

## Evaluates: MAX77789

#### **General Description**

The MAX77789 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that evaluates the MAX77789, standalone 3.15A USB Type-C<sup>®</sup> and I<sup>2</sup>C configurable charger in WLP Package.

The MAX77789 EV kit includes the IC evaluation board, USB micro-B cable, and MAXUSB\_INTERFACE# board. The MAXUSB\_INTERFACE# board allows the use of Windows<sup>®</sup> based graphical user interface (GUI) software with the EV kit and can be downloaded from Maxim's website at <u>www.analog.com/en/products/MAX77789.html</u> (under the *Design & Development* tab). Windows 7 or newer Windows operating system is required to use the EV kit software.

#### **Features**

- Evaluates the MAX77789 USB Type-C Autonomous Charger for Single Cell Li-Ion Battery
- 4.6V to 13.4V Input Operating Range
- Supports Charging Current Up to 3.15A
- Demonstrates 5V, 1.5A OTG Mode, and BYP Reverse Boost
- Includes On-Board Thermistor Options to Validate
   JEITA Compliance
- Demonstrates USB Type-C Power Source Detection and Sink Devices
- Demonstrates Spread Spectrum
- Easy Evaluation of Factory Ship Mode
- MAXUSB\_INTERFACE# Allows Easy Communication with a Windows PC
- GUI Software that Drives the I<sup>2</sup>C Serial Interface for Optional Software Control

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



#### MAX77789 EV Kit Photo

Figure 1. MAX77789 EV Kit Photo

USB Type-C is a registered trademark of USB Implementers Forum.

Windows is a registered trademark and registered service mark of Microsoft Corporation.

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#### MAX77789 EV Kit Files

SOFTWARE	DESCRIPTION
MAX77789GUISetupX.X.X.exe	Installs the EV kit software on PC

#### MAX77789 EV Kit Component List

HARDWARE	QTY	DESCRIPTION
MAX77789 EV kit	1	MAX77789 evaluation kit
USB high-speed A-to- B cable	1	USB Micro-B cable
MAXUSB interface board	1	Interface for the MAX77789 EV kit software

#### **Quick Start**

#### **Required Equipment**

- MAX77789 evaluation kit
- USB Type-C travel adapter and cable
- USB Micro-B cable
- MAXUSB interface board
- PC with Windows 7 or newer operating system and USB port
- Battery or battery simulator
- Power supply
- Oscilloscope
- Multimeters

#### Setup Overview

A typical bench setup for the MAX77789 EV kit is shown in *Figure 2*.

#### Procedure

The EV kit is fully assembled and tested. Follow the steps to verify the board operation. Use twisted wires that are as short as possible to connect the battery and power sources. Make sure the PC is connected to the internet throughout the process so that the USB driver can be automatically installed.

**Note:** Do not turn on the DC power supply until all connections are made.

- 1) Visit <u>www.maximintegrated.com/products/MAX77789</u> under the *Design & Development* tab to download the latest version of the MAX77789 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 MAX77789GUISetupX.X.X.exe program inside the temporary folder. This copies the program files and creates an icon in the Windows <u>Start</u> menu. The software requires the .NET Framework 4.5 or later. If connected to the internet, Windows automatically updates the .NET Framework as needed.
- The EV kit software launches automatically after installation, and it can be launched by clicking on its icon in the Windows <u>Start</u> menu.
- Make jumper connections based on the default position column in <u>Table 1</u>. Change it later when evaluating more features.
- 5) Plug in the MAXUSB interface board into the connector J10 on the EV kit.
- Use the USB Micro B cable provided with the EV kit to connect the MAXUSB interface board to the PC's USB port.

Connect a 1-cell battery or simulated battery to the connectors labeled BATT and GND2. Connect a DC power supply to the connectors labeled CHGIN and GND6. Note that CHGIN can come from three sources (the Micro-USB connector, the USB Type-C connector, or the CHGIN loop), but only one of these sources should be connected at any time. Take note that if CHGIN comes from the CHGIN loop, the GUI must be connected, and the BC1.2 dependency register under the BC/CC control tab must be written to 1, then the EV kit can be powered up successfully, whereby the STAT1 and INOKB LEDs lit up. This is not required for the Micro-USB connector or the USB Type-C connector.

BC1.2 dependency from Type C 1 = BC1.2 is now independent of type C

- 7) Launch the MAX77789 GUI software.
- Select Device→Connect from the window options to connect to the EV kit.

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Figure 2. MAX77789 EV Kit Board Connections

