or simulated battery to the BATTP and BATTN connectors.
7. Launch the MAX77978 GUI software.
8. Select **Device** > **Connect** from the window options to connect to the EV kit.

## EV Kit Photo

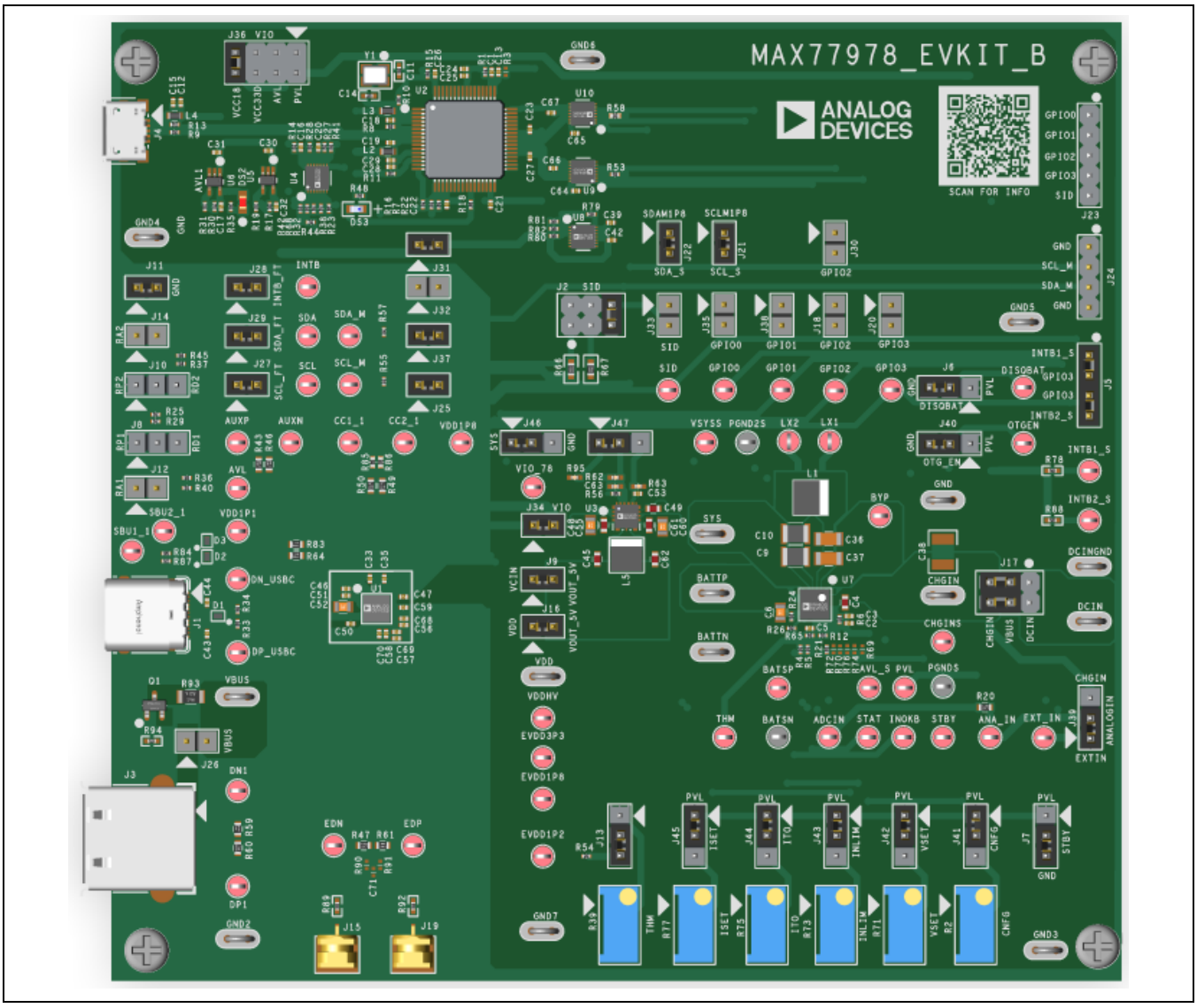



*Figure 1. MAX77978 EV Kit Photo*

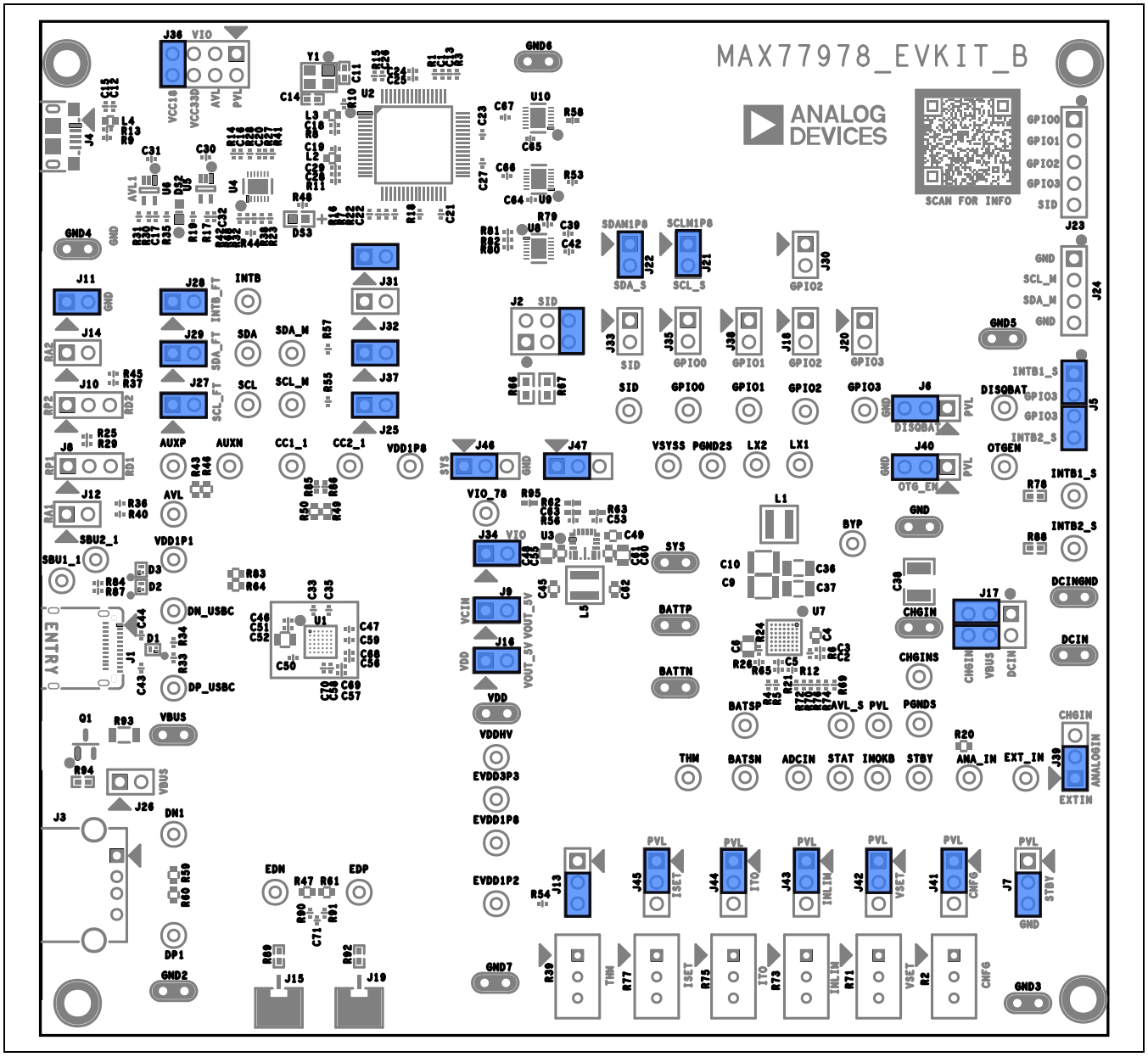



*Figure 2. MAX77978 EV Kit Jumps Default Connection*

## Table 1. Jumper Connection Guide

| DESCRIPTION | JUMPER | DEFAULT CONNECTION | FEATURE |
|---|---|---|---|
| VIO Connection | J34 | Short | **Short: Connect VIO to MAX77978.**<br>Open: Disconnect VIO from MAX77978. |
| | J36 | 7-8 | 1-2: VIO is powered by the PVL from the MAX77963.<br>3-4: VIO is powered by the AVL of the MAX77978.<br>5-6: VIO is powered by the VCC33D from the onboard MAXUSB.<br>**7-8: VIO is powered by the VCC18 from the onboard MAXUSB.**<br>Open: No power is applied to VIO. |

| DESCRIPTION | JUMPER | DEFAULT CONNECTION | FEATURE |
|---|---|---|---|
| USB Type-C Detection Test (When no USB Type-C cable is connected) | J8 | Open | 1-2: Connect R29 (Rp) to CC1.<br>2-3: Connect R36 (Rd) to CC1.<br>**Open: CC1 is active depending on the type of device connected to the USB Type-C port.** |
| | J10 | Open | 1-2: Connect R25 (Rp) to CC2.<br>2-3: Connect R37 (Rd) to CC2.<br>**Open: CC2 is active depending on the type of device connected to the USB Type-C port.** |
| | J12 | Open | Short: Connect R40 (Ra) to CC1.<br>**Open: CC1 is active depending on the type of device connected to the USB Type-C port.** |
| | J14 | Open | Short: Connect R45 (Ra) to CC2.<br>**Open: CC2 is active depending on the type of device connected to the USB Type-C port.** |
| | J11 | Short | **Short: USB Type-C Test, connect Rd and Ra to GND.**<br>Open: Disconnect Rd and Ra to GND. |
| VDD and VCIN Source (MAX42403 buck converter) | J9 | Short | **Short: Connect the BUCK_VOUT to VCIN.**<br>Open: Disconnect the BUCK_VOUT to VCIN. |
| | J46 | 1-2 | **1-2: Driving the EN pin high enables the VDD and VCIN output of the MAX42403 (buck converter configured for 3.3V or 5V output).**<br>2-3: Driving the EN pin low disables the VDD and VCIN outputs of the MAX42403 (buck converter configured for 3.3V or 5V output). |
| | J47 | 1-2 | **1-2: Connect R95 to the FB pin of the MAX42403 to set the output voltage to 3.3V.**<br>2-3: Connect R63 to the FB pin of the MAX42403 to set the output voltage to 5V. |
| VBUS from USB Type-A Connector | 26 | Open | Short: Connect USB Type-A to VBUS.<br>**Open: Disconnect USB Type-A to VBUS.** |
| I²C Controller to MAX77963 | J25 | Short | **Short: Connect SCLM to MAX77978.**<br>Open: Disconnect SCLM from MAX77978. |
| | J37 | Short | **Short: Connect SDAM to MAX77978.**<br>Open: Disconnect SDAM from MAX77978. |
| | J21 | Short | **Short: Connect I²C Controller SCL to MAX77963 to allow communication with the MAX77978.**<br>Open: Disconnect I²C Controller SCL to MAX77963. |
| | J22 | Short | **Short: Connect I²C Controller SDA to MAX77963 to allow communication with the MAX77978.**<br>Open: Disconnect I²C Controller SDA to MAX77963. |
| | J5 | 1-2 and 3-4 | **1-2: Connect GPIO3 to MAX77963 interrupt input 1 to allow communication with the MAX77978.**<br>**3-4: Connect GPIO3 to MAX77963 interrupt input 2 to allow communication with the MAX77978.**<br>Open: Disconnect GPIO3 to MAX77963 interrupt input 1 and 2. |
| | J31 | Short | **Short: Enables VCC18 (from MAXUSB) as the pull-up supply for I²C signals.**<br>Open: Disables the VCC18 (from MAXUSB) pull-up. |
| | J32 | Open | Short: Enables PVL (from MAX77963) as the pull-up supply for I²C signals.<br>**Open: Disables the PVL (from MAX77963) pull-up.** |

