

# **mPS**<sup>®</sup>

## **User Guide**

**MP2760 Evaluation Kit (EVKT-MP2760)**

**Table of Contents**

Overview .....	3
Introduction .....	3
Kit Contents .....	3
Features and Benefits .....	4
Kit Specifications .....	5
Section 1. Hardware Specifications .....	6
1.1 Personal Computer Requirements .....	6
1.2 EV2760-VT-00A Specifications .....	6
1.3 EVKT-USBI2C-02 Specifications .....	6
Section 2. Software Requirements .....	7
2.1 Software Installation Procedure .....	7
Section 3. Evaluation Kit Test Set-Up .....	8
3.1 Hardware Set-Up <sup>(2)</sup> .....	8
3.2 Powering Up the EVB .....	8
3.3 Software Set-Up .....	9
3.4 Device Programming Instructions .....	11
3.5 Troubleshooting Tips .....	13
Section 4. Ordering Information .....	15

## Overview

### Introduction

 Optimized Performance with MPS MPL-AL5030 Inductor Series

The EVKT-MP2760 is an evaluation kit for the MP2760. The board is designed to demonstrate the capabilities of the MP2760, a buck-boost narrow-voltage DC (NVDC) charger IC for battery packs with 1 to 4 cells in series. The device accepts a wide 4V to 22V input voltage ( $V_{IN}$ ) range to charge the battery and power the load connected on the SYS pin. It also supplies a wide 3V to 21V voltage range at the IN pin when source mode is enabled, which is compliant with USB powered device (PD) specifications.

### Kit Contents

EVKT-MP2760 kit contents (items below can be ordered separately):

#	Part Number	Item	Quantity
1	EV2760-VT-00A	MP2760-0000 evaluation board	1
2	EVKT-USBI2C-02 bag	Includes one USB to I <sup>2</sup> C communication interface, one USB cable, and one ribbon cable	1
3	Online resources	Includes GUI and supplemental documents	-