#### Table 1. Jumper Connection Guide

JUMPER NUMBER	DEFAULT POSITION	FUNCTION
		Short 1-2: Connect THM pin to a variable resistor
10		Short 3-4: Connect THM pin to a thermistor
J3	Short 3-4	Short 5-6: Connect THM pin to a fixed value resistor 10K
		Short 7-8: Connect THM pin to GND
		Short 1-2: Connect SDA, SCL pins to MAXUSB interface module
J4, J5	Short 1-2	Short 3-4: Connect SDA, SCL pins to VCC18
		Short 5-6: Connect SDA, SCL pins to GND
		Short 1-2: Connect INTB pin to MAXUSB interface module
J6	Short 3-4	Short 3-4: Connect INTB pin to VCC18
		Short 5-6: Connect INTB pin to GND
J7	Short 1-2	Short 1-2: Connect on-board LDO input to BATT
		Short 1-2: Connect CC1 to 10K pull-up resistor
J8	Open	Short 3-4: Connect CC1 to 22K pull-up resistor
		Short 5-6: Connect CC1 to 56K pull-up resistor
		Short 1-2: Connect CC2 to 10K pull-up resistor
J9	Open	Short 3-4: Connect CC2 to 22K pull-up resistor
00		Short 5-6: Connect CC2 to 56K pull-up resistor
14.4	Onen	Short 1-2: Connect EXTSM pin to SYS
JII	Open	Short 3-4: Connect EXTSM pushbutton to BATT
J12	Short 5-6	Short 1-2: Connect STBY pin to VCC18 (for USB suspend mode)
J13	Open	Short 1-2: Connect CC2 pin to 5.1K pull-down resistor
J14	Open	Short 1-2: Connect 5.1K pull-down resistors to GND
J15	Open	Short 1-2: Connect CC1 pin to 5.1K pull-down resistor
147	Short 2.2	Short 1-2: Connect VCC18 to MAXUSB interface module
JIT	Short 2-3	Short 2-3: Connect VCC18 to on-board LDO output
J18	Short 1-2	Short 1-2: Connect STAT2 pin to LED and pull-up resistor
J19	Short 1-2	Short 1-2: Connect STAT1 pin to LED and pull-up resistor
J20	Short 1-2	Short 1-2: Connect INOKB pin to LED and pull-up resistor
104	Short 2.2	Short 1-2: Connect OVLOA pin to resistor divider
JZT	Short 2-3	Short 2-3: Connect OVLOA pin to GND
100	Short 2.2	Short 1-2: Connect OVLOB pin to pull-up resistor
JZZ	SHULL 2-3	Short 2-3: Connect OVLOB pin to GND
100	Short 2.2	Short 1-2: Connect OTG_ENA pin to pull-up resistor
JZO	Short 2-3	Short 2-3: Connect OTG_ENA pin to GND

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104	Short 0.2	Short 1-2: Connect OTG_ENB pin to pull-up resistor
JZ4	Short 2-3	Short 2-3: Connect OTG_ENB pin to GND
105	Short 0.2	Short 1-2: Connect PCON pin to pull-up resistor
J25	Short 2-3	Short 2-3: Connect PCON pin to GND
106	Chart 0.0	Short 1-2: Connect OVP_ENB pin to pull-up resistor
JZO	Short 2-3	Short 2-3: Connect OVP_ENB pin to GND
		Short 1-2: Connect VCCEN pin to pull-up resistor
J27	Short 5-6	Short 3-4: Connect VCCEN pin to STAT2
		Short 5-6: Connect VCCEN pin to GND

#### **Detailed Description of Software**

The MAX77789 GUI software provides an easy-to-use interface to control the function blocks of the IC.

#### Software Installation

Double-click the **MAX77789GUISetupX.X.X.exe** icon to begin the installation process. Follow the prompts to complete the installation. The evaluation software can be uninstalled in the <u>Add/Remove Programs</u> tool in the <u>Control Panel</u>. After the installation is complete, open the **Analog Devices/MAX77789** folder and run **MAX77789.exe** or select it from the program menu. <u>Figure 3</u> shows a splash screen containing information about the evaluation kit that appears while the program is loading.

		ANALOG
MAX77789 USB	Type-C Charger EV Kit	
Version 1.0.0		
Copyright (C) Analo All rights reserved.	og Devices, Inc.	
Website: www.an	alog.com	
Support: support	.analog.com	
Disable Splasl	h Screen	

Figure 3. Splash Screen

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#### **Establish Communication**

Power up the MAX77789 by connecting a 1-cell battery or simulated battery at BATT/GND. Open the GUI software and select **Device** $\rightarrow$ **Connect**. A window should pop up showing that a slave address 0xD2 has been found. If not, check the USB connection and power. Choose **Read and Close** and the status bar displays "Connected" to signify active communication. An example of a successful connection is shown in *Figure 4*.

ynchroni	ze		×			
Currently nd devic	connected to FTDI "FTDIN e "MAX77789".	IPSSE"			Start Auto-Read Every 500 + ms In	clude R/C Registers
heck sl	aves vou want to synchron	ize:				
51ave	Address 0xD2 on I2C bus		evisio	on : 0x1 Version : 0x00		Refresh
			۲	Masked		Refresh
				C Masked		Mask
			t 🎯	Masked		Unmask
				Masked Masked		
	Read and Close	Close		Masked		
	4	Top Status Indicator	r			
		SYSUVLO Status In	ndicator	1 = SYS voltage is above SYSUVLO threshold		Refresh
		SYSOVLO Status In	ndicator	1 = SYS voltage is below SYSOVLO threshold		
		Thermal Shutdown	n Status Indicator	1 = Device is not in thermal shutdown		
		Software Reset				
		Software Reset	0x00			Read
						Write

Figure 4. Communication Window

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#### Main Display

Status bits and programmable functions of the charger can be accessed through the interface tabs in the left column of the window as shown in *Figure 5*. Follow the guidance on the MAX77789 IC data sheet for the usage of each register.

File Device Options Too	is Help							
<u>Top</u> Charger	Read Write			Start Auto-Read	Every	500 <mark>+</mark> m	s 📄 Include R/	C Registers
<ul> <li>Interrupts/Status</li> </ul>	Device Identification							
<ul> <li>Details</li> <li>Configurations 0-3</li> </ul>	(Not Yet Read)						(	Refresh
Configurations 4-7	TOP Interrupt							
Configurations 8-12     Configurations 13-15	SYSUVLO Interrupt	۲	C Masked					Refresh
USBC	SYSOVLO Interrupt		C Masked					Mask
<ul> <li>Interrupts/Status</li> <li>Details</li> <li>BC/CC Control</li> </ul>	Thermal Shutdown Interrupt	۲	C Masked					Unmask
	Charger Interrupt	۲	C Masked					_
	CC Interrupt	۲	C Masked					
	BC Interrupt	۲	C Masked					
	Top Status Indicator							
	SYSUVLO Status Indicator		1 = SYS voltage is above SYSUVLO threshold					Refresh
	SYSOVLO Status Indicator		1 = SYS voltage is below SYSOVLO threshold					
	Thermal Shutdown Status Indi	cator	1 = Device is not in thermal shutdown					
	Software Reset							
	Software Reset 0x00							Read
								Write
								W
				1				

Figure 5. Top-Level Registers

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#### **Register Explorer**

To view the ICs register map, select the **Tools** $\rightarrow$ **Register Explorer** menu from the main window. The value of all control registers is displayed and updated automatically when changes are made using the GUI.

