

Evaluates: MAX25460

MAX25460 Evaluation Kit

General Description

This evaluation kit (EV kit) demonstrates the MAX25460 automotive USB Type-A controller with 1GHz BW USB 2.0 D+/D- protection switches. The MAX25460 features a high-current, high-efficiency, host-charger with port-detection circuitry adhering to the USB 2.0 and the USB-IF BC1.2 battery charging specifications. The step-down DC-DC converter operates from up to 28V continuous and protects against load dump transients up to 40V. The converter switches at 2.2MHz and can deliver 1.5A continuously and 2.4A for up to 1.1ms. The MAX25460 integrates high-side current sensing and circuitry to automatically adjust the USB voltage to compensate for voltage drops in long automotive cables..

The EV kit is populated with a MAX25460ATGA/V+ product variant for 2.2MHz operation. The high-speed data switches of the MAX25460 generally do not require far-end eye tuning, so the EV kit is populated with 0Ω resistors in place of the LC tuning circuits.

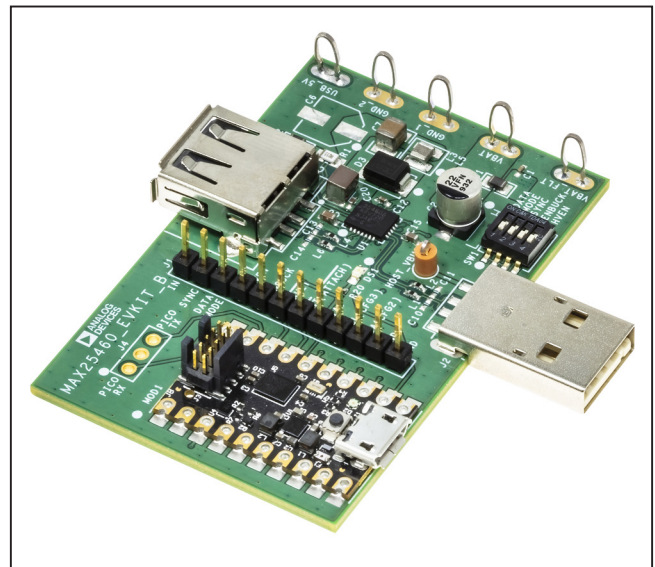
The EV kit allows evaluation of the following MAX25460 capabilities:

- Adjustable buck converter precision current limit for better system performance.
- Adjustable current limit debounce timer for overcurrent testing and system flexibility.
- Adjustable gain settings for cable compensation for low-cost captive cables up to 474mΩ.
- Electromagnetic interference (EMI) mitigation using spread spectrum switching.
- Detailed interrupt and fault status providing multilayer protection and recovery to improve system decisions during faults.

Features

- Configurable Charge Detection Modes
 - USB-IF BC1.2 SDP, CDP
- Automatic USB Voltage Adjustment by Integrated DC-DC Converter
- Proven PCB Layout
- Fully Assembled and Tested

MAX25460 Evaluation Kit Board



[Ordering Information](#) appears at end of data sheet.

Quick Start

Required Equipment

- MAX25460 EV kit
- Windows®-based PC
- Two-meter USB-A extension cable
- USB-A to Micro-B cable
- 3.5Ω 10W resistor or electronic load
- USB Type-A plug
- 14V/2A DC power supply or car battery (VBAT)
- Digital voltmeter
- USB Type-A flash drive

The following procedure demonstrates the MAX25460's high-speed data switches and voltage adjustment capability.

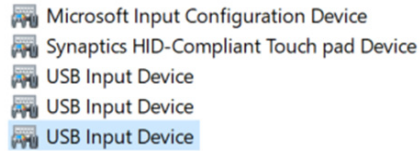
Procedure

Initial Setup

The EV kit is fully assembled and tested. Follow the steps to set up the board for evaluation.

- 1) Install the MAX25460 GUI. See the [MAX25460 GUI](#) section for additional information.
- 2) Verify that SW1 switch is set to HVEN=L, ENBUCK=L, SYNC=L, and DATA_MODE=L.
- 3) Connect the EV kit to the PC with USB Micro-B and USB-A extension cables (see [Figure 1](#)).

- 4) Verify that the EV kit is recognized in the Windows Device Manager as USB input device.



- 5) Set the VBAT power supply to 14V output, 2A current limit. Turn the output off. Connect negative lead to the “GND_1” test loop on the EV kit. Connect positive lead to “VBAT_FLT” test loop on the EV kit.
- 6) Plug a USB flash drive into the EV kit USB connector (J3).
- 7) Turn on the VBAT power supply output.
- 8) Start the MAX25460 GUI. Look at the message bar on the left of the GUI to verify that the EV kit is detected (see [Figure 2](#)).

High-Speed Data Switches

- 9) In the GUI, click ENBUCK PIN and Configuration Complete checkboxes.
- 10) Check that the USB flash drive is recognized on the host computer by opening the directory. This verifies the high-speed data switches are operating properly. See [Figure 3](#).
- 11) Unplug the flash drive from the EV kit.