| DESCRIPTION | JUMPER | DEFAULT CONNECTION | FEATURE |
|---|---|---|---|
| I2C_Device to the onboard MAXUSB (USB-to-I²C Interface) | J28 | Short | **Short: Connect I2C_Device INTB with the onboard MAXUSB to allow communication with the GUI software.**<br>Open: Disconnect I2C_Device INTB with the onboard MAXUSB. |
| | J27 | Short | **Short: Connect I2C_Device SCL with the onboard MAXUSB to allow communication with the GUI software.**<br>Open: Disconnect I2C_Device SCL with the onboard MAXUSB. |
| | J29 | Short | **Short: Connect I2C_Device SDA with the onboard MAXUSB to allow communication with the GUI software.**<br>Open: Disconnect I2C_Device SDA with the onboard MAXUSB. |
| MAX77978 Device ID Selector (One set of pins from 1-2, 3-4, or 5-6 must be populated.) | J2 | 5-6 | 1-2: Connect SID with an external 470kΩ pullup resistor to VIO; device address = 0x4C.<br>3-4: Connect SID with an external 470kΩ pulldown resistor to GND; device address = 0x4E.<br>**5-6: Connect SID to GND; device address = 0x4A.** |
| MAX77978 VDD | J16 | Short | **Short: Connect MAX77978 VDD to BUCK_VOUT.**<br>Open: Disconnect MAX77978 VDD from BUCK_VOUT. |
| MAX77978 VBUS | J17 | 3-5 and 4-6 | 1-3 & 2-4: Connect MAX77978 VBUS to DCIN for external device.<br>**3-5 & 4-6: Connect MAX77978 VBUS to MAX77963 CHGIN.**<br>Open: Isolate MAX77978 VBUS for the EPR test. |
| | J30 | Open | Short: Enables GPIO2 control of the VBUS Sink discharge circuit.<br>**Open: Disables GPIO2 control of the VBUS Sink discharge circuit.** |
| Internal Use Only | J18 | Open | Short: For internal use only. |
| | J20 | Open | Short: For internal use only. |
| | J33 | Open | Short: For internal use only. |
| | J35 | Open | Short: For internal use only. |
| | J38 | Open | Short: For internal use only. |
| MAX77963 Charger-Related Jumpers | J6 | 2-3 | 1-2: Connect DISQBAT to PVL. QBAT FET is disabled.<br>**2-3: Connect DISQBAT to GND. QBAT FET is controlled by the DISIBS bit and the power-path state machine/internal logic control.** |
| | J7 | 2-3 | 1-2: Connect STBY to PVL. DC-DC is disabled.<br>**2-3: Connect STBY to GND. DC-DC is controlled by the STBY_EN bit and the power-path state machine/internal logic control.** |
| | J40 | 2-3 | 1-2: Connect OTGEN to PVL. OTG function is enabled.<br>**2-3: Connect OTGEN to GND. The OTG function is enabled and controlled by the MODE[3:0] bitfield.** |
| | J42 | 1-2 | **1-2: Connect VSET to PVL. The default charge termination voltage is the same as the decode of the reset value of CHG_CV_PRM[7:0].**<br>2-3: Connects VSET to R71. R71 programs the default charge termination voltage. |
| | J43 | 1-2 | **1-2: Connect INLIM to PVL. The default input current limit is the same as the decode of the reset value of CHGIN_ILIM[6:0].**<br>2-3: Connect INLIM to R73. R73 programs the default input current limit. |
| | J44 | 1-2 | **1-2: Connect ITO to PVL. The default top-off charge current is the same as the decode of the reset value of TO_ITH[2:0].**<br>2-3: Connect ITO to R75. R75 programs the default top-off charge current. |
| | J45 | 1-2 | **1-2: Connect ISET to PVL. The default fast-charge current is the same as the decode of the reset value of CHGCC_MSB and** |

| DESCRIPTION | JUMPER | DEFAULT CONNECTION | FEATURE |
|---|---|---|---|
| | | | **CHGCC[7:0].**<br>2-3: Connect ISET to R77. R77 programs the default fast-charge current. |
| | J13 | 2-3 | 1-2: Connect THM to potentiometer R39. Adjust the resistance of R39 to emulate the change in resistance of a 10kΩ thermistor across different temperatures.<br>**2-3: Connects THM to a fixed 10kΩ resistor, which emulates the resistance of a 10kΩ thermistor at 25°C.** |
| | J39 | 1-2 | **1-2: Connect ADCIN to an external input EXT_IN through a resistor divider. The voltage-dividing ratio is (R20 + R21) / R21 = 20.1. The EXT_IN voltage should be no higher than 25V to avoid saturating the voltage sensing at ADCIN.**<br>2-3: Connect ADCIN to CHGIN through a resistor divider. The voltage-dividing ratio is (R20 + R21) / R21 = 20.1. The CHGIN voltage should be no higher than 25V to avoid saturating the voltage sensing at ADCIN. |
| | J41 | 1-2 | **1-2: Connects CNFG to PVL. The number of serially connected battery cells is configured as 2S. The switching frequency is configured as 600kHz. Inductance is selected as 2.2µH or 3.3µH.**<br>2-3: Connects CNFG to R2. R2 programs the number of serially connected battery cells, switching frequency, and inductance selection. |

*Default options are in **bold**.*

## Detailed Description of Software

The GUI allows for a quick, easy, and thorough evaluation of the MAX77978 and MAX77963. Every control in the GUI corresponds to a register in the MAX77978 and MAX77963. Refer to the *Register Map* section in the MAX77978 and MAX77963 IC data sheets for a complete description.

### Software Installation

The MAX77978 EV kit GUI can be downloaded from Analog Devices' website at www.analog.com. Save the EV kit software to a temporary folder and extract the ZIP file's contents. Run the .exe file and follow the on-screen instructions to complete the installation. *Figure 3* shows a splash screen with information about the evaluation kit that appears while the program loads.


*Figure 3. Splash Screen*

## Establish Communication

Power up the MAX77978 and MAX77963 by connecting a 2- or 3-cell Li-ion battery or simulated battery at BATTP/BATTN. Open the GUI software and select **Device** > **Connect**. A window should pop up, showing that device addresses 0x4A and 0xD2 have been found. If not, check the USB connection and power. Click **Close** to close the pop-up window shown in *Figure 4*. Click **Read** to confirm the current firmware version, as shown in *Figure 5*. Firmware version 01.11 is for non-EPR users to verify all non-EPR functionality. For EPR users, we offer firmware version FA.16 to validate EPR-related functionalities.

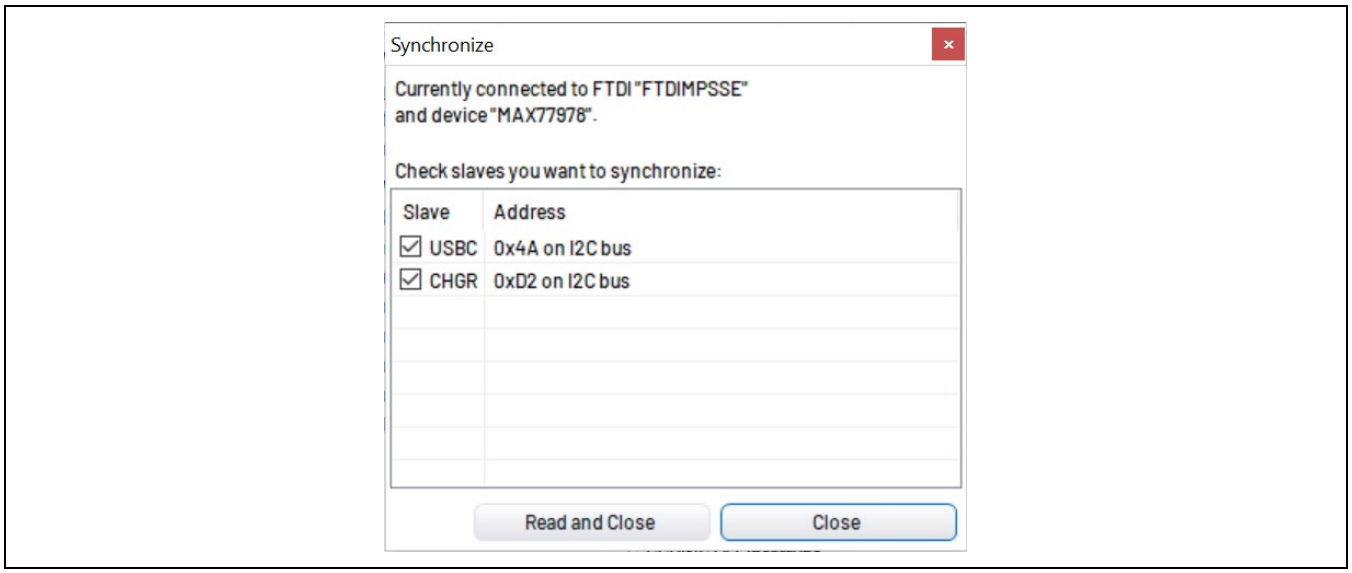



*Figure 4. Communication Window*

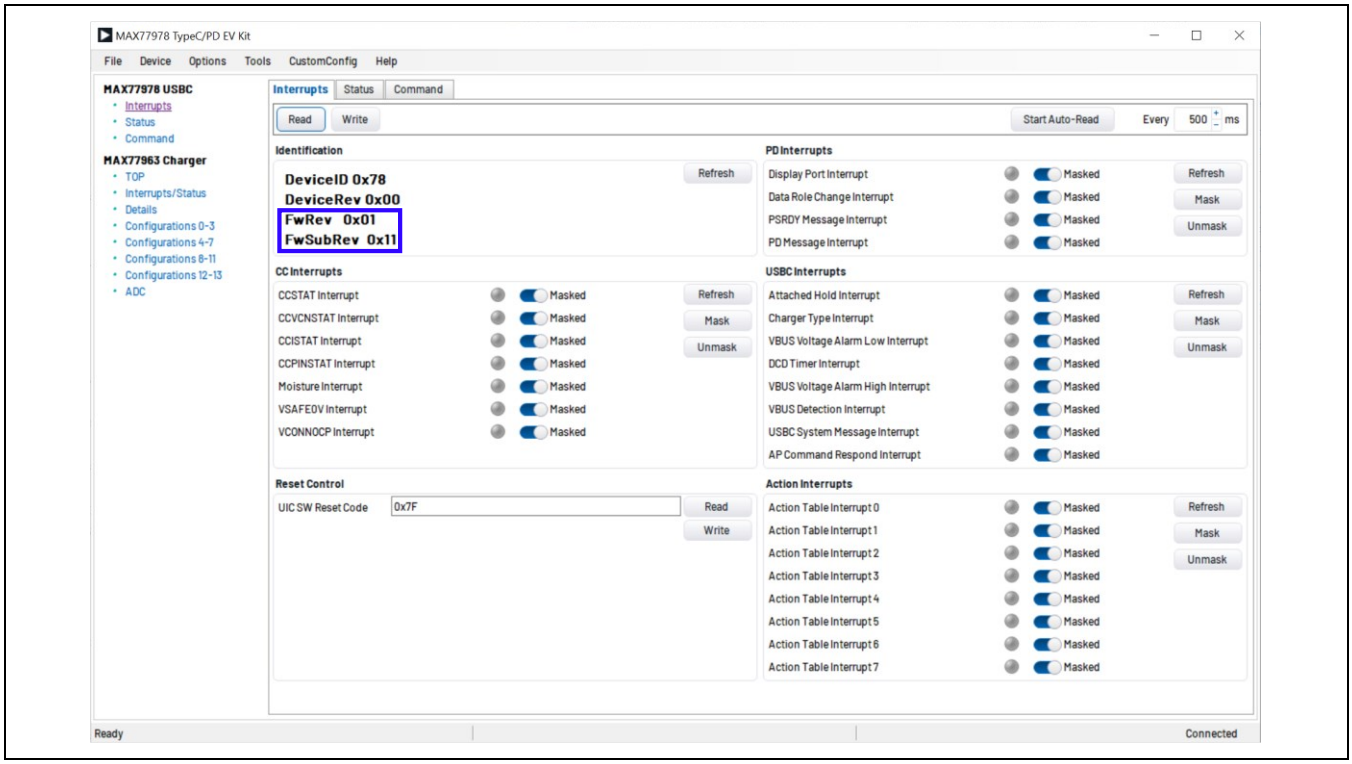



*Figure 5.* Main Display and the Firmware Version

## Detailed Description of Firmware

The MAX77978's firmware consists of two main parts: the core firmware and the customization script. The core firmware complies with the USB Type-C 2.3 and PD 3.2 specifications. The customization script is tailored to the application system, providing greater flexibility for system design. It is based on the customization script update, which enables functions such as GPIO matrix control, charger configuration initialization, and more.

The firmware version 01.11 is for non-EPR users to verify all non-EPR functionalities. For EPR users, we offer firmware version FA.16 to validate EPR-related functionalities.

### Core Firmware Update

The customization script defines the MAX77978's application-specific behavior. For example, it sets the charger's input current limit once USB device detection is complete.

1) Follow the established communication to connect the GUI with the MAX77978 EV kit.
2) Do not disconnect the EV kit from the PC during the firmware update.
3) Click **Tools** in the menu bar and select **Firmware Update**.
4) Click the **Open** button in the pop-up window to load the latest firmware. In the file selection window, click the .bin file, then select **Start** to activate the firmware update.
5) *Figure 6* shows the completion of the customization script update process.

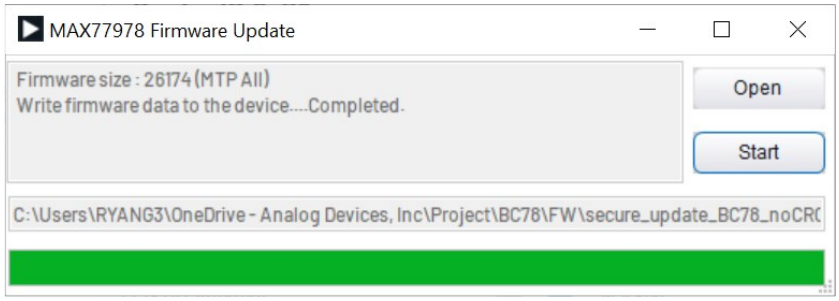



*Figure 6. Firmware Update Process Complete*

### Customization Script Update

The customization script defines the MAX77978's application-specific behavior. For example, it sets the charger's input current limit once USB device detection is complete.

1) Follow the established communication to connect the GUI with the MAX77978 EV kit.
2) Do not disconnect the EV kit from the PC while updating the customization script.
3) Click **Tools** in the menu bar, then go to **CUS Script Update**.
4) Click the **Open** button in the pop-up window to load the customization script, and then click **Start** to activate the customization script update.
5) *Figure 7* shows the completion of the customization script update process.