Double-click on register or bit names to open the selection to manually program the ICs registers. Writeable registers are indicated with a teal-colored background in the **Meaning** column as shown in <u>Figure 6</u>.

▼ Write ▼ Reset ▼   Copy Paste	Deselect Select	Show Bits	Settings 🔹				
Import/Export Search							
MAX77789	Slave	Register	Name	Hex	Meaning	Description	 
CHGR	CHGR	0xA0	CID	0x50		CHIP ID	
CHGR	CHGR	0xA1	CHIP_REVISION	0x10			
TOP	CHGR	0xA2	SWRST	0x00			
L. USBC	CHGR	0xA3	TOP_INT	0x00			
	CHGR	0xA4	TOP_INT_MASK	0x3F			
	CHGR	0xA5	TOP_INT_OK	0x07			
	CHGR	0xB0	CHG_INT	0x00			
	CHGR	0xB1	CHG_INT_MASK	0xFF			
	CHGR	0xB2	CHG INT OK	0xFF			
	CHGR	0xB3	CHG DTLS 00	0x00			
	CHGR	0xB4	CHG DTLS 01	0x00			
	CHGR	0xB5	CHG DTLS 02	0x00			
	CHGR	0xB6	CHG DTLS 03	0x00			
	CHGR	0x87	CHG_CNEG_00	0x05			
	CHCR	0v89	CHG_CNEG_01	0x80			
	CHOR	0,00	CHG_CNEG_02				
	CHOR	0,09	CHG_CNFG_02	0,04			
	CHGR		CHG_CNFG_03	0,00			
	CHGR	UXBB	CHG_CNFG_04	86X0			
	CHGR	0XBC	CHG_CNFG_05	UXEE			
	CHGR	UXBD	CHG_CNFG_06	0000			
	CHGR	0xBE	CHG_CNFG_07	0x48			
	CHGR	0xBF	CHG_CNFG_08	0x02			
	CHGR	0xC0	CHG_CNFG_09	0x13			
	CHGR	0xC1	CHG_CNFG_10	0x85			
	CHGR	0xC2	CHG_CNFG_11	0x01			
	CHGR	0xC3	CHG_CNFG_12	0x20			
	CHGR	0xC4	USB_TYPE_DTLS	0x00			
	CHGR	0xC5	USB_ILIM_DTLS	0x00			
	CHGR	0xC6	CHG_CNFG_13	0x04			
	CHGR	0xC7	CHG_CNFG_14	0x7C			
	CHGR	0xC8	BC_CTRL1	0x09			
	CHGR	0xC9	BC_CTRL2	0x00			
	CHGR	0xCA	CC_CTRL1	0x09			
	CHGR	0xCB	BC_INT	0x00			
	CHGR	0xCC	CC_INT	0x00			
	CHGR	0xCD	BC_INTMASK	0x87			
	CHGR	0xCE	CC_INTMASK	0x6D			
	CHGR	0xCF	BC_STATUS1	0x00			
	CHGR	0xD0	CC_STATUS1	0x00			

Figure 6. Register Explorer

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#### **Register Dashboard**

A **Register Dashboard** is also provided under **Tools** $\rightarrow$ **Register Dashboard**. In this interface, clicking on the empty slots allows the user to display specific registers of interest and their values in a compact window, as shown in <u>Figure 7</u>.

				Europe Eoo + ma Displudo B/C Bogisto	
er CHGR/CH	G_DTLS_01/ 0x0 = Charger in dead	d b	(Empty)	Sian Auto-Read	Every 500 - ms include Ric Registe
tails	G_CNFG_00/ 0x5 = Charger on, Buc	ck	(Empty)		Defee
nfigura			(Empty)		Refres
nfigura			(Empty)		
onfigura			(Empty)		Refres
errupts/Status	Thermal Shutdown Interrupt		Masked		Mask
etails	Charger Interrupt	ŏ	Masked		Unmas
	CC Interrupt		Masked		
	BC Interrupt		C Masked		
	Top Status Indicator				
	SYSUVLO Status Indicator		1 = SYS voltage is above SYSUVLO threshold		Refres
	SYSOVLO Status Indicator		1 = SYS voltage is below SYSOVLO threshold		
	Thermal Shutdown Status India	cator	1 = Device is not in thermal shutdown		
	Software Reset				
	Software Reset 0x00				Read
					Write

Figure 7. Register Dashboard

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#### **Detailed Description of Hardware**

#### **Battery Charger Test Setup**

1. Connect a 1-cell battery pack or simulated battery between BATT and GND2. For the battery simulator, adjust the voltage to 3.8V with a 3.5A current limit, and turn it on.

Note: Only use a battery pack with a charge termination voltage that matches the setting on the board (see step 8).

- 2. Connect the MAXUSB interface board to J10 on the EV kit. Then connect the MAXUSB interface board to the PC with a USB Micro-B cable.
- 3. Connect the DC power supply between CHGIN and GND6 on the EV kit board.
- 4. Adjust voltage and current limits of the DC power supply to 5.0V and 3.5A. Output of the power supply is off.
- 5. Open the EV kit software and connect to the EV kit (**Device**→**Connect**).
- 6. In this case, since CHGIN is coming from the CHGIN loop, set BC1.2 dependency from Type C under the BC/CC Control tab. Then click Write to send the command. If CHGIN come from a USBC or Micro USB source, then this step can be skipped.