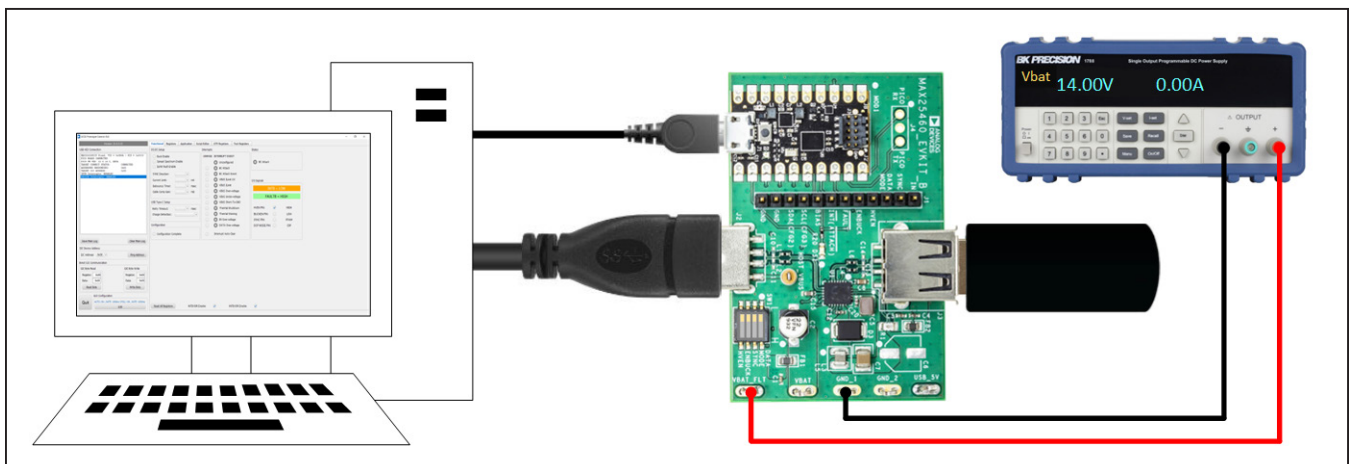


Figure 1. EV Kit Setup

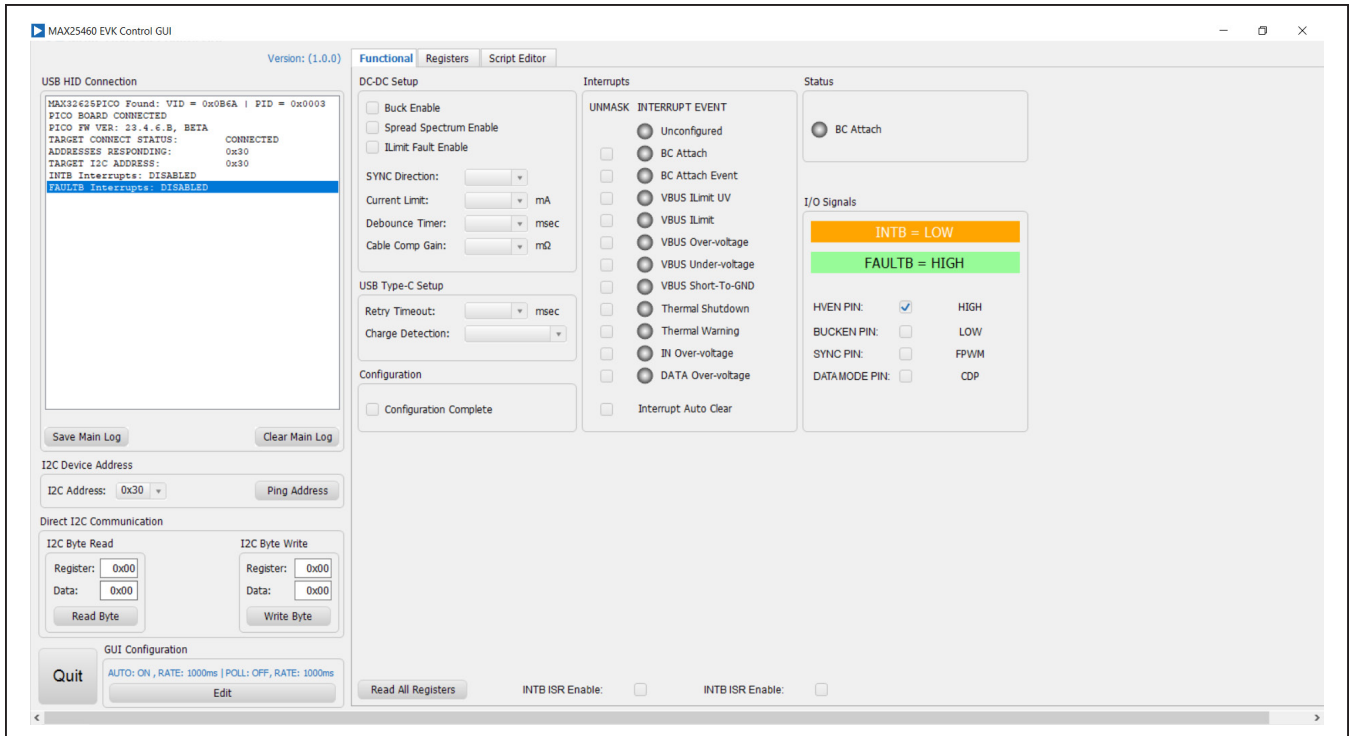


Figure 2. MAX25460 GUI Startup

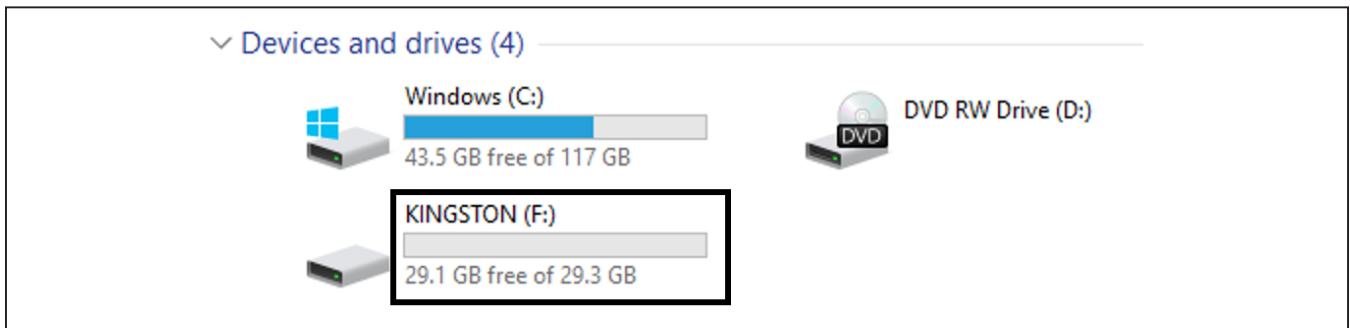


Figure 3. USB Flash Drive Recognized

USB BC1.2 CDP Charging

- 12) In the GUI, set Cable Comp Gain to 108mΩ and set Charge Detection to Auto_CDP.
- 13) Connect a USB cable and a BC1.2 CDP-compatible smartphone.
- 14) Check that the smartphone is recognized on the host computer and that it is charging.
- 15) V_{BUS} current can be checked by measuring the voltage drop across the current-sense resistor R1.
- 16) Unplug the smartphone and 2m USB-A extension cable from the EV kit.

Cable Compensation

- 17) Connect the 2m USB-A extension cable to the EV kit downstream USB connector (J3).
- 18) Connect the Type-A plug to the other end of the extension cable (see [Figure 4](#)).