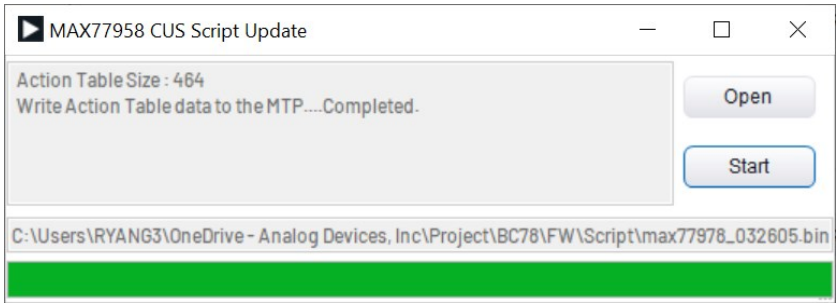



*Figure 7. Customization Script Update Process Complete*

## Detailed Description of Hardware

This evaluation kit should be used with the following documents:

- MAX77978 and MAX77963 IC data sheets
- MAX77978 EV kit data sheet (this document)

### Autonomous Mode 2S/3S Application Sink Mode

When the MAX77978 is configured as the Sink, it enables the MAX77963's charger mode and sets its input current limit based on USB Type-C and BC1.2 detection results.

1) Connect the simulated battery between BATTP and BATTN, adjust the voltage to 7.6V, and turn it on.
2) Connect the USB Type-C AC adapter to the EV kit.
3) Observe the current reading from the simulated battery. The MAX77978 sets the charger's input current limit based on the CC detection result. (If the simulated battery is unavailable, use the power supply in parallel with the electronic load to test.)

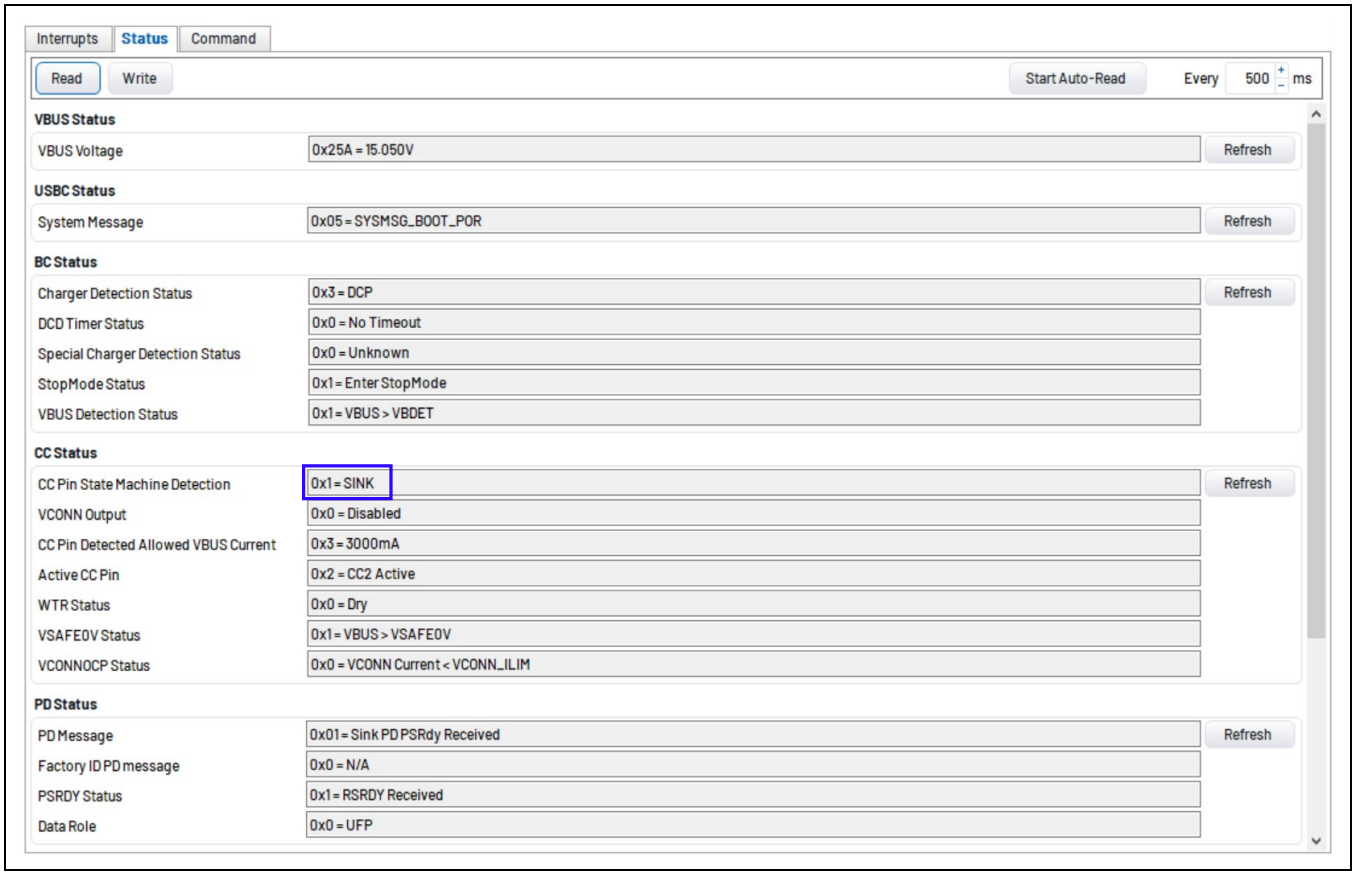



*Figure 8. Sink Mode*

## Source Mode

When the MAX77978 is configured as the Source, the MAX77963 automatically switches to reverse-buck mode and supplies 5.1V to VBUS.

1) Connect the simulated battery between BATTP and BATTN, adjust the voltage to 7.6V, and turn it on.
2) Make sure no USB Type-C cable is connected.
3) Short Pin1-2 of J11 and short Pin2-3 of J8 to connect a 5.1kΩ Rd to CC1.
4) To check the **CC Status** in the GUI, the MAX77978 should be in Source mode, and CC1 should be active.
5) Monitor the voltage of VBUS and check whether it equals 5.1V.

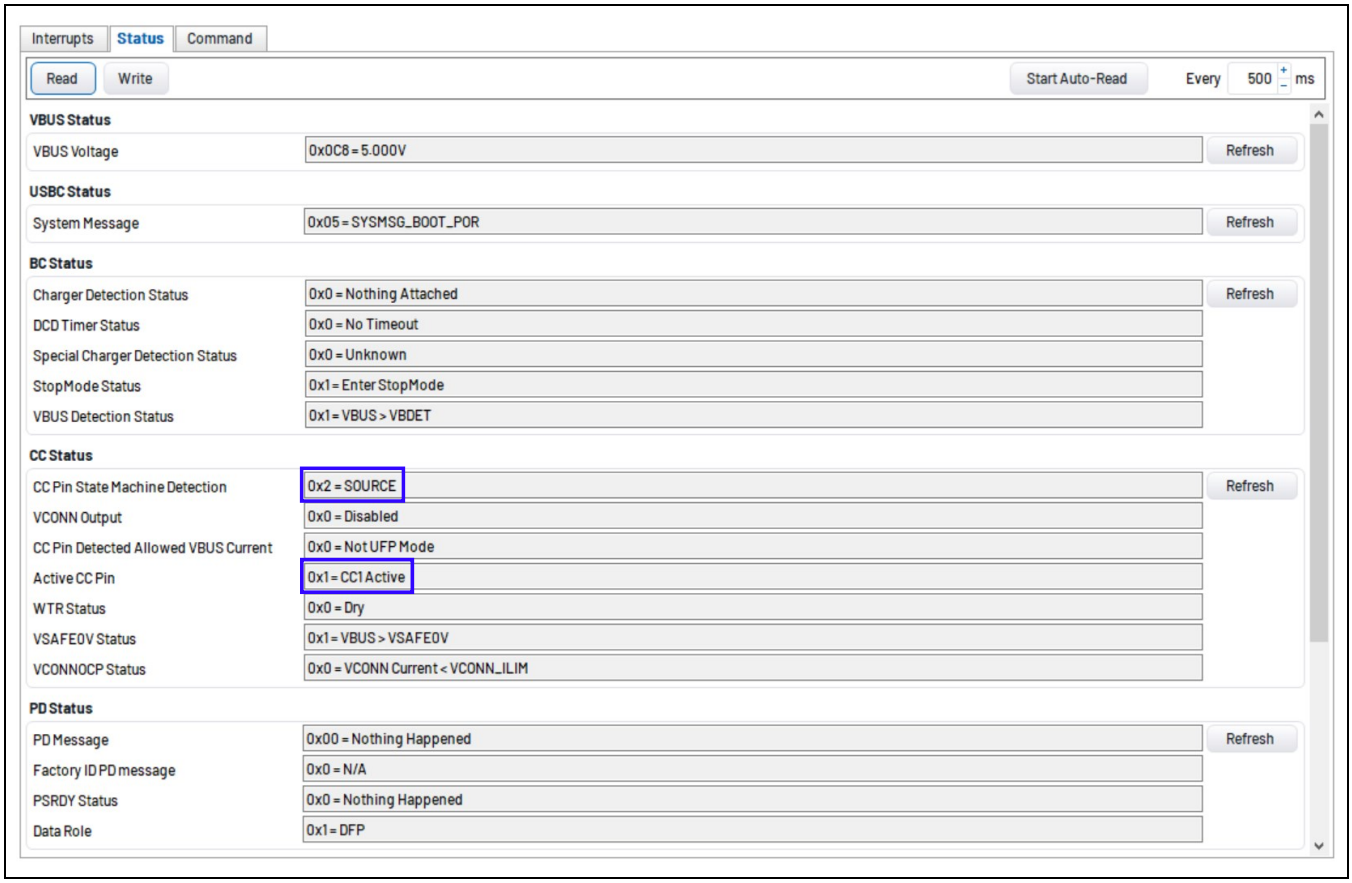



*Figure 9. Source Mode*

## BC1.2 Charger Type Detection

Plug in the USB Type-A to Type-C cable from a BC1.2 adapter or another legacy port, and check the **BC Status** under the status tab in the MAX77978 GUI to see whether the USBC detects the correct charge type. The BC1.2 Charger Type Detection result is shown in *Figure 10*.

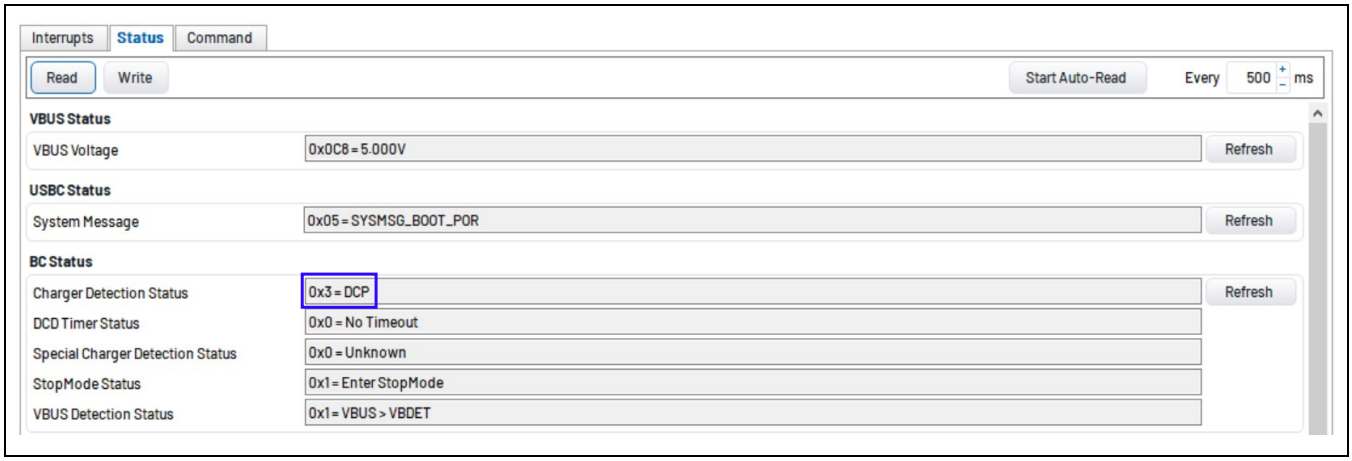



*Figure 10. BC Status after Connecting the DCP to the USB Type-C Connector of the EV Kit*

## Proprietary Charger Detection

Plug in the USB Type-A to Type-C cable from a proprietary charger and check the **BC Status** under the **Status** tab in the MAX77978 GUI to verify that the USBC detects the correct charge type. The **Special Charger Detection** result is shown in *Figure 11*.