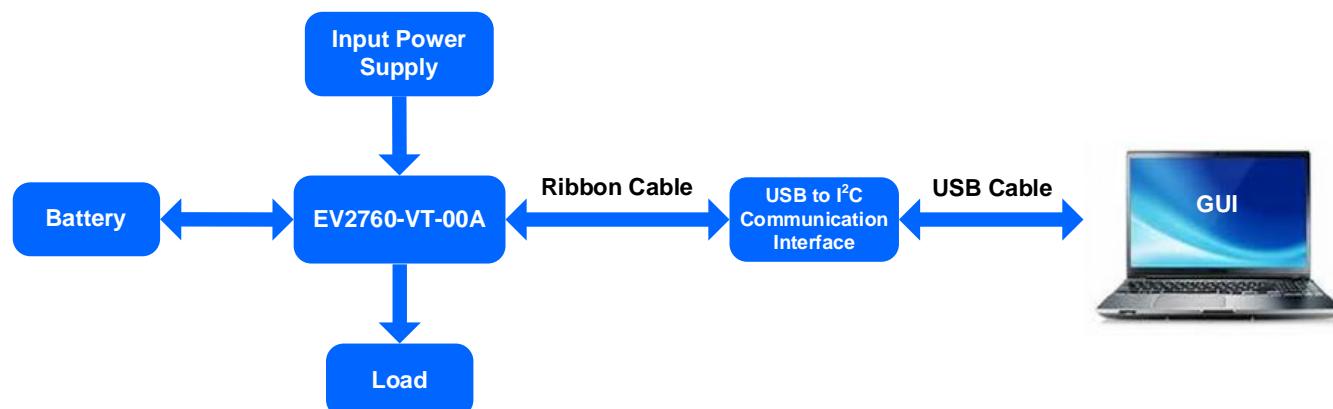


Figure 1: EVKT-MP2760 Evaluation Kit Set-Up

## Features and Benefits

### **MPL** Optimized Performance with MPS Inductor

- Fully Integrated Buck-Boost Charger with Low On Resistance ( $R_{DS(ON)}$ ) Power MOSFETs for 1 to 4 Cells in Series Battery Pack
- Integrated N-Channel MOSFET Driver for Narrow-Voltage DC (NVDC) Power Path Control
- Integrated N-Channel MOSFET Driver for Input Power Pass-Through
- Wide Operating Range:
  - 4V to 22V Operating Input Voltage ( $V_{IN}$ )
  - 3V to 21V Reverse Output Voltage ( $V_{OUT}$ ) with 20mV/Step
  - Up to 6A Input Current ( $I_{IN}$ ) Limit with 50mA/Step
  - Up to 6A Charge Current with 50mA/Step
  - Up to 6A Output Current ( $I_{OUT}$ ) with 50mA/Step
  - 3.4V/Cell to 4.67V/Cell Battery-Full Voltage with 0.5% Accuracy
  - 4V to 20.4V Minimum  $V_{IN}$  Limit with 80mV/Step
  - 500kHz to 1.2MHz Switching Frequency ( $f_{sw}$ )
- I<sup>2</sup>C or SMBus Host Control Interface to Support Flexible Parameter Setting and Status Reporting
- Integrated 10-Bit Analog-to-Digital Converter (ADC) for Voltage, Current, and Temperature Monitoring
- Analog Output Pin to Monitor Charge Current
- Built-In Robust Protections:
  - Input Over-Voltage Protection (OVP)
  - Battery OVP
  - Output Short-Circuit Protection (SCP) in Source Mode
  - Battery Missing Detection
  - NTC Pin Floating Detection
  - Configurable JEITA for Battery Temperature Protection
  - Thermal Regulation and Thermal Shutdown
  - Safety Charge Timer
- Available in a TQFN-30 (4mmx5mm) Package

 *All changes made in I<sup>2</sup>C mode are not retained once the evaluation board shuts down.*

 *Information written in OTP mode cannot be changed.*

## Adjustable Features

I <sup>2</sup> C	OTP
<ul style="list-style-type: none"> <li>Charge currents (<math>I_{TC}</math>, <math>I_{PRE}</math>, <math>I_{CC}</math>, and <math>I_{TERM}</math>)</li> <li>Battery cell number and battery-full voltage</li> <li>Minimum system voltage (<math>V_{SYS\_MIN}</math>) regulation</li> <li>Input minimum voltage regulation (<math>V_{IN\_MIN}</math>)</li> <li>Input current limit (<math>I_{IN\_LIM}</math>) regulation</li> <li>Switching frequency (<math>f_{sw}</math>)</li> <li>Output voltage (<math>V_{OUT}</math>) in source mode</li> <li>Output current (<math>I_{OUT}</math>) limit in source mode</li> <li>Safety charge timer</li> <li>Over-voltage protection (OVP) thresholds</li> <li>Under-voltage (UV) thresholds</li> <li>Negative temperature coefficient (NTC) thresholds</li> <li>Thermal regulation</li> </ul>	<ul style="list-style-type: none"> <li>Charge currents (<math>I_{TC}</math>, <math>I_{PRE}</math>, <math>I_{CC}</math>, and <math>I_{TERM}</math>)</li> <li>Battery cell number and battery-full voltage</li> <li><math>V_{SYS\_MIN}</math> regulation voltage</li> <li><math>V_{IN\_MIN}</math> regulation voltage</li> <li><math>I_{IN\_LIM}</math> regulation</li> <li><math>f_{sw}</math></li> </ul>

## Kit Specifications

Features	Specifications
Supply for Board	4V to 22V
Operating Input Voltage	4V to 22V
Battery Regulation Voltage	3.6V/Cell to 4.68V/Cell
Fast Charge Current	Up to 6000mA
Minimum System Voltage <sup>(1)</sup>	2.4V to 16.8V
Minimum Input Voltage Regulation	4V to 20.4V
Input Current Limit	Up to 6000mA
Output Voltage in Source Mode	3V to 21V
Operating Systems Supported	Windows XP, 7, or later
System Requirements	Minimum 22.2MB free
GUI Software	MP2760 programming tool
EVB Size (LxW)	8.9cmx8.9cm

### Note:

1) It is recommended to set the value according to the battery cell count.

## Section 1. Hardware Specifications

### 1.1 Personal Computer Requirements

The following minimum conditions must be met to use the EVKT-MP2760:

- Operating system of Windows XP, 7, or later
- Net Framework 4.0
- PC with a minimum of one available USB port
- At least 22.2MB of free space

### 1.2 EV2760-VT-00A Specifications ~MPL Optimized Performance with MPS Inductor

The EV2760-VT-00A is an evaluation board for the MP2760-0000. For more information, refer to the EV2760-VT-00A datasheet.