- 19) Measure the V_{BUS} voltage at the end of cable, it should be around 5.15V.
 - **Note:** This is the voltage at the portable device.
- 20) Connect the E-load or resistor bank to the USB plug's Ground and V_{BUS} pins.
- 21) Adjust the Cable Comp Gain in the GUI until the voltage at the far-end reaches 5.15V.
- 22) The voltage at the far-end of the 2m cable is regulated to approximately 5.15V regardless of the load current.

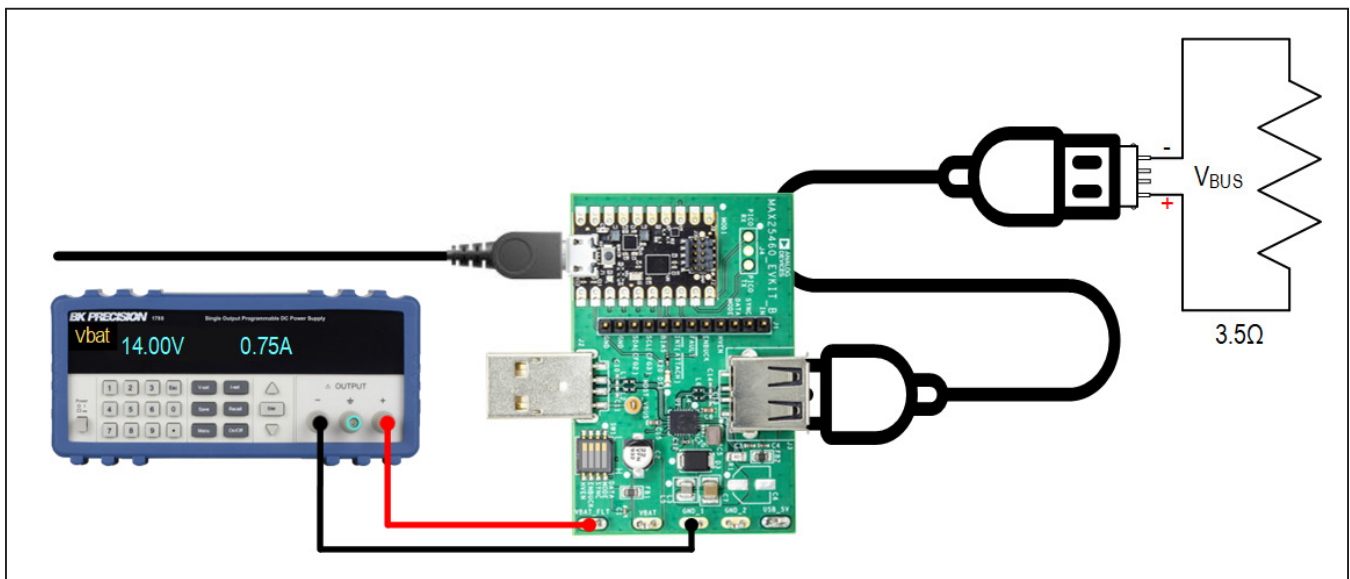


Figure 4. EV Kit Setup for Cable Compensation

Detailed Description

The MAX25460 EV kit comes fully assembled, tested, and installed with MAX25460ATGA/V+. The stand-alone variant can also be used on this EV kit by changing the IC and configuration resistors. See [Table 1](#) for an example of stand-alone configuration. Refer to the MAX25460 data sheet for further details on configuration resistors.