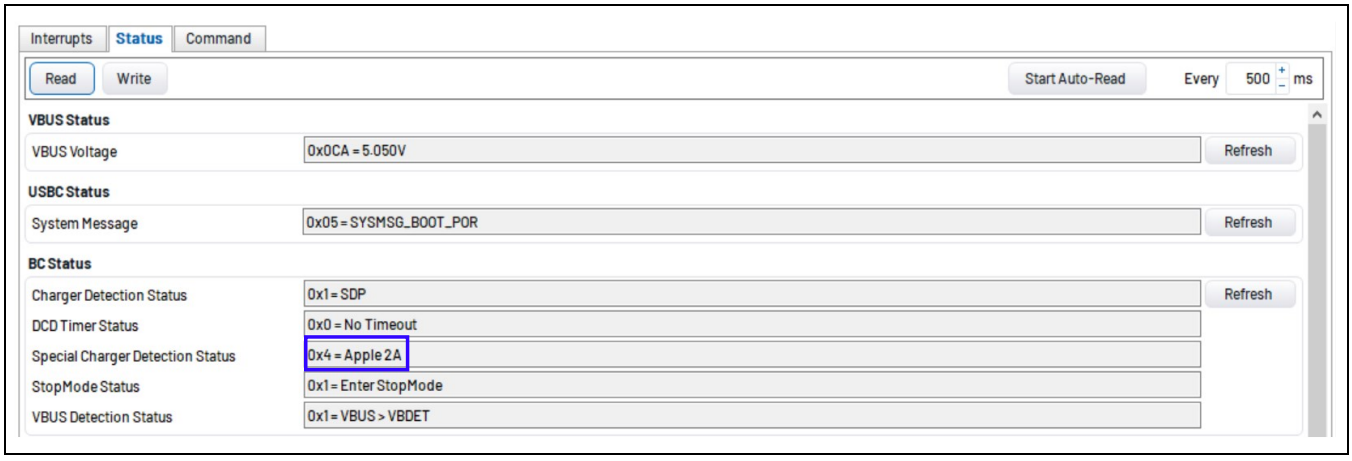



*Figure 11. Proprietary Charger Detection Status after Connecting the Apple 2A to the USB Type-C Connector of the EV Kit*

## USB Power Delivery Test

Source capability request function test.

1) Connect the USB Power Delivery AC adapter to the EV kit.
2) Use a voltmeter to monitor the voltage on VBUS.
3) Go to **Command** > **Current SrcCap (0x30)** and click the **Write** button to execute the command. The MAX77978 sends this command over the CC pin to the TA, which provides a list of available source capabilities. Additionally, the current PDO options are listed in *Figure 12* for PDO4: 15V/3A.
4) Review the source capabilities and note the desired PDO.

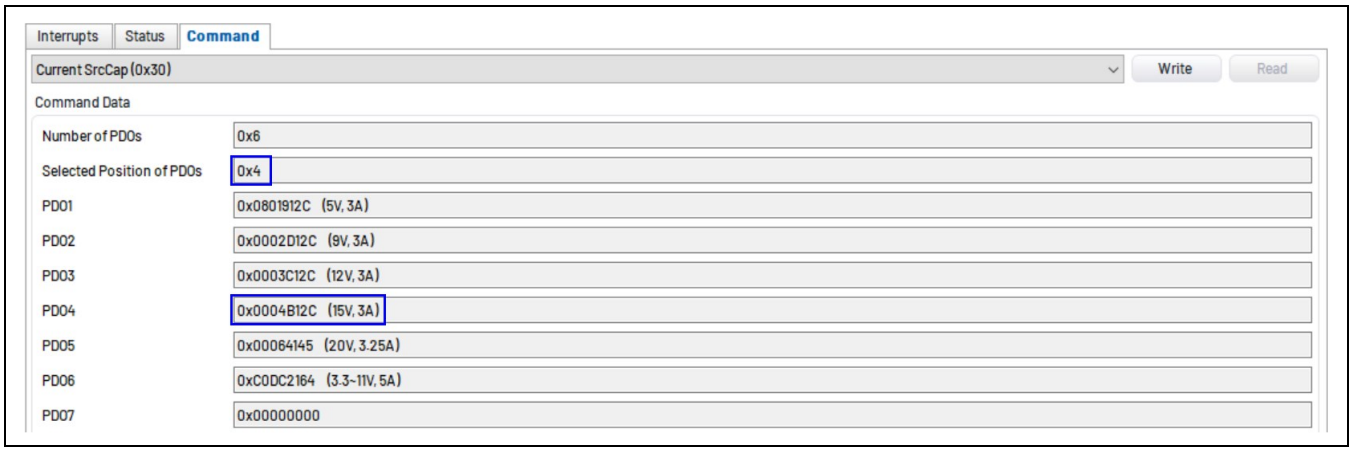



*Figure 12. Get Source Capability (Get SrcCap) Under the Command Section*

5) Go to **Command** > **SrcCap Request (0x32)** and enter “0x5” in the **Req PDO Position** field. Then, click the **Write** button to execute the command, as shown in *Figure 13*.

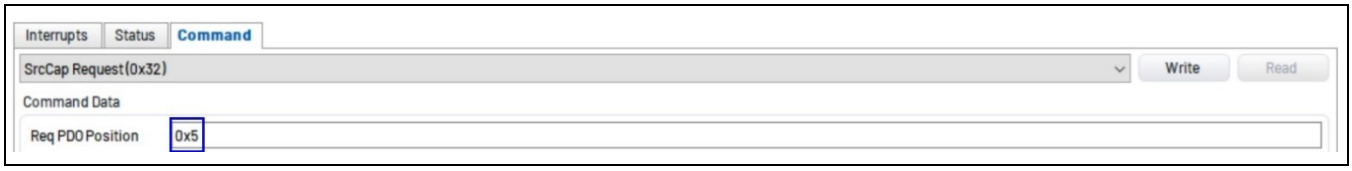



*Figure 13. Get Source Capability (Get SrcCap) Under the Command Section*

6) Go to **Command** > **Current SrcCap (0x30)** and click the **Write** button to execute the command. The MAX77978 sends this command over the CC pin to the TA, and the current PDO options are obtained, as shown in *Figure 14* for PDO5: 20V/3.25A.

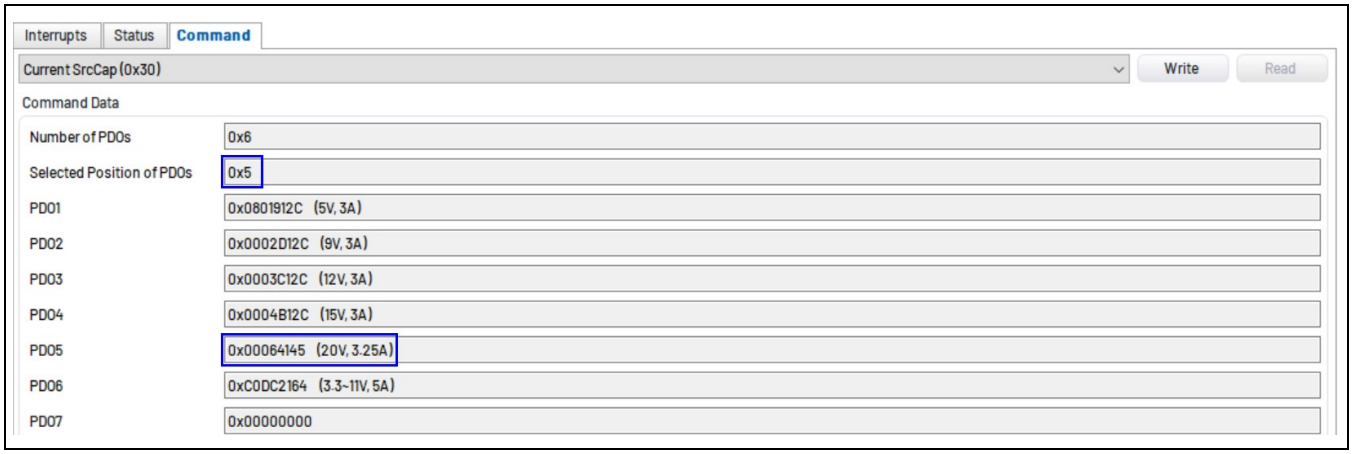



*Figure 14. Get Source Capability (Get SrcCap) Under the Command Section*

## I²C Controller Test

The MAX77978 EV kit is preconfigured with a test CUS script at the factory and autonomously operates. When the MAX77978 is configured as the Source, the MAX77963 automatically switches to reverse-buck mode and supplies 5.1V to VBUS. If the firmware is refreshed or the test CUS script is not loaded, manual configuration can be done through the Opcode command 0x86/0x86. For more configuration options for the MAX77963, refer to the *MAX77963* data sheet. Below are the steps to enable and disable the MAX77963 OTG mode through the Opcode command 0x86/0x86.

Connect the simulated battery between BATTP and BATTN, adjust the voltage to 7.6V, and turn it on.

Go to **Command > Controller I²C Control (0x85/0x86)**.

In the following fields, enter Save Address = 0xD2, Register = 0x16, Length = 0x01, and DATA0 = 0x8A.

Click on the **Write** button to execute the command.

The MAX77963 is in OTG mode, and the measured VBUS voltage should be 5.1V.

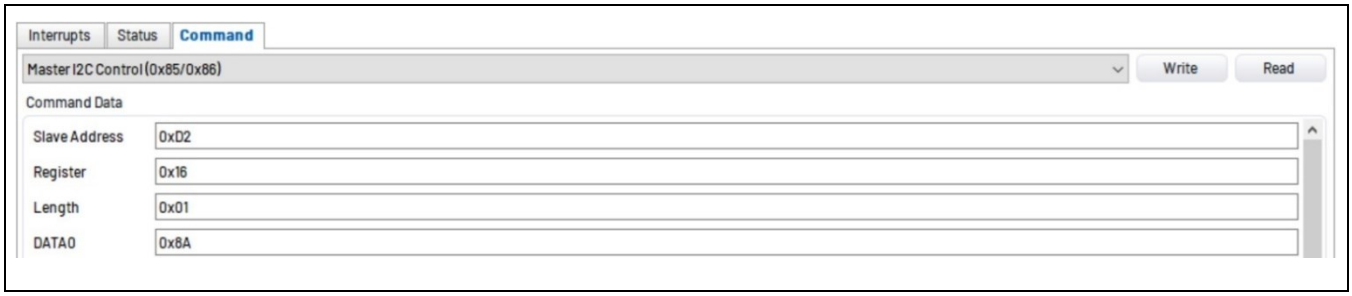



*Figure 15. Configure the OTG Mode for the MAX77963 (Device) Through the Opcode Command 0x85/0x86*

Go to **Command > Controller I²C Control (0x85/0x86)**.

In the following fields, enter Save Address = 0xD2, Register = 0x16, Length = 0x01, and DATA0 = 0x80.

Click on the **Write** button to execute the command.

The MAX77963 is disabled in all power conversions.

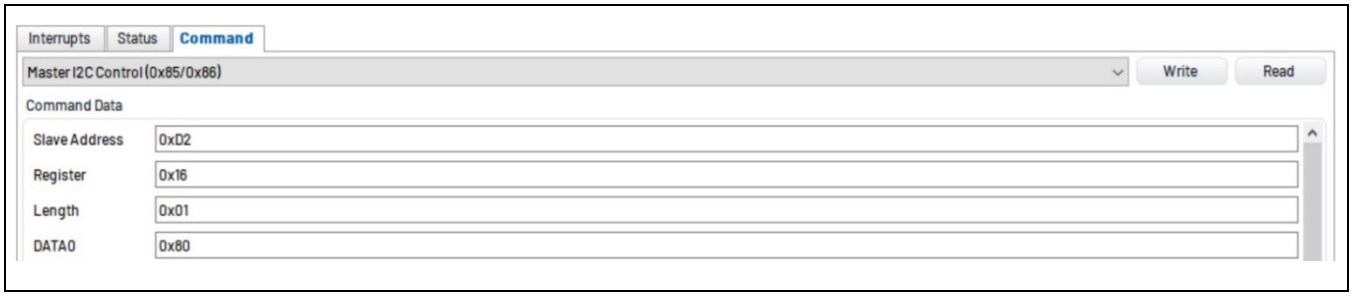



*Figure 16. Configure the MAX77963 (Device) to Disable all Power Conversions Through Opcode Command 0x85/0x86.*

## eUSB2-USB2.0 Repeater Test

The MAX77978 uses low-voltage processors to enable a USB 2.0-compliant port on the application processor. MAX77978 also integrates a USB-compliant eUSB2-USB 2.0 repeater that supports both device and host modes. It supports USB Low-Speed (LS), Full-Speed (FS), and High-Speed (HS) signals.

1) Connect the simulated battery between BATTP and BATTN, adjust the voltage to 7.6V, and turn it on.
2) Connect devices that support the eUSB2 protocol to the corresponding connectors. J1 is a Type-C connector, typically used for portable devices; J15 and J19 are SMP connectors, usually for oscilloscopes and function generators.
3) To send the Opcode command **EUSB_CTL (0x7D/0x7E)** through the GUI, enable the eUSB2 repeater module by setting **EUSB2_RPTR_EN** and enable the eUSB2 repeater auto resume functionality by setting **AUTO_RESUME_EN**, as shown in *Figure 17*.


*Figure 17. Turn on the Internal Switch's DN to eDN and DP to eDP*

4) To send the Opcode command **VENDOR_USBSW_CTRL (0x67/0x68)** through the GUI, turn on the internal switch's DN to eDN and DP to eDP as shown in *Figure 18*.
5) Opcode commands with the EUSB_ prefix optimize compensation for eUSB channel loss profiles, thereby improving jitter performance.