Feature	Specifications
Supply for Evaluation Board	4V to 22V
Operating Input Voltage	4V to 22V
Battery Regulation Voltage	3.6V/Cell to 4.68V/Cell
Fast Charge Current	Up to 6000mA
EVB Size (LxW)	8.9cmx8.9cm

Figure 2: EV2760-VT-00A Evaluation Board

### 1.3 EVKT-USBI2C-02 Specifications

The EVKT-USBI2C-02 refers to the USB-to-I<sup>2</sup>C communication interface, which connects the EVB, the PC, and its supporting accessories (see Figure 3). It provides PMBus capabilities. Together with MPS's Virtual Bench Pro and I<sup>2</sup>C GUI tools, it provides a quick and easy way to evaluate the performance of MPS digital products. For more details, refer to the EVKT-USBI2C-02 datasheet.



Figure 1: EVKT-USBI2C-02 Communication Interface

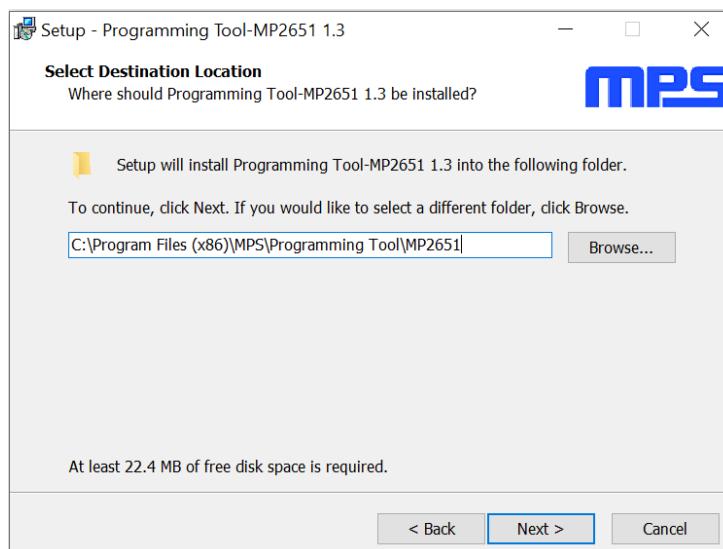
## Section 2. Software Requirements

### 2.1 Software Installation Procedure

Configuration occurs through the MPS I<sup>2</sup>C GUI. Follow the instructions below to install the software:

*Note: This software can be downloaded from the MPS website.*

1. Download and extract the relevant files.
2. Double click the “.exe” file to open the set-up guide (see Figure 4). If a protection window comes up, click “More info,” then click “Run anyway.”
3. Follow the prompts in the set-up guide.
4. Wait for the status screen to verify that installation is complete (see Figure 5).



**Figure 2: MPS I<sup>2</sup>C GUI Set-Up Guide**



**Figure 5: Driver Set-Up Success**

## Section 3. Evaluation Kit Test Set-Up

### 3.1 Hardware Set-Up <sup>(2)</sup>

The hardware must be properly configured prior to use. Follow the instructions below to set up the EVB:

1. Connect the EVB to the EVKT-USBI2C-02 communication interface with the 3-pin ribbon cable and ensure they are connected.
2. Connect SCL, SDA, and GND (see Figure 6). If needed, refer to the MP2760 datasheet for further clarification.
3. Connect the EVKT-USBI2C-02 to the computer.

**Note:**

- 2) It is important to adhere to the order of these steps. Failing to do so may cause damage to the communication pins (SCL and SDA) during a hot plug event.