When R6 and R7 are changed per [Table 1](#), 3.3V is sourced from the on-board LDO and the USB Micro-B connection to the Pico board should not be used.

EV Kit Interface

Header J1 includes input and output test points for controlling the IC and evaluating its functionality. [Table 2](#) lists the individual pins and their functions.

Switch SW1 allows the user to set the voltage on the HVEN, ENBUCK, SYNC, and DATA_MODE pins (see [Table 3](#)). Setting a switch to the ON position ties the connected pin high. Setting a switch to the OFF position ties the pin to ground through a pull-down resistor. To externally control these pins through the header J1 or the PC GUI, set all switches to the OFF position.

Table 1. Stand-Alone Configuration Example

PIN NAME	RESISTOR	VALUE	DESCRIPTION
CONFIG1	R2	0Ω	Spread Spectrum: On; Sync as Input; Fsw = 2.2MHz
CONFIG2	R4	14.7kΩ	GAIN[3:0] = 1100
CONFIG3	R3	2.26kΩ	GAIN[4] = 1; ILIM = 1.62A (min) <i>Note: Gain programmed with this configuration is 28.</i>
SDA/SCL	R15/R16	DNP	Remove SDA/SCL pull-ups.
3V3	R6	DNP	Jumper option, 3.3V from Pico interface board
3V3	R7	0Ω	Jumper option, 3.3V from MAX15006 LDO

Table 2. External Header

J1 PIN	NAME	DESCRIPTION
1	IN	3.3V supply for IN (input/output)
2	SYNC	Buck regulator synchronization pin (input/output)
3	DATA_MODE	Charge detection configuration pin (input)
4	HVEN	IC enable (active high, input)
5	ENBUCK	DC-DC enable (active high, input)
6	FAULT	Fault indicator (active low, open-drain, output)
7	INT (ATTACH)	I ² C interrupt output (active low, open-drain) Standalone: USB attach output (active low, open-drain)
8	BIAS	4.7V LDO output
9	SCL (CONFIG3)	I ² C: clock (input) Standalone: CONFIG3 (input)
10	SDA (CONFIG2)	I ² C: data (input/output) Standalone: CONFIG2 (input)
11	GND	EV kit ground
12	GND	EV kit ground

Table 3. External Switch

SW1 PIN	POSITION	DESCRIPTION
HVEN	0	Device disabled
	1	Device enabled
ENBUCK	0	Buck output disabled
	1	Buck output enabled
SYNC	0	SYNC configured as an input: DC-DC operates in FPWM. Refer to the MAX25460 data sheet for more information.
		SYNC configured as an output: DC-DC operates in FPWM. SYNC pin generates clock output for synchronization of other devices. If enabled, spread spectrum is also present on SYNC output to reduce EMI of the device synchronized to MAX25460. SYNC output is 180° out of phase with internal clock to further help reduce EMI.
	0 with clock applied to SYNC through J1	SYNC configured as an input: DC-DC operates in FPWM. The MAX25460 can be synchronized to an external clock - for example, another MAX25460. Spread spectrum is not applied to external clock from SYNC pin.
	1	SYNC configured as an input: DC-DC operates in skip mode with light/no-load, FPWM otherwise.
DATA_MODE	0	High-speed pass-through mode (SDP)
	1	Auto-CDP mode

Basic Functionality

Connect a 9V to 16V power source (battery supply) between VBAT_FLT and GND test loops and USB Micro-B to a host PC. Connecting the Micro-B to a PC pulls the HVEN pin to 3.3V and enables the device. The ENBUCK pin is driven by the GUI and SW1 and must be high for the DC-DC converter to turn on. The charge mode can be configured through I²C or using the DATA_MODE switch or pin. If the DATA_MODE pin is high, it overrides the current I²C register setting.

Fault Diagnostics

The $\overline{\text{FAULT}}$ pin is software compatible with ADI Type-A Automotive USB solutions. More advanced diagnostics can be performed using the I²C bus and the INT pin. The IRQ bits have an associated IRQ_MASK bit. When the IRQ_MASK bit is set to 1, the INT pin asserts and de-asserts following the IRQ bit. All IRQ bits clear on read. IRQ bit de-assertion is controlled by the IRQ_AUTOCLR

bit. When IRQ_AUTOCLR = 0 (default), the error bit stays asserted until the register is read even if the fault condition is no longer present. When IRQ_AUTOCLR = 1, the IRQ bit de-asserts without a read as soon as the fault criteria are no longer met. The EV kit GUI uses a polling mechanism to read all MAX25460 registers. A read is initiated when the **Read All Registers** button is clicked, or periodically if auto read is enabled. Due to the auto read polling mechanism, when IRQ_AUTOCLR = 1 it is possible that the GUI can miss IRQ bit assertions because the signal de-asserts too quickly after a fault.

PCB Layout Guidelines

A good PCB layout is critical to proper system performance. The loop area of the DC/DC conversion circuitry must be minimized as much as possible. Place the input capacitor, power inductor, and output capacitor very close to the IC. Shorter traces should be prioritized over wider traces.