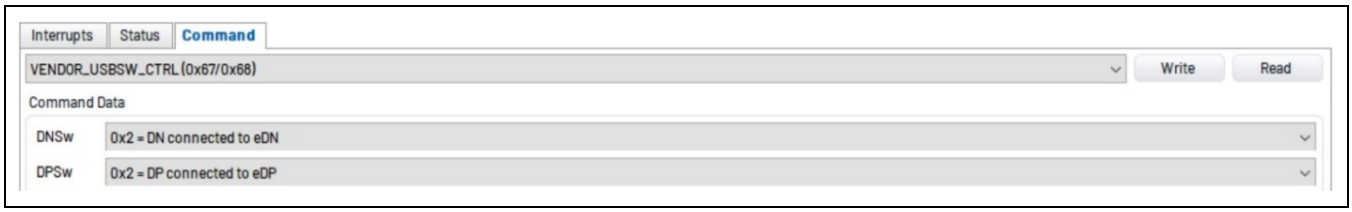



*Figure 18. Turn on the Internal Switch's DN to eDN and DP to eDP*

6) Opcode commands with the EUSB_ prefix are used to optimize compensation for eUSB channel loss profiles, thereby improving jitter performance.

## Extended Power Range (EPR) Mode Operations Test

With custom firmware for Sink EPR Mode, the MAX77978 can support Sink EPR mode operation. To operate in EPR mode, both the source and cable used should also be EPR-capable.

Using appropriate Opcodes, the MAX77978, acting as a Sink, can send an EPR_Mode Message with an action field of Enter or Exit and send an EPR_Request Message to the Source. The MAX77978 can also report the last EPR PDOs advertised by the Source and the last EPR_Mode Message from the Source.

1) Open J17 to isolate the MAX77978 VBUS and avoid triggering CHGINOVLO on MAX77963.
2) Connect J4 to a laptop to use the GUI and connect the battery simulator between BATTP and BATTN. Adjust the voltage to 7.6V and then turn it on.
3) Use **GUI** > **Tools** > **Firmware Update** to program the custom firmware for Sink EPR Mode to MAX77978. After completion, read the GUI **Interrupts** tab to confirm that the firmware version is FA.16.

   Custom Firmware for Sink EPR Mode: *secure_update_BC78_noCRC_FA160101_250401162437.bin*


*Figure 19. The FA.16 Firmware Version is Specifically Developed for EPR Testing*

4) Plug in an EPR-capable adapter with an EPR-capable cable. 5V is negotiated first. Reading the VBUS voltage in the **Status** tab confirms it.
5) Use Opcode **Set EPR Mode (0x84)** to send an EPR_Mode Message with the action field Enter.

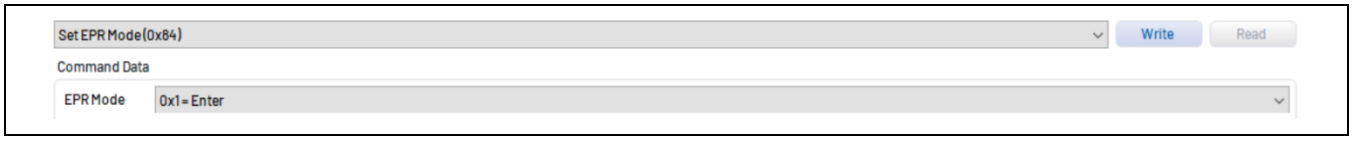



*Figure 20. Use Opcode Set EPR Mode (0x84) to Send a Message with 0x1 to Enter ERP Mode*

6) Use Opcode **EPR Result Read (0x83)** to verify that EPR mode has been entered successfully. Once EPR mode is entered, the MAX77978 periodically sends an EPR_KeepAlive Message.

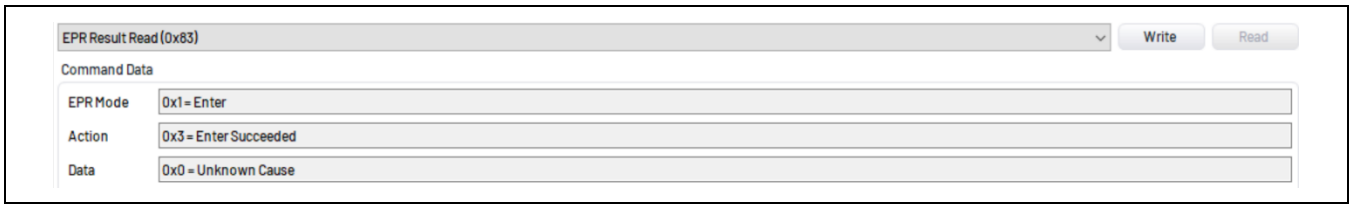



*Figure 21. EPR Mode is Entered Successfully*

7) Use Opcode **EPR SrcCap Request (0x82)** to request 28V, for example. According to the PD 3.2 Spec, EPR PDOs start at object position 8. PDO position 8 corresponds to 28V PDO. Reading the VBUS voltage in the **Status** tab confirms it.

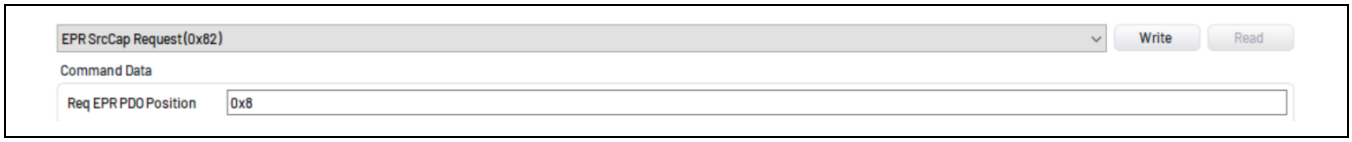



*Figure 22. Request 28V*

8) If the list of EPR PDOs advertised by the Source is needed, use Opcode **Current EPR SrcCap (0x80)**.

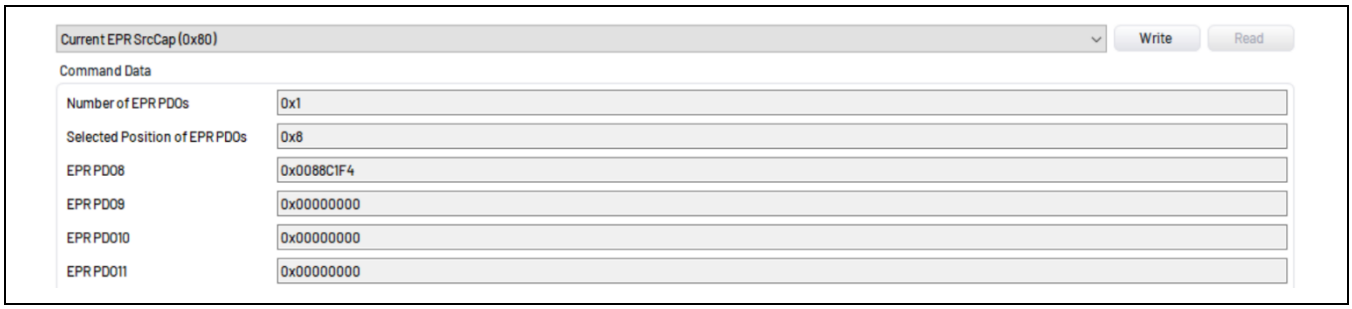



*Figure 23. Current EPR SrcCap (0x80)*

9) Before leaving EPR, a SPR PDO must be negotiated first. For example, use Opcode **EPR SrcCap Request (0x82)** to request 5V. Reading the VBUS voltage in the **Status** tab confirms it. To send an EPR_Request Message in accordance with the PD 3.2 Spec, although the requested PDO is SPR, Opcode **EPR SrcCap Request (0x82)** should be used.

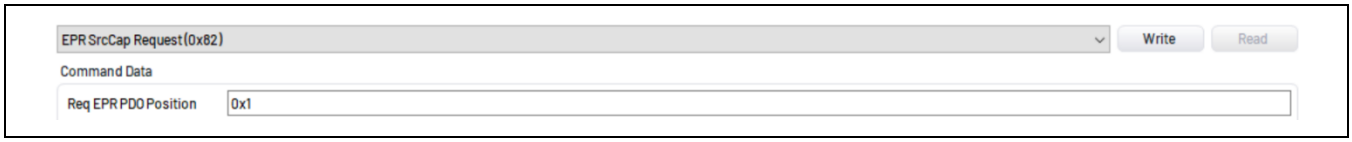



*Figure 24. Request 5V Before Leaving EPR Mode*

10) Use Opcode **Set EPR Mode (0x84)** to send an EPR_Mode Message with the action field set to Exit. Once EPR mode is exited, the MAX77978 stops sending an EPR_KeepAlive Message.

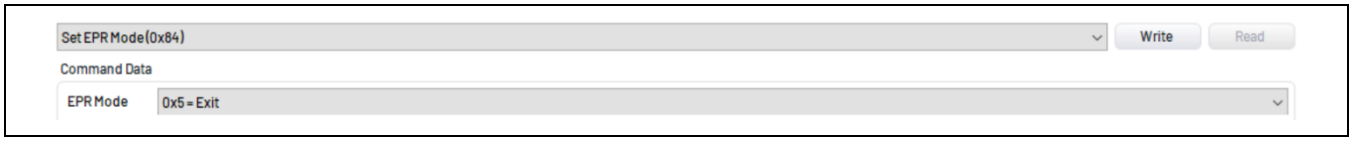



*Figure 25. Use Opcode Set EPR Mode (0x84) to Send a Message with 0x5 to Leave ERP Mode*

11) After completing the EPR test, if additional functionality tests for the MAX77978 are required, see the *Core Firmware Update* and the *Customization Script Update* sections. Flash the MAX77978 firmware using *secure_update_BC78_noCRC_01110101.bin* (v01.11) and the custom script using *max77978_P1_CUS_script.bin.* Then, connect J17 pins 3-5 and 4-6 to connect the MAX77978 VBUS to MAX77963 CHGIN.

## Ordering Information

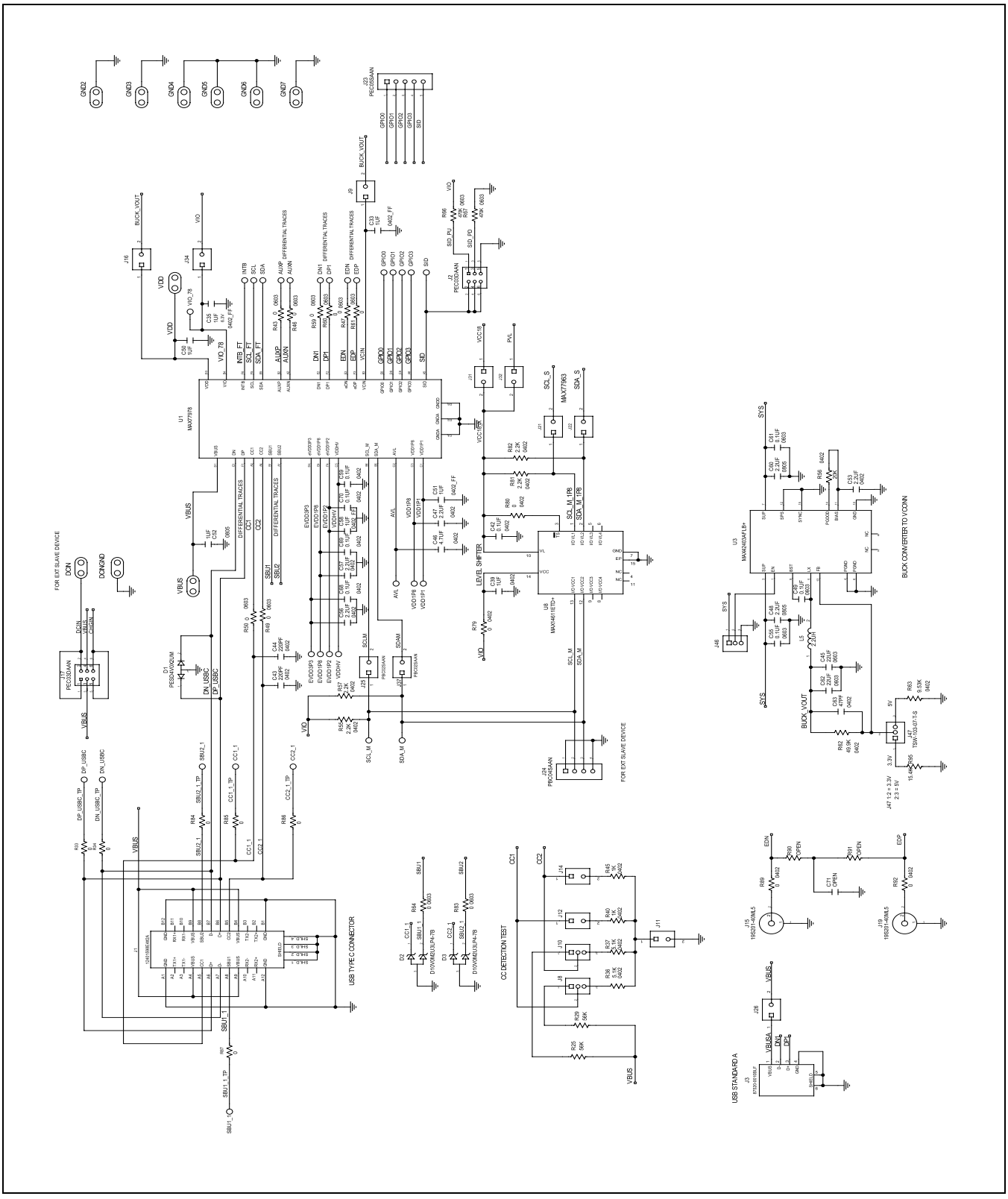
| PART | TYPE |
|---|---|
| MAX77978EVKIT# | EV Kit |