MAX///89 USB Type-C Charge File Device Options Too!	s Help									
Тор	Interrupts/Status Details BC/CC Control									
Interrupts/Status	Read Write		Start Auto-Read Every	/ 500 <mark>+</mark> ms						
<ul> <li>Details</li> <li>Configurations 0-3</li> </ul>	BC Control 1	C Control 1								
Configurations 4-7     Configurations 8-12	Enable Charger Detection 1 = BC1.2 runs automatically when CHGIN valid Rea									
Configurations 13-15	BC1.2 dependency from Type C     1 = BC1.2 is now independent of type C									
USBC • Interrupts/Status • Details • BC/CC Control	Data contact detection time out									
	BC Control 2									
	CDP non-standard type-C control 0 = No r	nodification of CHGIN_INLIM		Read						
	SDP non-standard type-C cable control 0x0 = No mod	tification of CHGIN_INLIM	~	Write						
	CHGIN_INLIM control options 0 = No gating of CHGIN_INLIM setting by BC1.2 FSM									
	BC Control 3									
	DP/DN automatic configuration 1 = DP/DN conf	gured by CCstat is 0x02(source) (DP is 3.3V & DN is 3.3V)		Read						
	DNDrv 0x0 = GROUND ( 15k	resistor to GND)	~	Write						
	DPDrv 0x0 = GROUND ( 15k	resistor to GND)	~							
	DPDNMan 0 = Resources on DP and DN are controlled by charger detection(ChgDetEn bit)									
	CC Control									
	Enable CC pin detection	💽 1 = Enable		Read						
	OTG_EN	1 = Reverse Boost Enabled Via CCStat Bit		Write						
	Enabling DFP Current Source when detecting SNK Device	I = Low Power Mode								
	DRP Mode setting	0x3 = DRP Mode	~							
	Try Sink Functionality	1 = Try.SNK Enabled								
	CC No Connection									
	CC Force Error	0 = Normal Operation		Read						
				Write						
		MAX77780 EV Ki+		Connected						

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7. Set Charger Settings Protection under the Configuration 4-7 tab to 0x3 = Write capability unlocked. Click Write to send the command. Note that 0x3 must be written to unlock the charger register setting.

e Device Options Tool	s Help										
p	Interrupts/Status Details	Configurations 0-3	Configurations 4-7	Configurations 8-12	Configurations 13-15						
arger Interrupts/Status	Read Write					Start Auto-Read	Every 500				
Details Configurations 0-3	Charger Configurations 4										
Configurations 4-7 Configurations 8-12	Charge Termination Voltage	Setting 0x18 =	= 4.2 V				Write				
Configurations 13-15 ISBC     Interrupts/Status     Details     BC/CC Control	Charger Configurations 5	Charger Configurations 5									
	Battery overcurrent threshold	Battery overcurrent threshold 0xE = 6.0A ~									
	Charger Configurations 6										
	Watchdog Timer Clear	0x0 = Watchdog time	er is not cleared				~ Read				
	Charger Settings Protectio	0x3 = Write capability	y unlocked				~ Write				
	AICL Disable feature 0 = AICL feature is enabled										
	LX slope control options	oxo = Fastest v									
	BATT to SYS Over-current	0 = 6ms debou	nce time								
	Charger Configurations 7										
	Factory Ship Mode	0 = No factory	/ ship mode				Rear				
	Thermal regulation threshol	0x9 = 130°C					~ Write				
	QBAT FET control	QBAT FET control 0 = Watchdog timer expires turn off only charger									
			MAX77789 FV Kit	•			Connect				

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8. Program the appropriate charger settings for your system. CHGIN input current limit can be programmed with CHGIN\_ILIM by setting Bypass USBC control for INLIM to 1.

In the Configuration 8-12 tab, set CHGIN input current limit (CHGIN\_ILIM) in the Charger Configurations 9 register. Click Write to send the command to the charger. Note that the maximum setting of the CHGIN input current limit for the MAX77789 is 0x7F = 3200mA.

lon	Intervente/Status Details Configurations 0.2 Configurations 0.42 Configurations 0.42								
Charger	interrupts/status Details Configurations 0-3 Configurations 4-7 Configurations 0-12 Configurations 0-12								
<ul> <li>Interrupts/Status</li> </ul>	Read Write Start Auto-Read	Every 500							
Details     Configurations 0-3	Charger Configurations 8								
Configurations 4-7	Switching Frequency Options 0x2 = 1.3MHz ~								
<u>Configurations 8-12</u>		Write							
Conligurations 13-15	Charger Configurations 9								
Interrupts/Status     Details     BC/CC Control	CHGIN input current limit 0x7F = 3200 mA	Read							
	Charger Software enable 0 = Charging enable controlled by USBC	Write							
	Charner Configurations 10								
	Minimum SYS Voltage 0x5 = 3.5V V								
	INLIM Soft Start Clock 0x2 = 1024µs v								
	Charger Contigurations 12	Pood							
	CHCIN Veltage Regulation Thrashold 00 = VCHCIN REC=4.5V and VCHCIN UVI 0=4.7V	Write							

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In the Configuration 0-3 tab, set Battery Charging Current in the Charger Configurations 2 register. Click Write to send the command to the charger. Note that the maximum setting of Fast Charge Current for the MAX77789 is 0x3F = 3150mA.