A low-impedance ground connection between the input and output capacitors is required for reliable operation. Make this connection through the ground pour on the exposed pad. Place multiple vias in the pad to connect to all other ground layers to reduce thermal resistance. Inadequate thermal performance may cause the IC to cycle in and out of thermal shutdown. Use a single common ground with GND vias directly adjacent to all components that connect down to an adjacent ground plane. This arrangement enables high frequency return currents to flow directly under their respective source traces.

The USB traces must be routed as a 90Ω differential pair with an appropriate keep-out area. Avoid routing USB traces near high frequency switching nodes or other sources of noise such as clocks. The length of the routing should be minimized and avoid 90° turns, excessive vias, and RF stubs. The MAX25460 has high-bandwidth data switches. See the IC data sheet for details on tuning recommendations.

See the *Layout Considerations* section in the MAX25460 data sheet for additional information.

MAX25460 GUI

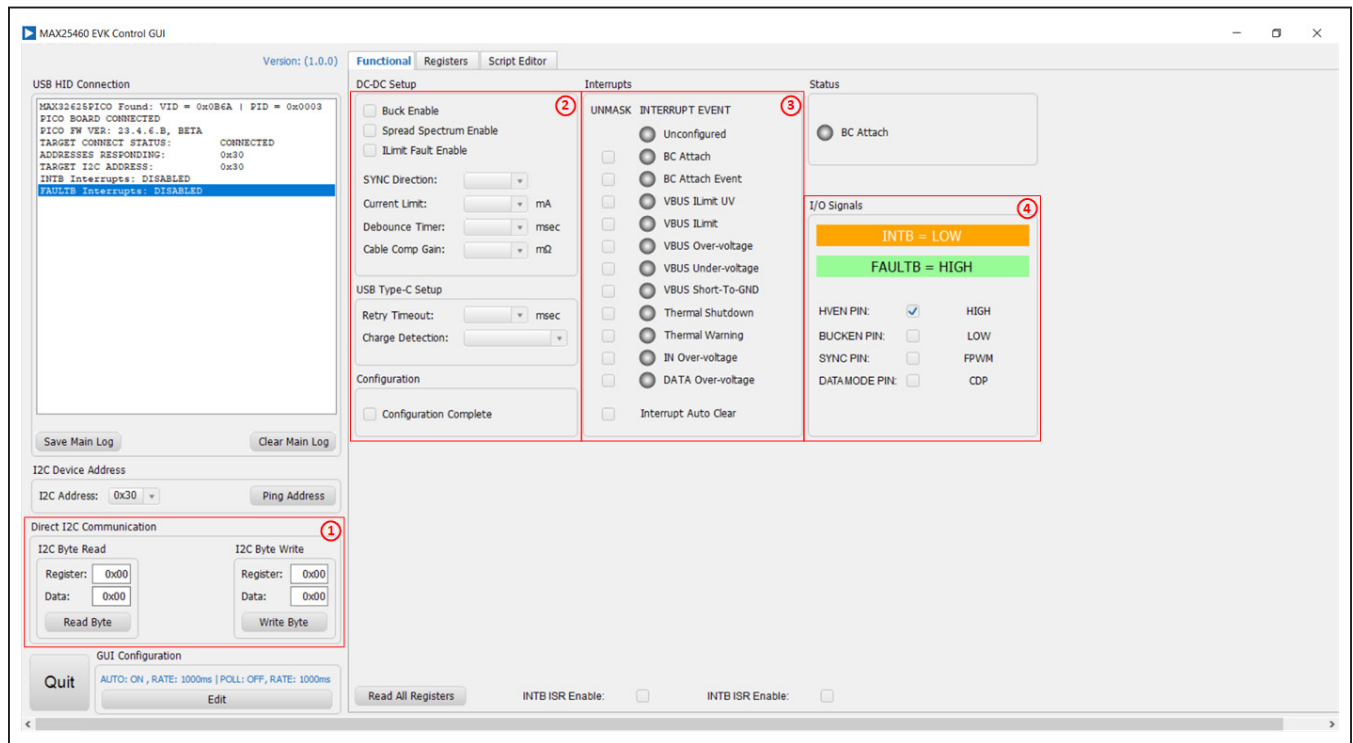
The latest GUI can be downloaded from the MAX25460 EV kit webpage: <https://www.analog.com/en/design-center/evaluation-hardware-and-software/evaluation-boards-kits/max25460evkit.html>

The GUI is divided into sections to allow the user easy access to all settings and direct register read/write.

- 1) Direct read/write access to all registers
- 2) Basic setup parameters for the buck converter, cable compensation, and USB data switch mode
- 3) Interrupt mask and interrupt flag indicators
- 4) Control for MAX25460 hardware I/O pins

All GUI setting changes immediately affect the MAX25460.

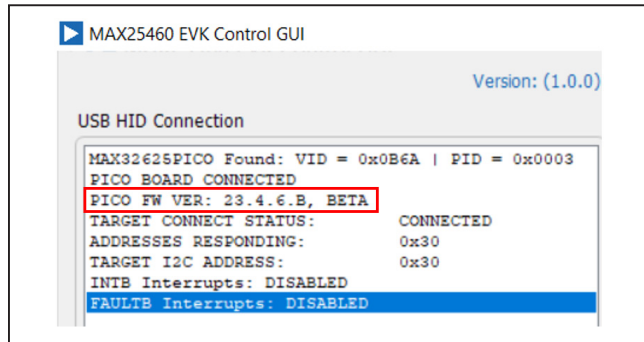
Auto-polling of MAX25460 registers by the GUI can also be enabled in the *GUI Configuration* section.