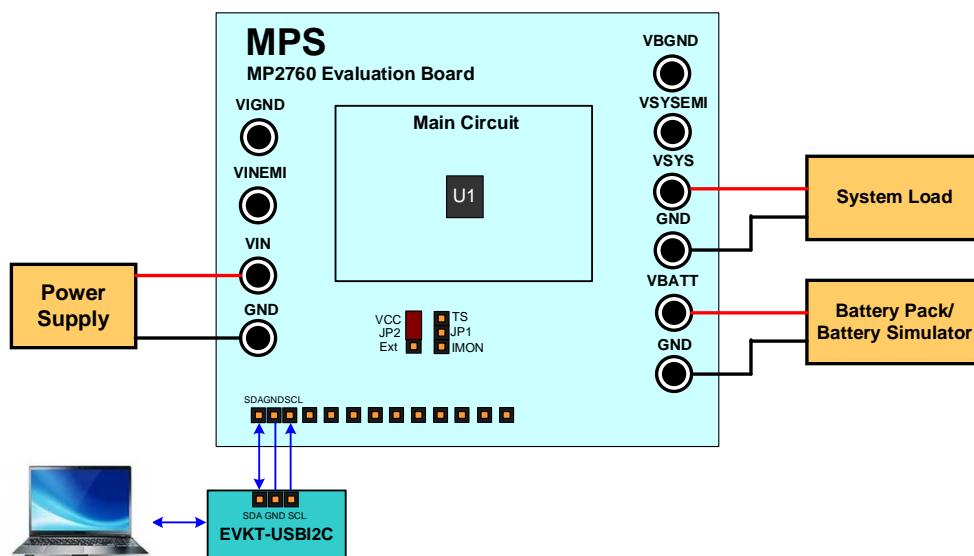


Figure 6: EVB to MPS I<sup>2</sup>C Communication Interface Wire Connection

### 3.2 Powering Up the EVB

1. Connect the battery terminals to:
  - a. Positive (+): VBATT
  - b. Negative (-): GND
2. If using a battery simulator, preset the battery voltage ( $V_{BATT}$ ) between 0V and 8.4V, then turn off the battery simulator.
3. Connect the battery simulator output terminals to:
  - a. Positive (+): VBATT
  - b. Negative (-): GND
4. Ensure that  $V_{BATT}$  is present. If using a battery simulator, turn on the simulator after making the connections.
5. For charge mode testing, connect the power supply terminals to:
  - a. Positive (+): VIN
  - b. Negative (-): GND

6. Preset the power supply output between 4V and 22V, then turn on the power supply.
7. For source mode testing, connect the load terminals to:
  - a. Positive (+): VIN
  - b. Negative (-): GND
8. Connect the system load terminals to:
  - a. Positive (+): VSYS
  - b. Negative (-): GND
9. For EMI testing, connect the input or load terminals to:
  - a. Positive (+): VINEMI
  - b. Negative (-): VIGND

Connect the system load terminals to:

  - c. Positive (+): VSYSEMI
  - d. Negative (-): VBGND

10. Remove all other connectors (VIN, GND, VBATT, and GND) and pin headers.

### 3.3 Software Set-Up

After connecting the hardware according to the steps above, follow the steps below to use the GUI software:

1. Start the software. It should automatically check the EVB connection.
  - If the connection is successful, “Device connected” is listed at the bottom (see Figure 7).

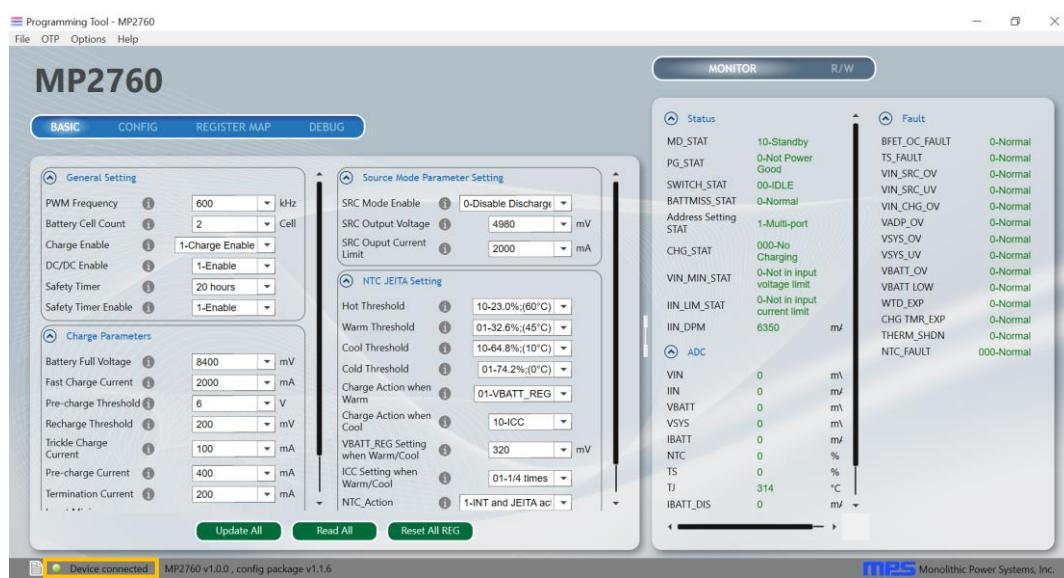


Figure 7: Status Shows Successful Connection

- If the connection is unsuccessful, a warning appears at the bottom. There are two warnings that the user can expect:
  - “Device disconnected” means that the evaluation board is not connected correctly (see Figure 8 on page 10).