At the same time, set Smart Power Selector to 0x5 = Charger = On, Buck = On, OTG = Off, and Boost = Off and click Write to enable charger mode.

p	Interrupts/Status Detail	Configurations 0-3	Configurations 4-7	Configurations 8-12	Configurations 13-15			
narger • Interrupts/Status	Read Write					Start Auto-Read	Every	500 <sup>+</sup> m
Details <u>Configurations 0-3</u> Configurations 4-7     Configurations 8-12	Charger Configurations 0							
	Smart Power Selector	0x5 = Charger	on, Buck on, OTG off, Bo	ost off			~	Read
	Watchdog Timer Enable	0 = Watch	dog timer disabled					Write
Configurations 13-15	JEITAEnable	JEITAEnable O = JEITA Enable						
BC Interrupts/Status	BATT to SYS FET Disable C	ontrol 🛛 🔿 0 = QBAT	(switch between SYS &	BATT) controlled by FSM				
Details	Charger Configurations 1							
BC/CC Control	Fast Charge Timer	0x4 = 6 hrs					~	Read
	Event Recycle Option	🚺 1 = Syste	m will recycle after 150	ms (min)				Write
	Charger Restart Threshold	0x0 = 100mV k	elow CV				~	
	LSEL	LSEL O = 0.47µH inductor						
	Low-Battery Prequalification Mode C 1 = Enable							
	Charger Configurations 2							
	Battery charging current	0x0B = 550 m	A					Read
	CHGIN Output Current Limit	0x3 = 1500mA					~	Write
	Charger Configurations 3							
	Top off current threshold	0x0 = 50mA					~	Read
	Top off timer	0x0 = 30 second					~	Write

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10. In the Configuration 4-7 tab, set Charge Termination Voltage Setting in the Charger Configurations 4 register. Click Write to send the command to the charger. Note that the maximum setting of Charge Termination Voltage setting for the MAX77789 is 0x3F = 4.55V.

File Device Options Tools	Help					
Гор	Interrupts/Status Details Configurations 0-3 Configurations 4-7 Configurations 8-12 Configurations	13-15				
• Interrupts/Status	Read Write	Start Auto-Read Every	500 <mark>+</mark> ms			
Details     Configurations 0-3	Charger Configurations 4					
<u>Configurations 4-7</u>	Charge Termination Voltage Setting 0x1D = 4.25 V		Read			
Configurations 8-12     Configurations 12 15			Write			
	Charger Configurations 5					
<ul> <li>Interrupts/Status</li> </ul>	Battery overcurrent threshold 0xE = 6.0A	~	Read			
Details			Write			
- BC/CC Control	Charges Configurations 6					
	Watchdog Timer Clear 0x0 = Watchdog timer is not cleared	~	Read			
	AICI Disable feature 0 = AICI feature is enabled		Write			
	LX slope control options 0x0 = Fastest ~					
	BATT to SYS Over-current 0 = 6ms debounce time					
	Earton: Shin Mode		Read			
	Thermal regulation threshold 0x9 = 130°C	~	Write			
	OBAT EET control		THILE			
	QBAT FET control 0 = Watchdog timer expires turn off only charger					

11. Turn on the DC power supply's output to enable charging.

12. Use data log equipment to log the charge current and battery voltage profile while charging a 1-cell battery.

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#### **BC1.2 and CC Detection Setup**

- 1. Connect a 1-cell battery pack or simulated battery between BATT and GND2. For the battery simulator, adjust the voltage to 3.8V with a 3.5A current limit, and turn it on.
- 2. Set Charger Settings Protection under Configuration 4-7 tab to 0x3 = write capability unlocked. Click Write to send the command. Note that 0x3 must be written to unlock the charger register setting.
- 3. For the input current limit, which is set by USB, set Bypass USBC control for INLIM to 0.

le Device Options Tool	s Help				
q	Interrupts/Status Details Configurations 0-3 Configurations 4-7 Configurations 8-12 Configurations 13-15				
arger • Interrupts/Status	Read Write Start Auto-Read Every	500 <mark>+</mark> ms			
Details	Charger Configurations 8				
Configurations 0-3     Configurations 4-7	Switching Frequency Options 0x2 = 1.3MHz ~	Read			
Configurations 8-12		Write			
Configurations 15-15	Charger Configurations 9				
Interrupts/Status	CHGIN input current limit 0x13 = 500 mA				
Details BC/CC Control	Charger Software enable 0 0 = Charging enable controlled by USBC	Write			
	Charger Configurations 10				
	Minimum SYS Voltage 0x5 = 3.5V ~	Read			
	INLIM Soft Start Clock         0x2 = 1024µs	Write			
	Charger Configurations 12				
	Charger skip mode disable 💿 0 = Auto skip mode	Read			
	CHGIN Voltage Regulation Threshold 0x0 = VCHGIN_REG=4.5V and VCHGIN_UVL0=4.7V <	Write			
	Bypass USBC control for INLIM O = INLIM is set by USBC				
	MAX77789 FV Kit	Connected			

4. In the Configuration 0-3 tab, set Battery Charging Current to 0x3F (3150mA) in the Charger Configurations 2 register. Click Write to send the command to the charger.

At the same time, set Smart Power Selector to 0x5 = Charger = On, Buck = On, OTG = Off, and Boost = Off and click Write to enable charger mode.

- 5. Plug in USB Type-C cable from travel adaptor/PC to J1 connector on the MAX77789 EV kit.
- 6. The MAX77789 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 a proprietary charger type that the MAX77789 can detect, the MAX77789 sets the input current limit according to I<sup>2</sup>C register CHGIN\_ILIM (0xC0).

## **Evaluates: MAX77789**

#### **OTG Reverse Boost Setup**

- 1. Connect the power supply between BATT and GND2, adjust the voltage to 3.8V with 3.5A current limit, and turn it on.
- 2. Set Charger Settings Protection under Configuration 4-7 tab to 0x3 = write capability unlocked. Click Write to send the command. Note that 0x3 must be written to unlock charger register setting.
- 3. In the **Configuration 0-3** tab, set **Smart Power Selector** to **0xA** in the **Charger Configurations 0** register. Click **Write** to send the command to the charger. This enables the OTG mode.