Pico Board Firmware Update

The Pico Board comes preprogrammed, however it may be necessary to update the firmware as new versions are published on the EV kit webpage.

- 1) Perform the **Initial Setup** steps to start the GUI.
- 2) Check the Pico Board firmware version.

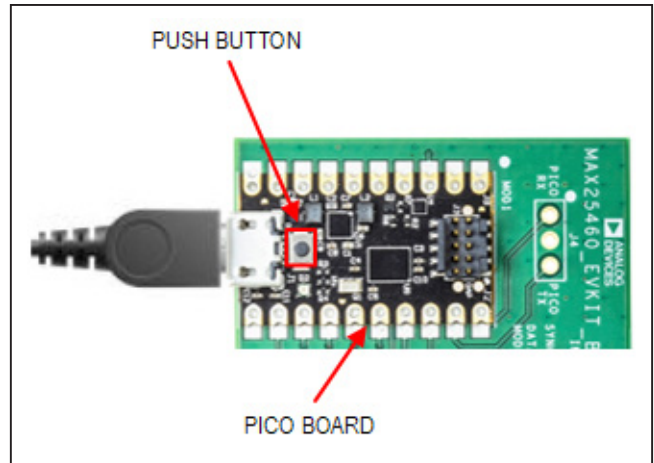


The Pico Board firmware version follows a Year/Month/Day format from when it is released.

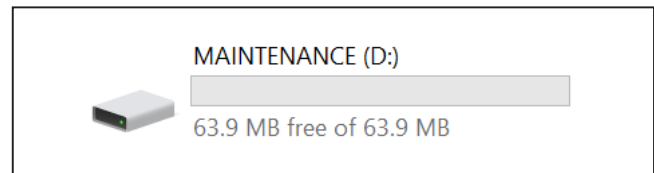
- 3) If the firmware image from the EV kit webpage has a later date, follow the Programming Procedure to update the Pico Board's firmware to the latest version. This update requires the MAX25460 EV kit, a USB Micro-B cable, and a PC with USB Write access.

Programming Procedure

- 1) Download the latest Pico Board firmware on the EV kit webpage (.bin file).
- 2) Connect the USB Micro-B cable to the Pico Board.
- 3) While holding the button down on the Pico Board, plug the USB Micro-B cable into the PC. The button is small, it may be helpful to use a pencil eraser, stylus, or any other non-metallic tool to press the button.



- 4) Continue holding the button down for at least 3 seconds after making the connection.
- 5) A new drive called MAINTENANCE appears on the PC if Step 4 is successful.



- If the MAINTENANCE drive does not appear, disconnect the USB cable and repeat steps 3 to 5.
- 6) Drag and drop the .bin file onto the MAINTENANCE drive. The Pico Board LED blinks during programming.
 - 7) Wait for the blinking to stop, which takes about 5 seconds.
 - 8) When all is finished, launch the GUI and make sure that the Pico Board is detected with the expected firmware version.