- “USB disconnected” means that the USB to I<sup>2</sup>C communication interface is not connected correctly (see Figure 9).

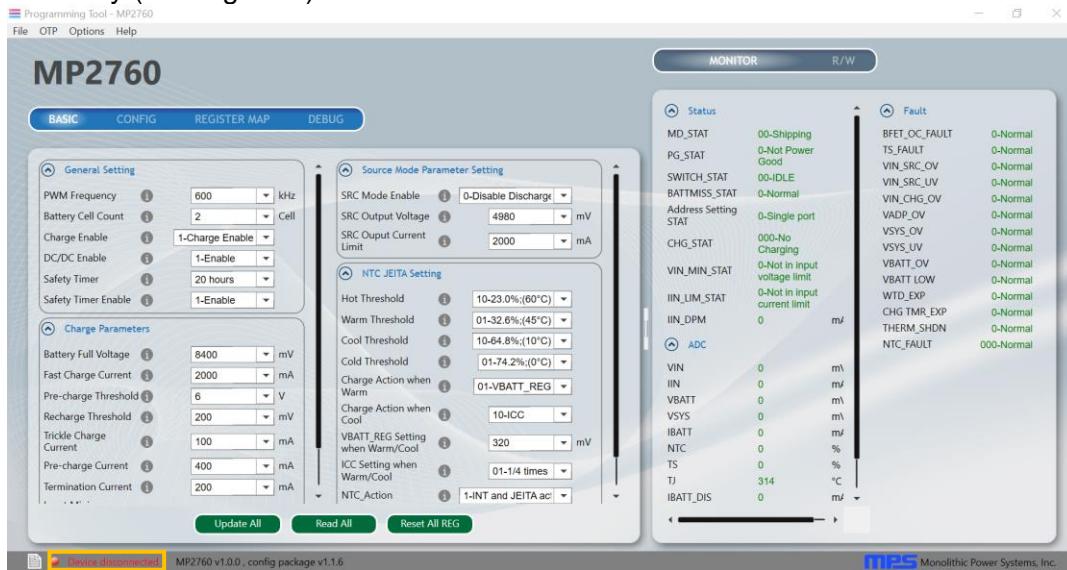


Figure 8: Warning Indicates Unsuccessful Evaluation Board Connection



Figure 9: Warning Indicates Unsuccessful USB I<sup>2</sup>C Communication Interface Connection

- If the connection is successful, proceed to Step 3. Otherwise, check connections between the EVB, communication interface, and PC. Re-plug the USB into the computer and restart the GUI.
- Click the “Read All” button to read the I<sup>2</sup>C register values. The default values are displayed (see Figure 10 on page 11).
- Find the item to be changed, then select the desired value from the drop-down menu.
- Click the “Write All” button to update the values. The changed information should download to the IC.

**⚠ All changes made via the I<sup>2</sup>C are restored to their default values once the EVB shuts down.**

Command code	Command name	Register Value
05H	Device Address Setting	0200
06H	Input Minimum Voltage Limit Setting	0039
07H	System Minimum Voltage Setting	001E
08H	Input Current Limit Setting	000A
09H	Output Voltage Setting	00F9
0AH	Battery Impedance Compensation and Output Current Limit Setting	0028
0BH	Battery Low Voltage Setting and Battery Discharge Current Regulation	3080
0CH	JEITA Action Setting	3410
0DH	Temperature Protection Setting	B399
0EH	Configuration Register 0	0010
0FH	Configuration Register 1	F244
10H	Configuration Register 2	0A40
11H	Configuration Register 3	60E8
12H	Configuration Register 4	3C53
14H	Charge Current Setting	0A00
15H	Battery Full Voltage Setting	3480

Figure 10: Default Register Values from the I<sup>2</sup>C

### 3.4 Device Programming Instructions

The MP2760-xxxx is a one-time programmable (OTP) part, where “-xxxx” is the register setting option. The factory default is “-0000,” and this content can be viewed in the I<sup>2</sup>C register map. Follow the instructions outlined below to create and export customized configurations:

1. Using a computer, open the MPS GUI software. Make sure you have powered on the EVB.
2. Ensure connection between the EVB and computer.
3. Select “OTP View” under OTP in the toolbar (see Figure 11).