Set CHGIN Output Current Limit to 0x3 for maximum output current limit 1.5A.

Read Write Charger Configurations 0 Smart Power Selector Watchdog Timer Enable JEITA Enable	Start Auto-Read     Every       0xA = Charger off, Buck off, OTG on, Boost on     ✓       0 = Watchdog timer disabled     ✓       0 = UritA Enable     ✓	500 <mark>+</mark> n Read Write
Charger Configurations 0 Smart Power Selector Watchdog Timer Enable JEITA Enable	0xA = Charger off, Buck off, OTG on, Boost on	Read Write
Smart Power Selector Watchdog Timer Enable JEITAEnable	0xA = Charger off, Buck off, OTG on, Boost on     ~       0 = Watchdog timer disabled	Read Write
Watchdog Timer Enable JEITA Enable	0 = Watchdog timer disabled     0 = UFITA Enable	Write
JEITA Enable	0 = JEITA Enable	
BALL TO SYS FET DISable Control	0 = QBAT (switch between SYS & BATT) controlled by FSM	
Charger Configurations 1		
Fast Charge Timer	0x4 = 6 hrs ~	Read
Event Recycle Option	1 = System will recycle after 150ms (min)	Write
Charger Restart Threshold	0x0 = 100mV below CV ~	
LSEL	O = 0.47µH inductor	
Low-Battery Prequalification Mode	1 = Enable	
Charger Configurations 2		
Battery charging current	0x0A = 500 mA	Read
CHGIN Output Current Limit 0x3	3 = 1500mA 🗸 🗸	Write
Charger Configurations 3		
Top off current threshold 0x0 = 5	50mA ~	Read
Top off timer 0x0 = 3	30 second 🗸	Write
	Charger Configurations 1 Fast Charge Timer Event Recycle Option Charger Restart Threshold LSEL Low-Battery Prequalification Mode Charger Configurations 2 Battery charging current CHGIN Output Current Limit Charger Configurations 3 Top off current threshold Top off timer Ox0 =	Charger Configurations 1         Fast Charge Timer       0x4 = 6 hrs         Event Recycle Option       1 = System will recycle after 150ms (min)         Charger Restart Threshold       0x0 = 100mV below CV         LSEL       0 = 0.47 µH inductor         Low-Battery Prequalification Mode       1 = Enable         Charger Configurations 2       0 = 0.47 µH inductor         Battery charging current       0x0 = 500 mA         CHGIN Output Current Limit       0x3 = 1500 mA         Charger Configurations 3       Charger Configurations 4         Charger Configurations 3       Charger Configurations 4         Charger Configurations 3       Charger Configurations 3         Charger Configurations 4       0x0 = 50mA         Charger Configurations 3       Charger Configurations 3         Charger Configurations 4       0x0 = 50mA

4. Monitor the voltage of CHGIN at the CHGINS test point and see whether it equals 5.1V. Note that VCHGIN must be lower than 0.7V for OTG mode; otherwise, CHGIN does not supply current when OTG mode is enabled.

### **Evaluates: MAX77789**

#### **BYP Reverse Boost Test Setup**

- 1. Connect the power supply between BATT and GND, adjust the voltage to 3.8V with a 3.5A current limit, and turn it on.
- 2. Set Charger Settings Protection under Configuration 4-7 tab to 0x3 = write capability is unlocked. Click Write to send the command. Note that 0x3 must be written to unlock charger register setting.
- 3. In the **Configuration 0-3** tab, set **Smart Power Selector** to **0x8** in the **Charger Configurations 0 register**. Click **Write** to send the command to the charger. This enables the reverse boost BYP mode.
- 4. Monitor the voltage of BYP at BYPS test point and check that it equals 5.1V.

ор		
	Interrupts/Status Details Configurations 0-3 Configurations 4-7 Configurations 8-12 Configurations 13-15	
harger • Interrupts/Status	Read Write Start Auto-Read Every	500 <mark>+</mark> m:
Details     Configurations 0.2	Charger Configurations 0	
Configurations 4-7	Smart Power Selector 0x8 = Charger off, Buck off, OTG off, Boost on	Read
Configurations 8-12	Watchdog Timer Enable 💿 0 = Watchdog timer disabled	Write
Configurations 13-15	JEITAEnable 🔘 0 = JEITA Enable	
<ul> <li>SBC</li> <li>Interrupts/Status</li> </ul>	BATT to SYS FET Disable Control 0 = QBAT (switch between SYS & BATT) controlled by FSM	
Details	Charger Configurations 1	
BC/CC Control	FastCharge Timer 0x4 = 6 hrs	Read
	Event Recycle Option  (1 = System will recycle after 150ms (min)	Write
	Charger Restart Threshold 0x0 = 100mV below CV ~	
	LSEL 0 0 = 0.47µH inductor	
	Low-Battery Prequalification Mode 🛛 🚺 1 = Enable	
	Charger Configurations 2	
	Battery charging current 0x0A = 500 mA	Read
	CHGIN Output Current Limit 0x3 = 1500mA v	Write
	Charger Configurations 3	
	Top off current threshold 0x0 = 50mA	Read
	Top off timer 0x0 = 30 second ~	Write

### **Evaluates: MAX77789**

#### **LED Indicator**

- 1. Three LED indicators are installed on the EV kit: DS1 is for INOKB, DS2 is for the STAT1, and DS5 is for STAT2.
- 2. The STAT1 pin is an open-drain and active-low output that indicates charge status. See <u>Table 2</u> details.

#### Table 2. STAT1 Output with Charging Status

CHARGING STATUS	STAT1	LOGIC STATE	CHARGE STATUS LED
No Input	High Impedance	High	Off
Trickle, Precharge, 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

- 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.
- 4. STAT2 is an open-drain and active low output. There is an option to display either the Fault indication or the Charger Type detection done indication by setting the register STAT2 PIN Usage in the Configuration 13-15 tab. See <u>Table</u> <u>3</u> for details. The STAT2 pin also has options to be controlled by either a state machine or an external MCU. Options can be selected by the setting of the register STAT2 PIN Control in the Configuration 13-15 tab.