*#Denotes RoHS-compliant.*

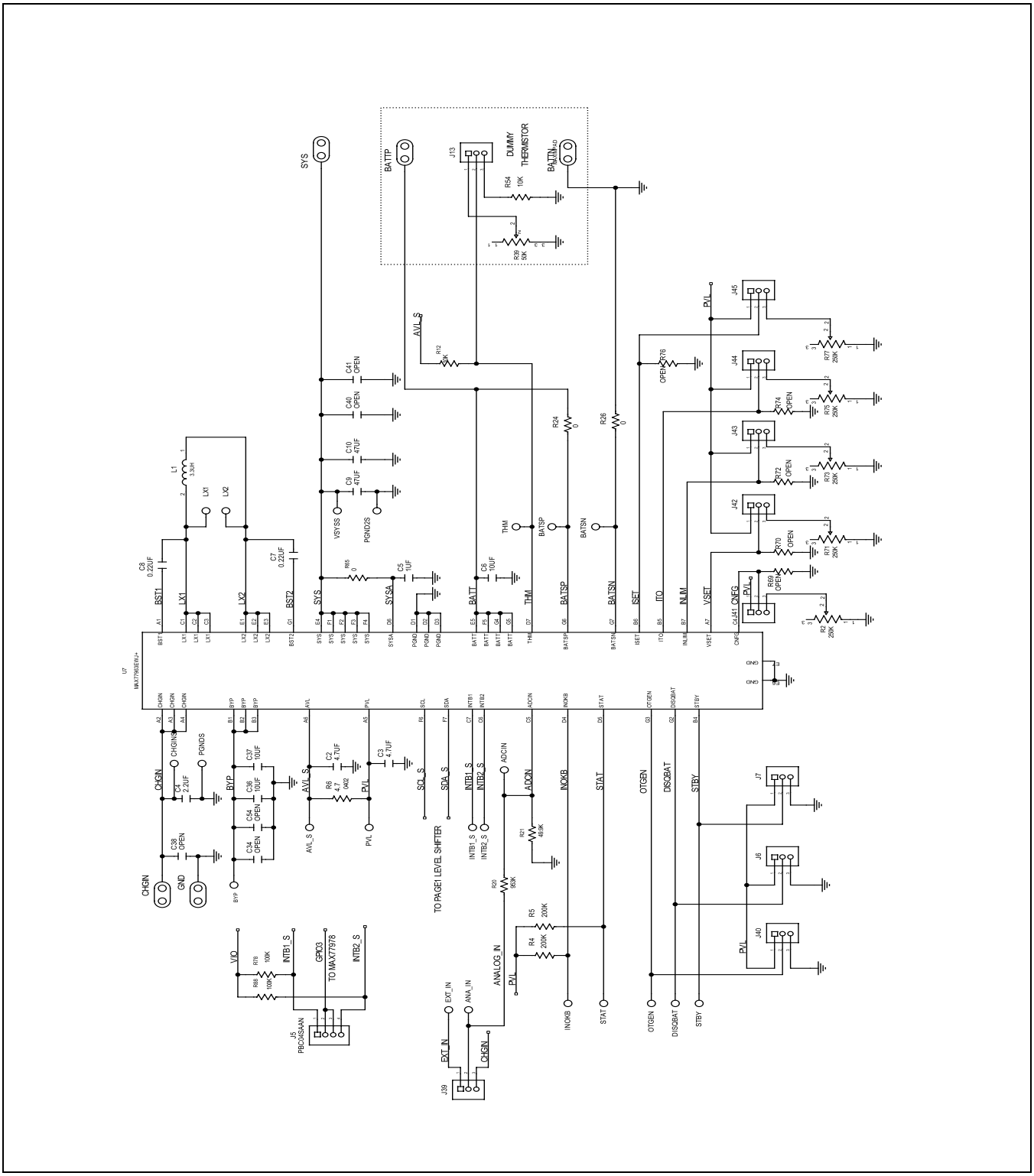
## MAX77978 EV Kit Bill of Materials

| ITEM | REF_DES | QTY | MFG PART # | MANUFACTURER | VALUE | DESCRIPTION |
|---|---|---|---|---|---|---|
| 1 | ADCIN, ANA_IN, AUXN, AUXP, AVL, AVL_S, BATSP, BYP, CC1_1, CC2_1, CHGINS, DISQBAT, DN1, DN_USBC, DP1, DP_USBC, EDN, EDP, EVDD1P2, EVDD1P8, EVDD3P3, EXT_IN, GPIO0-GPIO3, INOKB, INTB, INTB1_S, INTB2_S, LX1, LX2, OTGEN, PVL, SBU1_1, SBU2_1, SCL, SCL_M, SDA, SDA_M, SID, STAT, STBY, THM, VDD1P1, VDD1P8, VDDHV, VIO_78, VSYSS | 49 | 5000 | KEYSTONE | N/A | TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; |
| 2 | BATSN, PGND2S, PGNDS | 3 | 5001 | KEYSTONE | N/A | TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; |
| 3 | BATTN, BATTP, CHGIN, DCIN, DCINGND, GND, GND2-GND7, SYS, VBUS, VDD | 15 | 9020 BUSS | WEICO WIRE | MAXIMPAD | EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG |
| 4 | C1, C15, C18-C21, C23-C29, C42, C59, C66-C70 | 20 | GRM155R71A104JA01 | MURATA | 0.1UF | CAP; SMT (0402); 0.1UF; 5%; 10V; X7R; CERAMIC |
| 5 | C2, C3, C12, C13, C22 | 5 | ZRB15XR61A475ME01; CL05A475MP5NRN;GRM155R61A475MEAA;C1005X5R1A475M050BC | MURATA;SAMSUNG;MURATA;TDK | 4.7UF | CAP; SMT (0402); 4.7UF; 20%; 10V; X5R; CERAMIC |
| 6 | C4 | 1 | C1608X5R1V225K080AC;GRM188R6YA225KA12 | TDK;MURATA | 2.2UF | CAP; SMT (0603); 2.2UF; 10%; 35V; X5R; CERAMIC |
| 7 | C5 | 1 | GRM155C81E105KE11 | MURATA | 1UF | CAP; SMT (0402); 1UF; 10%; 25V; X6S; CERAMIC |
| 8 | C6 | 1 | GRM21BR61E106K;C2012X5R1E106K085AC125AB;C2012X5R1E106K085AC;TMK212BBJ106KG;CL21A106KAFN3N | MURATA;TDK;TDK;TAIYO YUDEN;SAMSUNG | 10UF | CAP; SMT (0805); 10UF; 10%; 25V; X5R; CERAMIC |
| 9 | C7, C8 | 2 | GRM155R71C224KA12 | MURATA | 0.22UF | CAP; SMT (0402); 0.22UF; 10%; 16V; X7R; CERAMIC |
| 10 | C9, C10 | 2 | TMK325ABJ476MM | TAIYO YUDEN | 47UF | CAP; SMT (1210); 47UF; 20%; 25V; X5R; CERAMIC |
| 11 | C11, C14 | 2 | C0402C0G500270JNP; GRM1555C1H270JA01 | VENKEL LTD.;MURATA | 27PF | CAP; SMT (0402); 27PF; 5%; 50V; C0G; CERAMIC |
| 12 | C16, C17, C30-C32, C39, C64, C65 | 8 | C0402C105K8PAC;CC0402KRX5R6BB105 | KEMET;YAGEO | 1UF | CAP; SMT (0402); 1UF; 10%; 10V; X5R; CERAMIC |
| 13 | C33, C35, C51, C58 | 4 | ANY | ANY | 1UF | CAPACITOR; SMT (0402); CERAMIC CHIP; 1UF; 6.3V; TOL=10%; MODEL=; TG=-55 DEGC TO +85 DEGC; TC=X5R; |
| 14 | C36, C37 | 2 | CGA5L1X7R1V106K160AC;CGA5L1X7R1V106K160AC160AC;GMJ316BB7106KLH | TDK;TDK;TAIYO YUDEN | 10UF | CAP; SMT (1206); 10UF; 10%; 35V; X7R; CERAMIC |
| 15 | C43, C44 | 2 | GRM155R71H221KA01;C1005X7R1H221K050BA | MURATA;TDK | 220PF | CAP; SMT (0402); 220PF; 10%; 50V; X7R; CERAMIC |
| 16 | C45, C62 | 2 | C1608X5R1A226M080AC;GRM188R61A226ME15;CL10A226MPCNUBE;CL10A226MPMNUB;GRM187R61A226ME15 | TDK;MURATA;SAMSUNG;SAMSUNG;MURATA | 22UF | CAP; SMT (0603); 22UF; 20%; 10V; X5R; CERAMIC |
| 17 | C46 | 1 | C1005X5R1A475K050 | TDK | 4.7UF | CAP; SMT (0402); 4.7UF; 10%; 10V; X5R; CERAMIC |
| 18 | C47, C53, C57 | 3 | GRM155R61C225KE44;GRM155R61C225KE11 | MURATA;MURATA | 2.2UF | CAP; SMT (0402); 2.2UF; 10%; 16V; X5R; CERAMIC |
| 19 | C48, C60 | 2 | C2012X7R1H225K125AC | TDK | 2.2UF | CAP; SMT (0805); 2.2UF; 10%; 50V; X7R; CERAMIC |
| 20 | C49, C55, C61 | 3 | CC0603KRX7R0BB104;GRM188R72A104KA35;HMK107B7104KA;06031C104KAT2A;GRM188R72A104K | YAGEO;MURATA;TAIYO YUDEN;AVX;MURATA | 0.1UF | CAP; SMT (0603); 0.1UF; 10%; 100V; X7R; CERAMIC |
| 21 | C50 | 1 | C1005X5R1V105K050BC;MSASG105AB5105KFNA01 | TDK | 1UF | CAPACITOR; SMT (0402); CERAMIC CHIP; 1UF; 35V; TOL=10%; TG=-55 DEGC TO +85 DEGC; TC=X5R |
| 22 | C52 | 1 | C2012X7S2A105K125AB;GRJ21BC72A105KE11;GRM21BC72A105KE01 | TDK;MURATA;MURATA | 1UF | CAP; SMT (0805); 1UF; 10%; 100V; X7S; CERAMIC |
| 23 | C56 | 1 | C1005X5R1V225K050BC;GRM155R6YA225KE11 | TDK;MURATA | 2.2UF | CAP; SMT (0402); 2.2UF; 10%; 35V; X5R; CERAMIC |
| 24 | C63 | 1 | GRM1555C1E470JA01 | MURATA | 47PF | CAP; SMT (0402); 47PF; 5%; 25V; C0G; CERAMIC |
| 25 | D1 | 1 | PESD4V0X2UM | NEXPERIA | PESD4V0X2UM | DIODE; TVS; SMT (DFN1006-3); VRWM= 4V; IPP=11.5A |
| 26 | D2, D3 | 2 | D10V0M2U3LP4-7B | DIODES INCORPORATED | D10V0M2U3LP4-7B | EVKIT PART - DIODE; TVS; SMT (X2-DFN1006-3) |
| 27 | DS2 | 1 | LTST-C191KRKT | LITE-ON ELECTRONICS INC. | LTST-C191KRKT | DIODE; LED; SMD LED; RED; SMT (0603); VF=2V; IF=0.02A |
| 28 | DS3 | 1 | LTST-C190KFK | LITE-ON ELECTRONICS INC | LTST-C190KFK | DIODE; LED; ULTRA BRIGHT CHIP LEAD; ORANGE; SMT (0603); VF=2V; IF=0.02A |
| 29 | J1 | 1 | 12401598E4#2A | AMPHENOL | 12401598E4#2A | CONNECTOR; FEMALE; THROUGH HOLE; USB 3.1; GEN2; TYPE C RECEPTACLE; RIGHT ANGLE; 24PINS |
| 30 | J2, J17 | 2 | PEC03DAAN | SULLINS ELECTRONICS CORP. | PEC03DAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 6PINS; -65 DEGC TO +125 DEGC |
| 31 | J3 | 1 | 87520-0010BLF | FCI CONNECT | 87520-0010BLF | CONNECTOR; FEMALE; THROUGH HOLE; USB RECEPTACLE; RIGHT ANGLE; 4PINS |
| 32 | J4 | 1 | 10118193-0001LF | FCI CONNECT | 10118193-0001LF | CONNECTOR; FEMALE; SMT; MICRO USB B TYPE RECEPTACLE; RIGHT ANGLE; 5PINS |
| 33 | J5, J24 | 2 | PBC04SAAN | SULLINS ELECTRONICS CORP. | PBC04SAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 4PINS; -65 DEGC TO +125 DEGC |
| 34 | J6-J8, J10, J13, J39-J47 | 14 | TSW-103-07-T-S | SAMTEC | TSW-103-07-T-S | CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 3PINS |
| 35 | J9, J11, J12, J14, J16, J18, J20-J22, J25-J35, J37, J38 | 22 | PBC02SAAN | SULLINS ELECTRONICS CORP. | PBC02SAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 2PINS |
| 36 | J15, J19 | 2 | 19S201-40ML5 | ROSENBERGER | 19S201-40ML5 | CONNECTOR; MALE; SMT; PLUG PCB LIMITED DETENT; RIGHT ANGLE; 2 PINS |
| 37 | J23 | 1 | PEC05SAAN | SULLINS ELECTRONICS CORP. | PEC05SAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 5PINS |
| 38 | J36 | 1 | PEC04DAAN | SULLINS ELECTRONICS CORP. | PEC04DAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 8PINS |