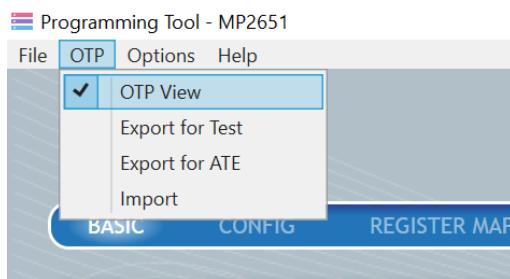


Figure 11: Select OTP

4. Enter a new table in OTP view (see Figure 12). All selectable parameters can be changed.

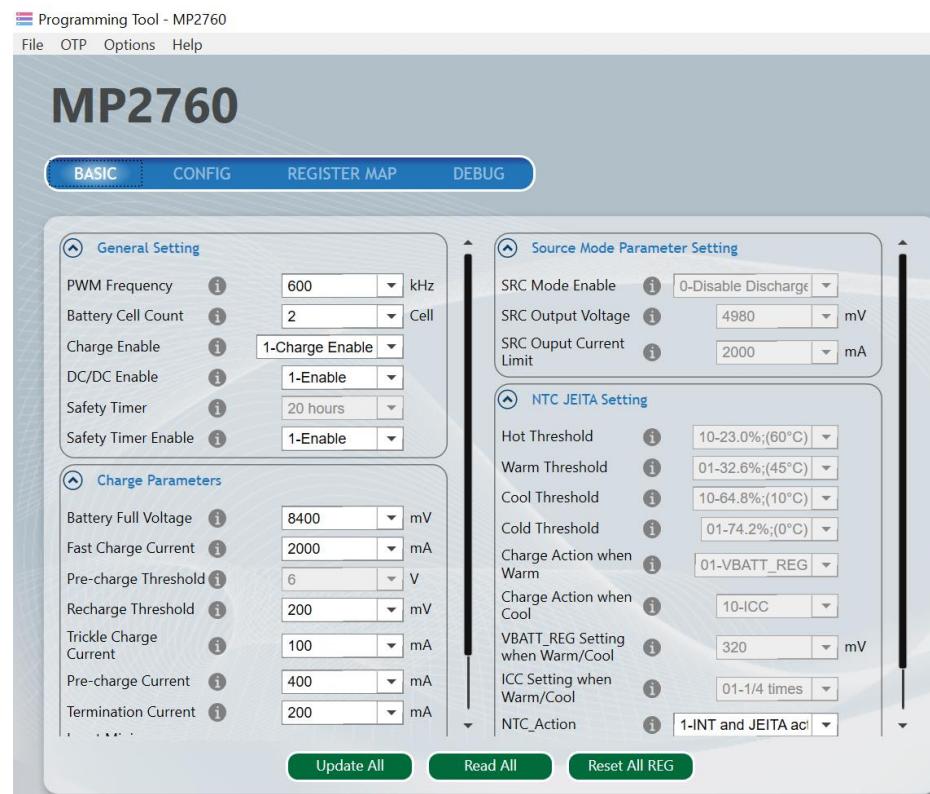


Figure 12: Adjustable Parameters in OTP Mode

- Select the desired values from the drop-down menus.
- Ensure that all the parameters are inputted before selecting “Export for test” in the toolbar.
- Click “Export” to export the selected configurations (see Figure 13).

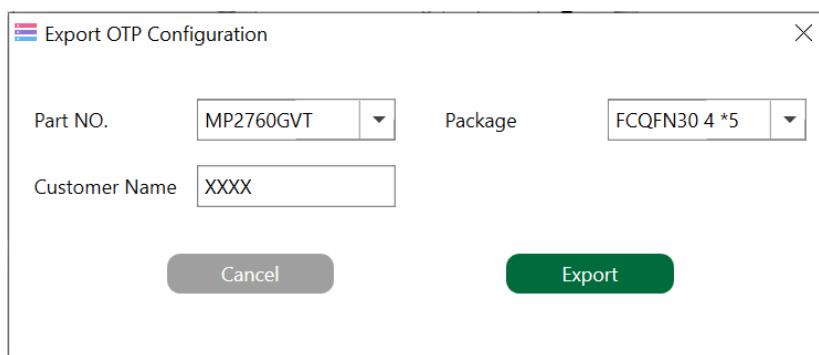


Figure 13: Export the Fully Populated Table

- Find a location for the exported file and click “Save”. The configurations are saved in a text file (see Figure 14 on page 13).