#### Table 3. STAT2 Output with Fault Indication or Charger Type Detection

USAGE	INPUT	INITIAL STATE	AFTER STATE	STATUS LED (AFTER STATE)
Fault Indication	Charger Timer Fault Thermal Shutdown SYS OVLO/UVLO	High	Low	Solid On
Charger Type	DCP	Low	Low	Solid On
Detection Done	SDP/CDP	Low	High	Off

#### EXTSM Pin

1. The EXTSM pin is an active-high input. When the EXTSM pin is pulled high, the MAX77789 is operating in three ways based on the status of the IC. See <u>Table 4</u> for details.

Note: In the Configuration 4-7 tab, Factory Ship Mode (FSHIP\_MODE) in the Charger Configurations 7 register makes MAX77789 enter factory ship mode or non-factory ship mode.

#### Table 4. EXTSM Pin Function

PIN	INITIAL STATE	FUNCTIONS
EXTSM	Factory ship mode (FSHIP_MODE = 1)	Pull EXTSM pin high by pressing the pushbutton SW1 for 10ms forces the MAX77789 to <b>exit from Ship Mode</b> .
	Non-factory ship mode (FSHIP_MODE = 0), QBAT_RST = 0 and CHGIN invalid	Pull EXTSM pin high by pressing the pushbutton SW1 for 10s forces MAX77789 <b>enter the System Reset mode</b> . After releasing EXTSM pin, Q <sub>BAT</sub> is turning ON to provide power to SYS.
	Battery charging and FSHIP_MODE = 0, QBAT_RST = 0 and CHGIN is valid	Pull EXTSM pin high by connecting J11 (short 3–4). This makes the MAX77789 <b>stop charging</b> the battery and Q <sub>BAT</sub> is off.

## **Evaluates: MAX77789**

#### Spread Spectrum

- 1. The spread-spectrum modulation can be enabled/disabled by setting the **Spread Spectrum Enable** to 1 or 0 in **Charger Configurations 13-15** tab.
- 2. Set Charger Settings Protection under Configuration 4-7 tab to 0x3 = write capability unlocked. Click Write to send the command. Note that 0x3 must be written to unlock charger register setting.
- 3. Spread-spectrum modulation pattern is programmable either pseudo-random or triangular by the **Spread-Spectrum Pattern Setting** in **Charger Configuration 13-15** tab.

e benee options tool	пер					
p	Interrupts/Status Details Configurations 0-3 Configurations 4-7 Configurations 8-12 Configurations 13-15					
arger Interrupts/Status	Read Write	Start Auto-Read Even	ry 500 <mark>+</mark> r			
Details     Configurations 0-3     Configurations 4-7     Configurations 8-12	Charger Configurations 13 Delay enterion ESHIP Mode 0 = 1s		Read			
	Delay for entering FSHIP Mode 1 = enter FSHIP in tFSHIP DI Y when FSHIP bit is set		Write			
Configurations 13-15	tQBAT_RST 0 = QBAT remains OFF after EXTSM is asserted for 1s	Deap to entering commode 1 - enter communication of the transmission of the transmissi				
BC	QBAT reset					
Details	CHGIN Standby Enable 0 = DC-DC is controlled by the power-path state machine					
BC/CC Control	Charger Configurations 14					
	Spread Spectrum Enable		Read			
	Spread-Spectrum Envelope Setting 0 = ±6%		Write			
	Spread-Spectrum Pattern Setting 1 = Pseudo-random pattern					
	JEITA controller battery fast charge current (COOL) 0x3 = Battery fast charge current is reduced to 50% of CHGCC	````	1			
	JEITA controller battery termination (WARM) 0x3 = Battery termination voltage is set by (CHG_CV_PRM - 150mV)	```	1			
	JEITAEnable O = HOTCOLD Disable					
	Charger Configurations 15					
	STAT2 PIN Manual Control 0 = High		Read			
	STAT2 PIN control O = STAT2 PIN is controlled via State machine		Write			
	STAT2 PIN Usage O = FAULT Indication					
	Enable CHGCV reduction in cool 0 = No Change in CHGCV when cool					

#### **Ordering Information**

PART NUMBER	IC	TYPE	
MAX77789EVKIT#	MAX77789EWX+	EV Kit	

#Denotes RoHS-compliance.

# Evaluates: MAX77789

### MAX77789 EV Kit Bill of Materials

QTY	REF DES	MFG PART#	MANUFACTURER	VALUE
MINIM	AL BILL OF MATERIAL	S FOR MAX77789 AUTONOM	OUS CHARGER WITH JEITA	
2	C1, C8	C1005X5R1A225K050BC	ток	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	ток	10µF; 20%; 16V; JB; SMT (0603); CERAMIC
1	C4	GRM155R61C104KA88	MURATA	0.1µF; 10%; 16V; X5R; SMT (0402); CERAMIC
3	C5, C7, C9	C1608X5R1A106K080AC	ток	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	RC0402FR-0710KL	YAGEO PHICOMP	10KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
1	U1	MAX77789	ANALOG DEVICES	MAX77789EWX+
OTHE	R COMPONENTS FOR E			
0	C10	N/A	N/A	NOT INSTALLED
2	C11, C12	C0402X5R100-105KNE; GRM155R61A105KE15	VENKEL LTD; MURATA	1µF;10V;10%; X5R; SMT (0402); CERAMIC
1	C13	GRM155R71E104ME14	MURATA	0.1µF; 25V; 20%; X7R; SMT (0402); CERAMIC
3	R1, R3, R20, R21	RC0402FR-0710KL	YAGEO PHICOMP	10KΩ; 1%; SMT (0402); ±100PPM/°C; 0.063W
1	R2	3296Y-1-503LF	BOURNS	50KΩ; 10%; THROUGH-HOLE- RADIAL LEAD; 0.5W
2	R4, R7	CRCW04022K20JN	VISHAY DALE	2.2KΩ; ±5%; SMT (0402); ±200PPM/K; 0.063W
3	R5, R6, R29	CR0402-16W-1651FT	VENKEL LTD.	1.65KΩ; ±1%; SMT (0402); ±100PPM/°C; 0.063W
6	R8, R11, R12, R14, R15, R28	ERJ-2RKF1003	PANASONIC	100KΩ; ±1%; SMT (0402); ±100PPM/°C; 0.1W