| 39 | L1 | 1 | XAL4030-332ME | COILCRAFT | 3.3UH | INDUCTOR; SMT; COMPOSITE; 3.3UH; 20%; 6.60A |
| 40 | L2-L4 | 3 | BLM18AG601SN1 | MURATA | 600 | INDUCTOR; SMT (0603); FERRITE-BEAD; 600; TOL=+/-; 0.5A |
| 41 | L5 | 1 | XFL4020-222ME | COILCRAFT | 2.2UH | INDUCTOR; SMT; METAL COMPOSITE CORE; 2.2UH; TOL=+/-20%; 8A; -40 DEGC TO +125 DEGC |
| 42 | MISC1 | 1 | AK67421-2 | ASSMANN | AK67421-2 | CABLE; MALE; USB; USB2.0 MICRO CONNECTION CABLE; USB B MICRO MALE TO USB A MALE; 2000 MILLIMETERS; 5PINS-4PINS |
| 43 | Q1 | 1 | PMV37ENEA | NEXPERIA | PMV37ENEA | TRAN; NCH; 60 V; N-CHANNEL TRENCH MOSFET; SOT-23; PD-(0.71W); I-(3.5A); V-(60V) |
| 44 | R1, R7, R14-R16, R18, R22, R24, R26, R32-R34, R44, R53, R58, R68, R79, R80, R84-R87, R89, R92 | 24 | ERJ-2GE0R00 | PANASONIC | 0 | RES; SMT (0402); 0; JUMPER; JUMPER; 0.1000W |
| 45 | R2, R71, R73, R75, R77 | 5 | 3296W-1-254LF | BOURNS | 250K | RES; THROUGH HOLE-RADIAL LEAD; 250K; 10%; +/-100PPM/DEGC; 0.5W |
| 46 | R4, R5, R23 | 3 | CRCW0402200KFK; RF73H1ELTP2003 | VISHAY DALE;KOA SPEER ELECTRONICS | 200K | RES; SMT (0402); 200K; 1%; +/-100PPM/DEGC; 0.0630W |
| 47 | R6 | 1 | CRCW04024R70FK | VISHAY DALE | 4.7 | RES; SMT (0402); 4.7; 1%; +/-100PPM/DEGC; 0.0630W |
| 48 | R8 | 1 | CRCW04212K0FK;MCR01MZPF1202 | VISHAY DALE;ROHM SEMICONDUCTOR | 12K | RES; SMT (0402); 12K; 1%; +/-100PPM/DEGC; 0.0630W |
| 49 | R9, R13 | 2 | RC0402FR-0727RL | YAGEO | 27 | RES; SMT (0402); 27; 1%; +/-100PPM/DEGC; 0.0630W |
| 50 | R10 | 1 | CRCW04021M00FK | VISHAY DALE | 1M | RES; SMT (0402); 1M; 1%; +/-100PPM/DEGC; 0.0630W |
| 51 | R11, R40, R45 | 3 | RC0402FR-071KL;MCR01MZPF1001 | YAGEO;ROHM SEMICONDUCTOR | 1K | RES; SMT (0402); 1K; 1%; +/-100PPM/DEGC; 0.0630W |
| 52 | R12, R54, R94 | 3 | RC0402FR-0710KL;CR0402-FX-1002GLF | YAGEO;BOURNS | 10K | RES; SMT (0402); 10K; 1%; +/-100PPM/DEGC; 0.0630W |
| 53 | R17 | 1 | CRCW04024752FK; SC04021A4752FLHF3; CRCW040247K5FK | VISHAY DALE;YAGEO;VISHAY DALE | 47.5K | RES; SMT (0402); 47.5K; 1%; +/-100PPM/DEGC; 0.0630W |
| 54 | R19, R31, R41, R78, R88 | 5 | CRCW0402100KFK;RC0402FR-07100KL | VISHAY;YAGEO | 100K | RES; SMT (0402); 100K; 1%; +/-100PPM/DEGC; 0.0630W |
| 55 | R20 | 1 | ERJ-3EKF9533;CRCW0603953KFK | PANASONIC;VISHAY | 953K | RES; SMT (0603); 953K; 1%; +/-100PPM/DEGC; 0.1000W |
| 56 | R21 | 1 | ERJ-2RKF4992 | PANASONIC | 49.9K | RES; SMT (0402); 49.9K; 1%; +/-100PPM/DEGC; 0.1000W |
| 57 | R25, R29 | 2 | ERJ-2RKF5602 | PANASONIC | 56K | RES; SMT (0402); 56K; 1%; +/-100PPM/DEGC; 0.0630W |
| 58 | R27, R28 | 2 | CRCW04024K70FK;MCR01MZPF4701 | VISHAY DALE;ROHM SEMICONDUCTOR | 4.7K | RES; SMT (0402); 4.7K; 1%; +/-100PPM/DEGC; 0.0630W |
| 59 | R30 | 1 | CRCW0402169KFK | VISHAY DALE | 169K | RES; SMT (0402); 169K; 1%; +/-100PPM/DEGK; 0.0630W |
| 60 | R35 | 1 | CRCW04024707FK | VISHAY DALE | 470 | RES; SMT (0402); 470; 1%; +/-100PPM/DEGC; 0.0630W |
| 61 | R36, R37 | 2 | CRCW04025K10FK | VISHAY DALE | 5.1K | RES; SMT (0402); 5.1K; 1%; +/-100PPM/DEGC; 0.0630W |
| 62 | R38, R42, R55, R57, R81, R82 | 6 | RC0402FR-072K2L | YAGEO | 2.2K | RES; SMT (0402); 2.2K; 1%; +/-100PPM/DEGC; 0.0630W |
| 63 | R39 | 1 | 3296W-1-503LF | BOURNS | 50K | RESISTOR; THROUGH-HOLE-RADIAL LEAD; 50K OHM; 10%; 100PPM; 0.5W; MOLDER CERAMIC OVER METAL FILM |
| 64 | R43, R46, R47, R49, R50, R59-R61, R64, R83 | 10 | CRCW06030000Z0EAHP | VISHAY DRALORIC | 0 | RES; SMT (0603); 0; JUMPER; JUMPER; 0.2500W |
| 65 | R48 | 1 | ERJ-2GEJ132 | PANASONIC | 1.3K | RES; SMT (0402); 1.3K; 5%; +/-200PPM/DEGC; 0.1000W |
| 66 | R56 | 1 | CRCW040220K0FK | VISHAY DALE | 20K | RES; SMT (0402); 20K; 1%; +/-100PPM/DEGC; 0.0630W |
| 67 | R62 | 1 | 9C04021A4992FLHF3;RC0402FR-0749K9L | YAGEO;YAGEO | 49.9K | RES; SMT (0402); 49.9K; 1%; +/-100PPM/DEGC; 0.0630W |
| 68 | R63 | 1 | CRCW04029K53FK | VISHAY DALE | 9.53K | RES; SMT (0402); 9.53K; 1%; +/-100PPM/DEGC; 0.0630W |
| 69 | R65 | 1 | RC0402JR-070RL; CR0402-16W-000RJT | YAGEO PHYCOMP;VENKEL LTD. | 0 | RES; SMT (0402); 0; 5%; JUMPER; 0.0630W |
| 70 | R66, R67 | 2 | CRCW0603470KFK | VISHAY DALE | 470K | RES; SMT (0603); 470K; 1%; +/-100PPM/DEGC; 0.1000W |
| 71 | R93 | 1 | SR1206JR-7W120RL | YAGEO | 120 | RES; SMT (1206); 120; 5%; +/-200PPM/DEGK; 0.5000W |
| 72 | R95 | 1 | ERJ-2RKF1542 | PANASONIC | 15.4K | RES; SMT (0402); 15.4K; 1%; +/-100PPM/DEGC; 0.1000W; |
| 73 | U1 | 1 | MAX77978 | ANALOG DEVICES | MAX77978 | EVKIT PART - IC; STANDALONE USB TYPE-C AND USB POWER DELIVERY CONTROLLER; WLP30;PACKAGE OUTLINE: 21-100767; PACKAGE CODE: W363H3+1 |
| 74 | U2 | 1 | FT2232HL | FUTURE TECHNOLOGY DEVICES INTL LTD. | FT2232HL | IC; MMRY; DUAL HIGH SPEED USB TO MULTIPURPOSE UART/FIFO; LQFP64 |
| 75 | U3 | 1 | MAX42403AFLB+ | ANALOG DEVICES | MAX42403AFLB+ | EVKIT PART - IC; MAX42403AFLB+; PACKAGE CODE: F15SB3FY+1; PACKAGE OUTLINE DRAWING:21-100532; PACKAGE LAND PATTERN:90-100188; FC2QFN15 |
| 76 | U4, U8-U10 | 4 | MAX14611ETD+ | MAXIM | MAX14611ETD+ | IC; TRANS; QUAD BIDIRECTIONAL LOW-VOLTAGE LOGIC LEVEL TRANSLATOR; TDFN14-EP |
| 77 | U5, U6 | 2 | MAX8512EXK+ | MAXIM | MAX8512EXK | IC, VREG, Ultra-Low-Noise, High PSRR, Adjustable Vout, SC70-5 |
| 78 | U7 | 1 | MAX77963EWJ+ | MAXIM | MAX77963EWJ+ | EVKIT PART -IC; MAX77963EWJ+; 23VIN 3.2A OUT USB-C BUCK-BOOST CHARGER WITH INTEGRATED FETS FOR 2S/3S LI-ION BATTERIES; PACKAGE OUTLINE DRAWING: 21-100558; PACKAGE CODE: W493H3Z+1 |
| 79 | Y1 | 1 | 7M-12.000MAAJ | TXC CORPORATION | 12MHZ | CRYSTAL; SMT; 12MHZ; 18PF; TOL = +/-30PPM; STABILITY = +/-30PPM |
| 80 | PCB | 1 | MAX77978 | MAXIM | PCB | PCB:MAX77978 |
| 81 | C71 | 0 | N/A | N/A | OPEN | CAPACITOR; SMT (0402); OPEN; FORMFACTOR |
| 82 | R3, R69, R70, R72, R74, R76, R90, R91 | 0 | N/A | N/A | OPEN | RESISTOR; 0402; OPEN; FORMFACTOR |
| 83 | C34, C38, C40, C41, C54 | 0 | N/A | N/A | OPEN | CAPACITOR; SMT (1210); OPEN; IPC MAXIMUM LAND PATTERN |
| TOTAL | | 288 | | | | |