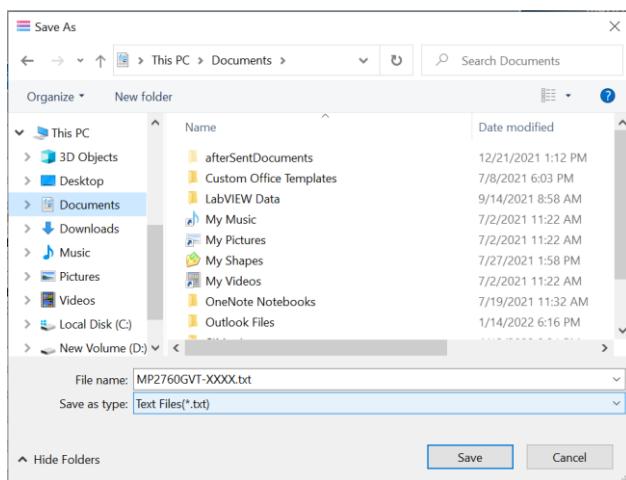


Figure 14: Save the Exported Configurations

- Send this file to an MPS FAE to request a custom “-xxxx” code.

### 3.5 Troubleshooting Tips

#### EVKT-USBI2C-02 Driver Installation Problem

If the USBI2C-02 driver is not properly installed, manual installation is required. Follow the steps below to manually install the EVKT-USBI2C-02 driver:

*Note: Find “USBXpress Device” in the Device Manager.*



*If the PC is running Windows 10, check the driver version of USBXpress Device. Windows 10 automatically installs the older USB driver, which is not compatible. The correct driver version is 4.0.0.0 (see Figure 15 on page 13).*

- Install the correct “USBXpress .exe” file. Choose either the 32-bit or 64-bit operating system.
  - 32-bit: USBXpressInstaller\_x86.exe
  - 64-bit: USBXpressInstaller\_x64.exe
- Connect the EVKT-USBI2C-02 communication interface to the PC with the USB cable.

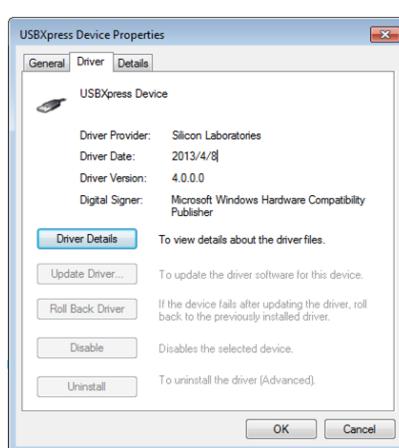


Figure 15: Correct Driver Version

**No Supply**

The IC's input pin has an under-voltage lockout (UVLO) detection circuit. If the input voltage ( $V_{IN}$ ) is below the UVLO rising threshold, the PMIC's functions are disabled.

**Shutdown Event**

If the IC detects that  $V_{IN}$  is below the UVLO falling threshold (enter no supply state) or over-temperature protection is triggered (enter shutdown state), then the IC switches to a no supply state or shutdown state, regardless of the current state.

**Thermal Recovery**

If the MP2760 is in a shutdown state due to the die temperature exceeding the thermal protection threshold, then the IC starts up again once the die temperature decreases.

## Section 4. Ordering Information

The components of the evaluation kit can be purchased separately, depending on user needs, and the GUI installation file and supplemental documents can be downloaded from the MPS website.

Part Number	Description
EVKT-MP2760	Complete evaluation kit
<b>Contents of EVKT-2760</b>	
EV2760-VT-00A	MP2760-0000 evaluation board
EVKT-USBI2C-02 bag	Includes one USB to I <sup>2</sup> C communication interface, one USB cable, and one ribbon cable
Online resources	Includes GUI and supplemental documents

**Order directly from [MonolithicPower.com](http://MonolithicPower.com) or our distributors.**

**REVISION HISTORY**

<b>Revision #</b>	<b>Revision Date</b>	<b>Description</b>	<b>Pages Updated</b>
1.0	2/17/2023	Initial Release	-

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