Ordering Information

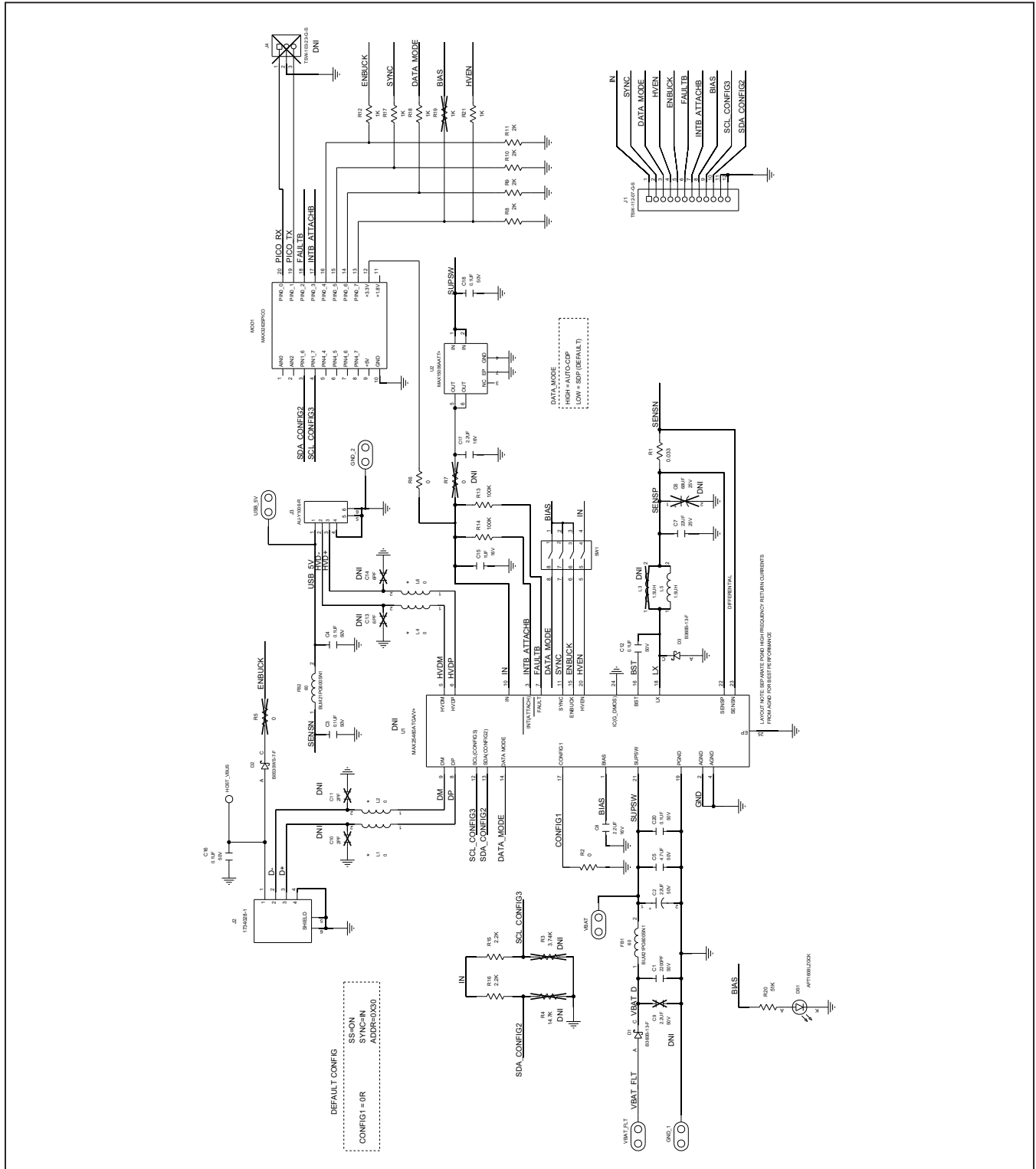
PART	TYPE
MAX25460EVKIT#	EV Kit

#Denotes RoHS compliance.

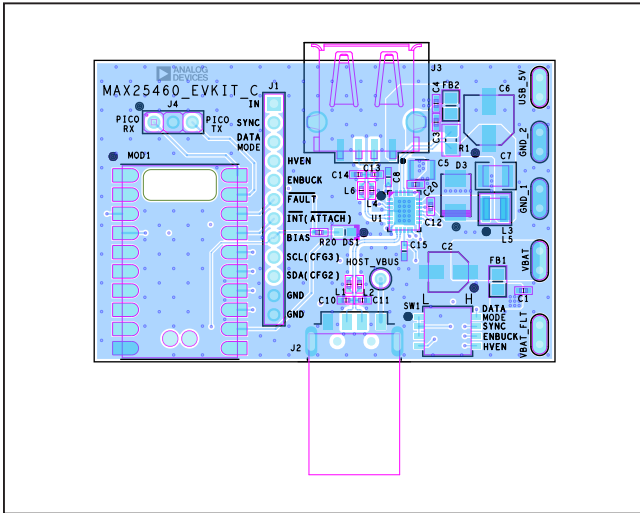
MAX25460 EV Kit Bill of Materials

QTY	REFERENCE	DESCRIPTION	PART NUMBER	MANUFACTURER
1	C1	CERAMIC CAPACITOR (0402) 2200PF 10% 50V X7R	GRM155R71H222KA01	MURATA
1	C2	ALUMINUM-ELECTROLYTIC CAPACITOR 22UF 20% 50V	EEE-FT1H220AR	PANASONIC
6	C3, C4, C12, C16, C18, C20	CERAMIC CAPACITOR (0402) 0.1UF 10% 50V X7R	GRM155R71H104KE14	MURATA
1	C5	CERAMIC CAPACITOR (1210) 4.7UF 10% 50V X7R	GRM32ER71H475KA88	MURATA
1	C7	CERAMIC CAPACITOR (1210) 22UF 10% 25V X7R	GRM32ER71E226KE15	MURATA
2	C8, C17	CERAMIC CAPACITOR (0603) 2.2UF 10% 16V X7R	GRM188Z71C225KE43	MURATA
1	C15	CERAMIC CAPACITOR (0603) 1UF 10% 16V X7R	C0603C105K4RAC	KEMET
2	D1, D3	SCHOTTKY BARRIER DIODE (SMB) 60V 3A	B360B-13-F	DIODES INCORPORATED
1	D2	SCHOTTKY BARRIER DIODE (SOD-323) 30V 0.5A	B0530WS-7-F	DIODES INCORPORATED
1	DS1	GREEN WATER CLEAR LED	APT1608LZGCK	KINGBRIGHT
2	FB1, FB2	FERRITE-BEAD (0805) 60R 25% 3.5A	BLM21PG600SN1	MURATA
5	GND_1, GND_2, USB_5V, VBAT, VBAT_FLT	TEST POINT	5020	KEYSTONE
1	HOST_VBUS	TEST POINT	5003	KEYSTONE
1	J1	HEADER 12-PINS	TSW-112-07-G-S	SAMTEC
1	J2	USB TYPE-A PLUG	1734028-1	TE CONNECTIVITY
1	J3	USB TYPE-A RECEPTACLE	AU-Y1006-R	ASSMANN
1	L5	INDUCTOR 1.5UH 20% 2.7A	DFE252012F-1R5M	MURATA
1	MOD1	MAX32625PICO MODULE	MAX32625PICO	MAXIM
1	R1	RESISTOR (0805) 0.033R 1% +/-50PPM/C 0.5W	KRL1220E-M-R033-F	SUSUMU CO LTD.
6	L1, L2, L4, L6, R2, R6	RESISTOR (0402) 0R 0.2W	CRCW0402000Z0EDHP	VISHAY DALE
4	R8-R11	RESISTOR (0402) 2K 5% 0.063W	CRCW04022K00JN	VISHAY DALE
4	R12, R17, R18, R21	RESISTOR (0402) 1K 5% 0.063W	CRCW04021K00JK	VISHAY DALE
2	R13, R14	RESISTOR (0402) 100K 5% 0.063W	CRCW0402100KJN	VISHAY DALE
2	R15, R16	RESISTOR (0402) 2.2K 5% 0.063W	CRCW04022K20JN	VISHAY DALE
1	R20	RESISTOR (0402) 51K 5% 0.063W	CRCW040251K0JN	VISHAY
1	SW1	QUAD SPST HALF-PITCH DIP SWITCH	TDA04H0SB1	C&K COMPONENTS
1	U1	MAX25460ATGA/V+	MAX25460ATGA/V+	ANALOG DEVICES
1	U2	ULTRA-LOW QUIESCENT-CURRENT LINEAR REGULATOR	MAX15006AATT+	ANALOG DEVICES
1	PCB	MAX25460 REVC	MAX25460 REVC	ANALOG DEVICES