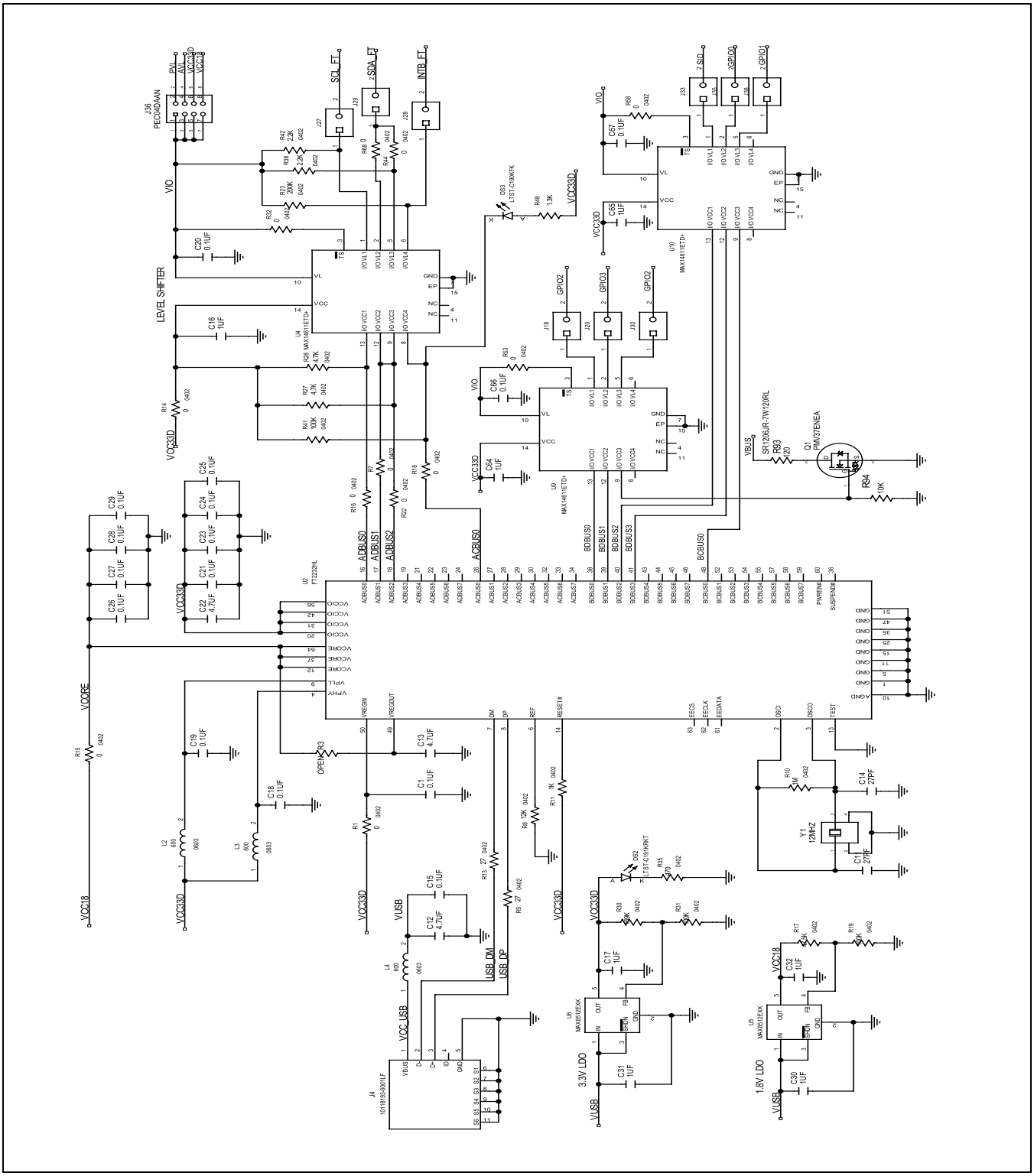
## MAX77978 EV Kit Schematic



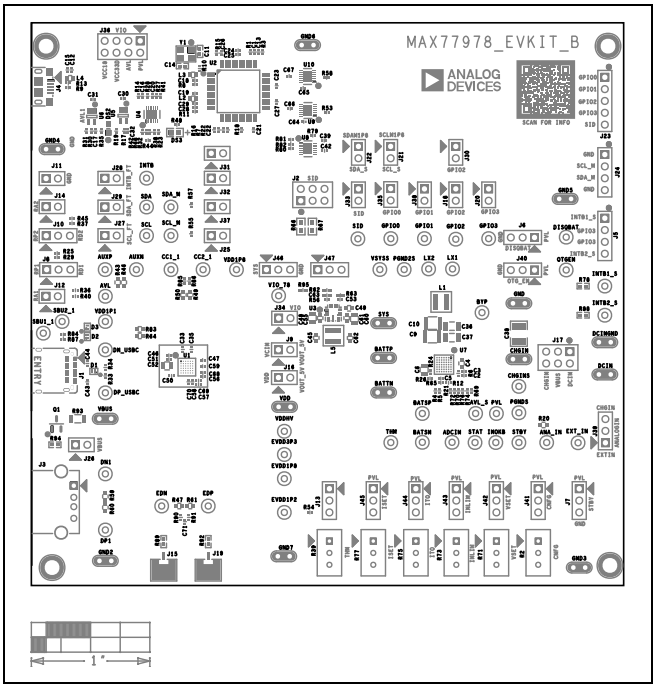
## MAX77978 EV Kit Schematic (continued)



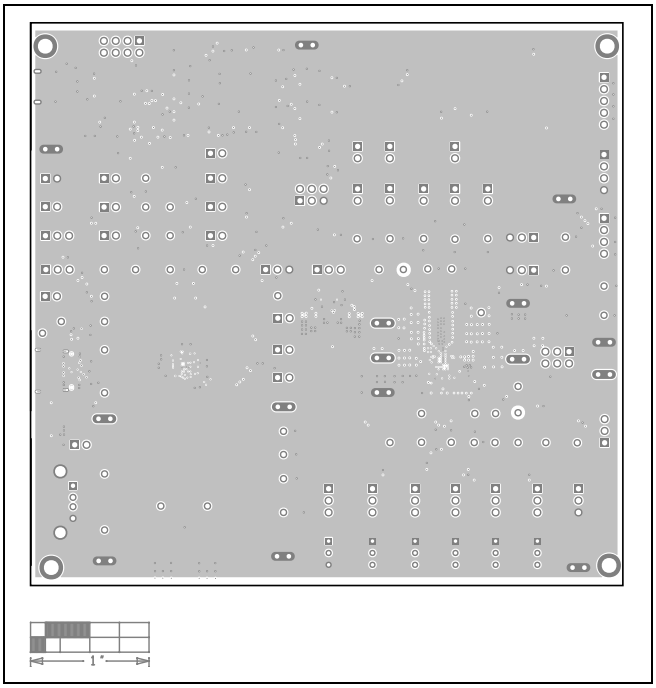
## MAX77978 EV Kit Schematic (continued)



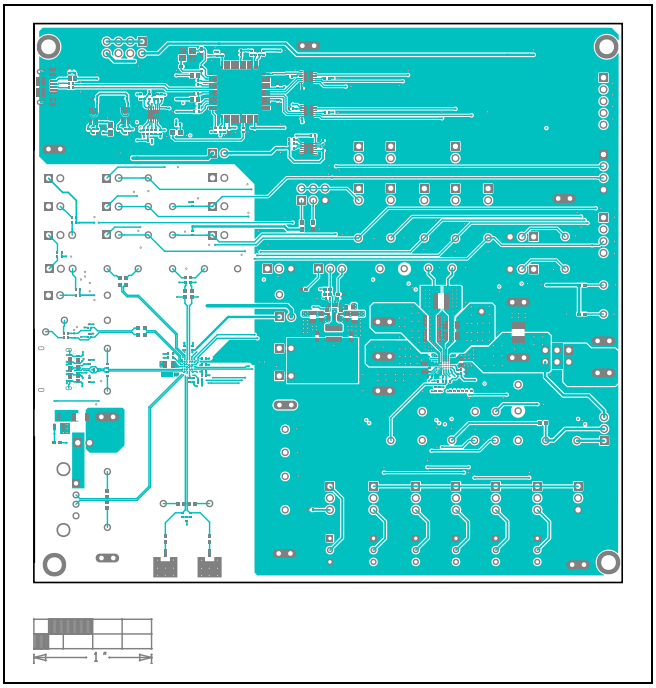
## MAX77978 EV Kit PCB Layout



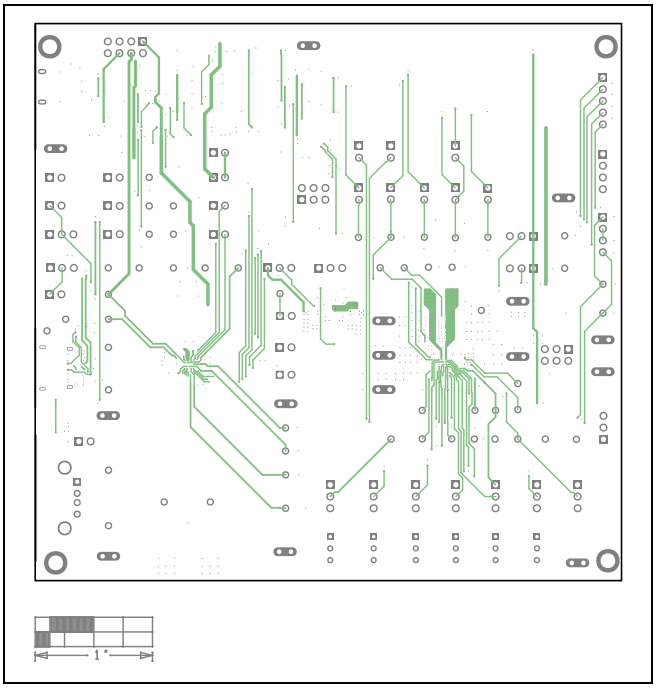

*MAX77978 EV Kit Component Placement Guide—Top Silkscreen*



*MAX77978 EV Kit PCB Layout—Layer 2*

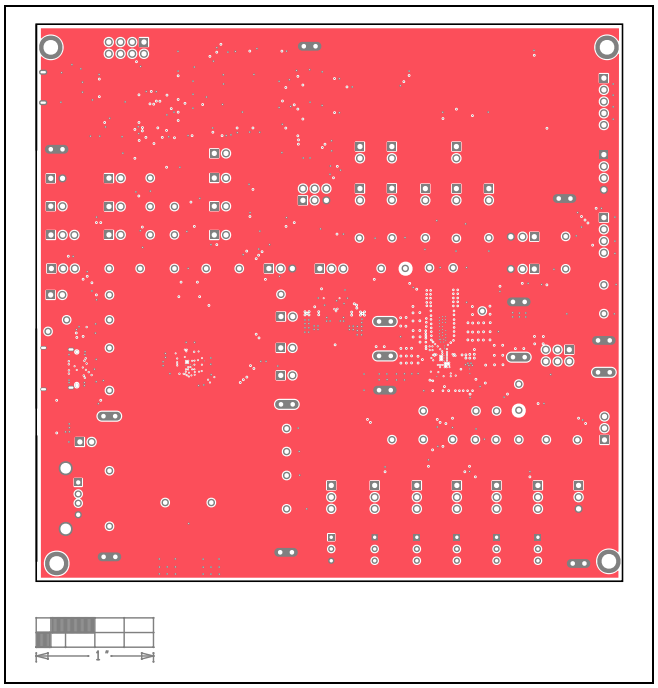


*MAX77978 EV Kit PCB Layout—Top Layer*

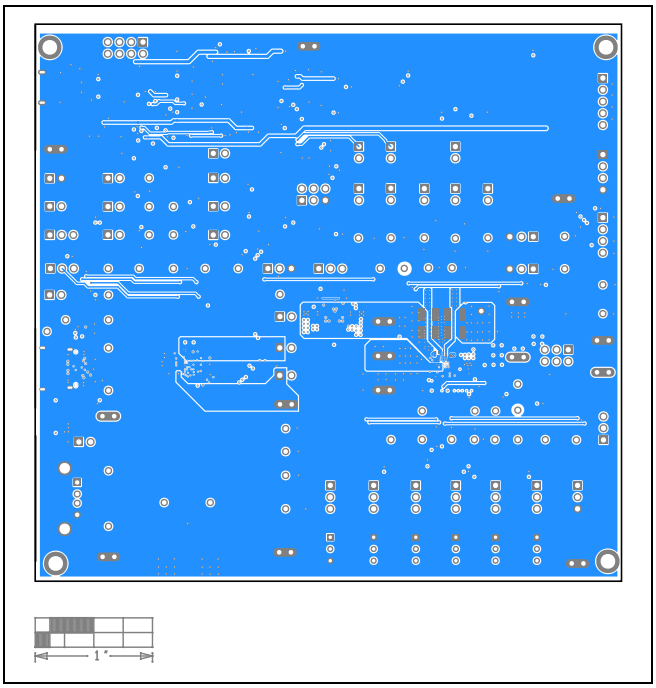


*MAX77978 EV Kit PCB Layout—Layer 3*

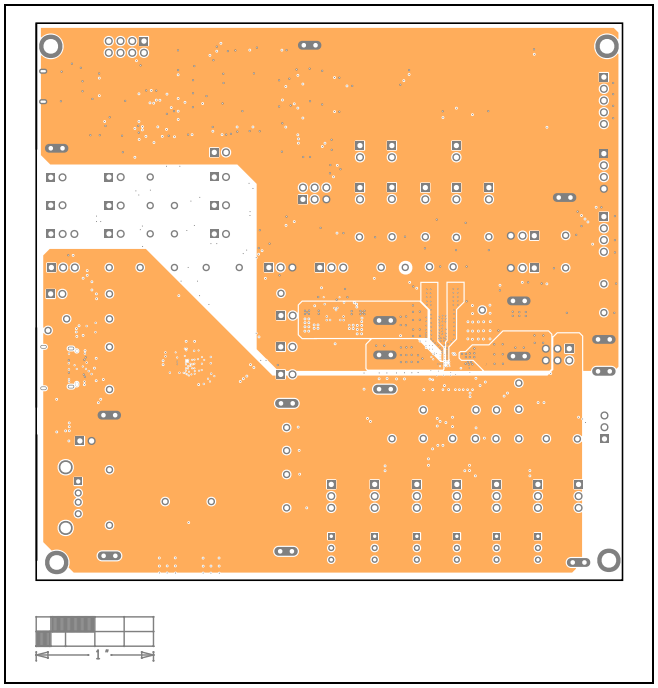
## MAX77978 EV Kit PCB Layout (continued)



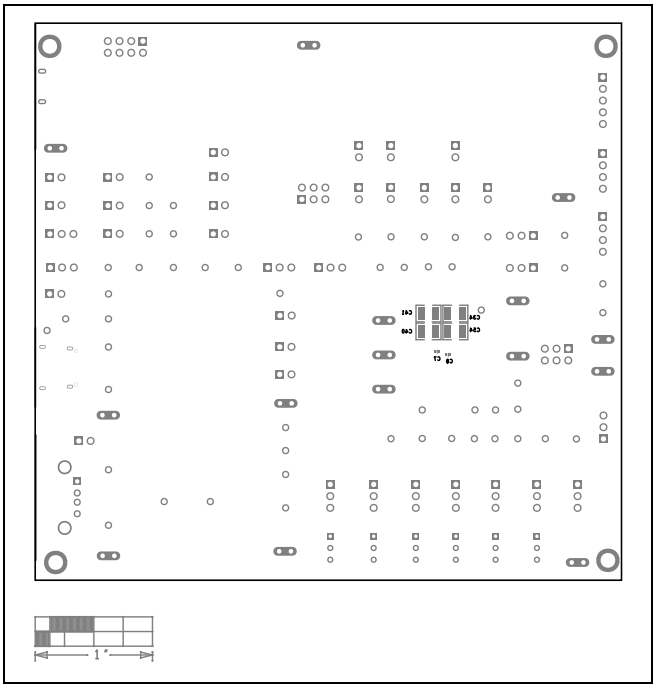
*MAX77978 EV Kit PCB Layout—Layer 4*



*MAX77978 EV Kit PCB Layout—Bottom Layer*



*MAX77978 EV Kit PCB Layout—Layer 5*



*MAX77978 EV Kit Component Placement Guide—Bottom Silkscreen*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 5/26 | Initial release | — |

## Notes