# Evaluates: MAX77789

QTY	REF DES	MFG PART#	MANUFACTURER	VALUE
3	R9, R22, R27	RC0402JR-070RL; CR0402-16W-000RJT	YAGEO PHYCOMP; VENKEL LTD.	0Ω; ±5%; SMT (0402); JUMPER; 0.063W
2	R23, R24	ERJ-2RKF2202	PANASONIC	22KΩ; ±1%; SMT (0402); ±100PPM/°C; 0.1W
2	R25, R26	ERJ-2GEJ563	PANASONIC	56KΩ; ±5%; SMT (0402); ±200PPM/°C; 0.1W
1	R28	ERJ-S02F2401	PANASONIC	RES; SMT (0402); 2.4K; 1%; +/- 200PPM/DEGK; 0.1000W
2	R33, R34	CRCW04025K10FK	VISHAY DALE	5.1KΩ; ±1%; SMT (0402); ±100PPM/°C; 0.063W
0	R10, R13, R16, R17	N/A	N/A	0603; NOT INSTALLED
0	R18, R19	N/A	N/A	0805; NOT INSTALLED
1	L2	DFE322520F-1R0M	MURATA	1µH; ±20%; 6.3A
1	J1	12401832E402A	AMPHENOL	FEMALE; USB TYPE C CONNECTOR; 24 PINS
1	J2	10118193-0001LF	FCI CONNECT	FEMALE; MICRO USB B TYPE RECEPTACLE; 5 PINS
1	J3	PEC04DAAN	SULLINS ELECTRONICS CORP.	CONNECTOR; MALE; THROUGH HOLE; STRAIGHT; 8 PINS
8	J4, J5, J8, J9, J27	PEC03DAAN	SULLINS ELECTRONICS CORP.	CONNECTOR; MALE; THROUGH HOLE; STRAIGHT; 6 PINS
2	J6, J11	PEC02DAAN	SULLINS ELECTRONICS CORP.	CONNECTOR; MALE; THROUGH HOLE; STRAIGHT; 4 PINS
7	J7, J12-J15, J18-J20	PBC02SAAN	SULLINS ELECTRONICS CORP.	CONNECTOR; MALE; THROUGH HOLE; STRAIGHT; 2 PINS
1	J10	PPPC092LJBN-RC	SULLINS ELECTRONICS CORP.	CONNECTOR; FEMALE; THROUGH HOLE; RIGHT ANGLE; 18 PINS
8	J17, J21-J26	TSW-103-07-T-S	SAMTEC	CONNECTOR; THROUGH HOLE; STRAIGHT; 3 PINS
11	BATT, BYP, CHGIN, GND1-GND6, SYS, VIN	9020 BUSS	WEICO WIRE	MAXIM PAD; WIRE; SOLID; 20AWG

# Evaluates: MAX77789

QTY	REF DES	MFG PART#	MANUFACTURER	VALUE	
25	BATTS, BYPS, CC1, CC2, CHGINS, DN, DP, EXT1, EXT2, GNDS, INAOK, INBOK, LX, OTGENA, OTGENB, OVLOA, OVLOB, OVPENB, PCON, PVL, SYSS, THM, USB_DN, USB_DP, VDD	5000	KEYSTONE	TEST POINT; RED	
6	INOKB, INTB, SCL, SDA, STAT1, STAT2	5002	KEYSTONE	TEST POINT; WHITE	
3	DS1, DS2, DS5	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	
17	EV_KIT_BOX1, EV_KIT_BOX2	NPC02SXON-RC	SULLINS ELECTRONICS CORP.	JUMPER; MINI SHUNT; 0.100IN CC; 2 PINS	
1	РСВ	MAX77789	MAXIM	MAX77789EVKIT#	
1	U2	MAX8891EXK18+	MAXIM	LOW DROP-OUT LINEAR REGULATOR	
1	U3	MAX20336ENT+	MAXIM	DPST ANALOG SWITCH	
1	U4	MAX14727EWV+	MAXIM	BIRECTIONAL OVERVOLTAGE PROTECTOR	
1	SW1	EVQ-Q2K03W	PANASONIC	SWITCH; SPST; 15V; 0.02A; LIGHT TOUCH SWITCH	

# Evaluates: MAX77789

#### MAX77789 EV Kit Schematic



## **Evaluates: MAX77789**

#### MAX77789 EV Kit PCB Layouts



MAX77789 EV Kit Component Placement Guide—Top Silkscreen



MAX77789 EV Kit PCB Layout—Top

MAX77789 EV Kit PCB Layout—Layer 2



MAX77789 EV Kit PCB Layout—Layer 3

# Evaluates: MAX77789

# MAX77789 EV Kit PCB Layouts (continued)



MAX77789 EV Kit PCB Layout—Bottom

## **Evaluates: MAX77789**

#### **Revision History**

REVISION	REVISION	DESCRIPTION	PAGES
NUMBER	DATE		CHANGED
0	4/23	Initial release	—



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