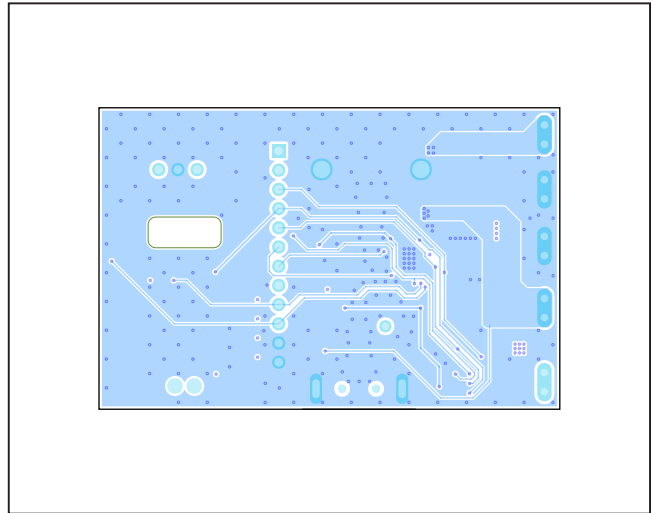
MAX25460 EV Kit Schematic



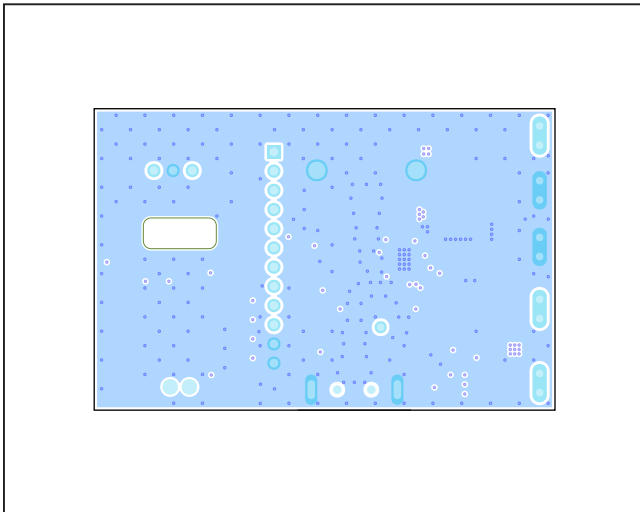
MAX25460 EV Kit Layout



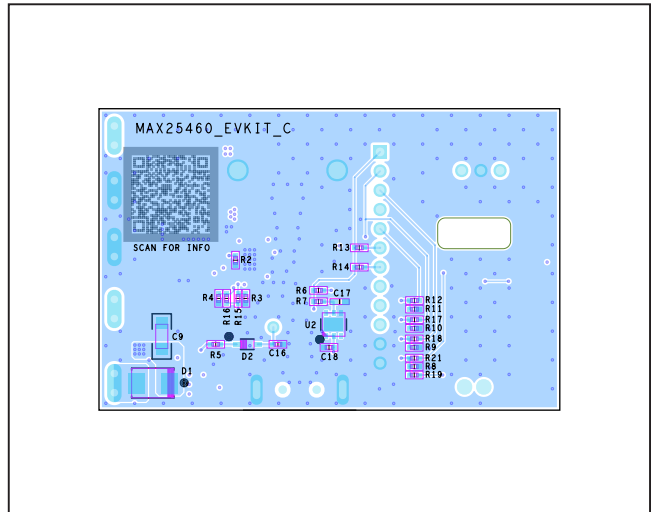
MAX25460 EV Kit PCB Layout—Top View



MAX25460 EV Kit PCB Layout—Layer 3



MAX25460 EV Kit PCB Layout—Layer 2



MAX25460 EV Kit PCB Layout—Bottom View