MCP19110/11/18/19 – Buck Power Supply Graphical User Interface User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.

- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.

- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.

- Microchip is willing to work with the customer who is concerned about the integrity of their code.

- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Object of Declaration: MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In

EU Declaration of Conformity

Manufacturer: Microchip Technology Inc.
                       2355 W. Chandler Blvd.
                       Chandler, Arizona, 85224-6199
                       USA

This declaration of conformity is issued by the manufacturer.

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not intended to be a finished appliance, nor is it intended for incorporation into finished appliances that are made commercially available as single functional units to end users. This development/evaluation tool complies with EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.

Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA
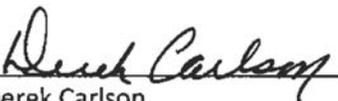
Derek Carlson

Derek Carlson
VP Development Tools

12-Sep-14
Date

NOTES:

MCP19110/11 – BUCK POWER SUPPLY GRAPHICAL USER INTERFACE USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In and a description of the user's guide.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	`file`.o, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`

	Represents code supplied by user	`void main (void)`
		`{ ...`
		`}`

RECOMMENDED READING

This user's guide describes how to use the DSTEMP. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP19110/11 Data Sheet** – *"Digitally Enhanced Power Analog Controller with Integrated Synchronous Driver"* **(DS20002331)**
- **MCP19118/19 Data Sheet** – *"Digitally Enhanced Power Analog Controller with Integrated Synchronous Driver"* **(DS20005350)**
- **MCP87018 Data Sheet** – *"High-Speed N-Channel Power MOSFET"* **(DS20002329)**
- **MCP87050 Data Sheet** – *"High-Speed N-Channel Power MOSFET"* **(DS20002308)**
- **MCP19111 User's Guide** – *"MCP19111 Evaluation Board User's Guide"* **(DS50002109)**
- **MCP19110/11 Programming Specification** – *"MCP19110/11 Flash Memory Programming Specification"* **(DS20002336)**
- **MCP19118/19 Programming Specification** – *"MCP19118/19 Flash Memory Programming Specification"* **(DS20005321)**

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, and Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision B (December 2014)

• Added MCP19118/19 documentation to **"Recommended Reading"**.
• Added **Section 2.3 "Plug-In Features"**.
• Updated **Section 2.4 "GUI Tab Descriptions"**.

Revision A (March 2013)

• Initial Release of this Document.

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In is a stand-alone, hybrid (analog + digital), synchronous buck Pulse-Width Modulation (PWM) controller for point-of-load (POL) applications. It offers the ability to adjust many key attributes of the analog PWM controller's operation. While at first it may seem that adjusting and configuring the product performance and feature set may be a challenge, it was with this in mind that the MCP19110/11/18/19 MPLAB X Plug-In was developed. This graphical user interface (GUI) simplifies the configuration of the controller and power conversion system and enables users to get to solutions faster.

The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface User's Guide explains how to install and use the plug-in.

FIGURE 1-1: *General System Diagram.*
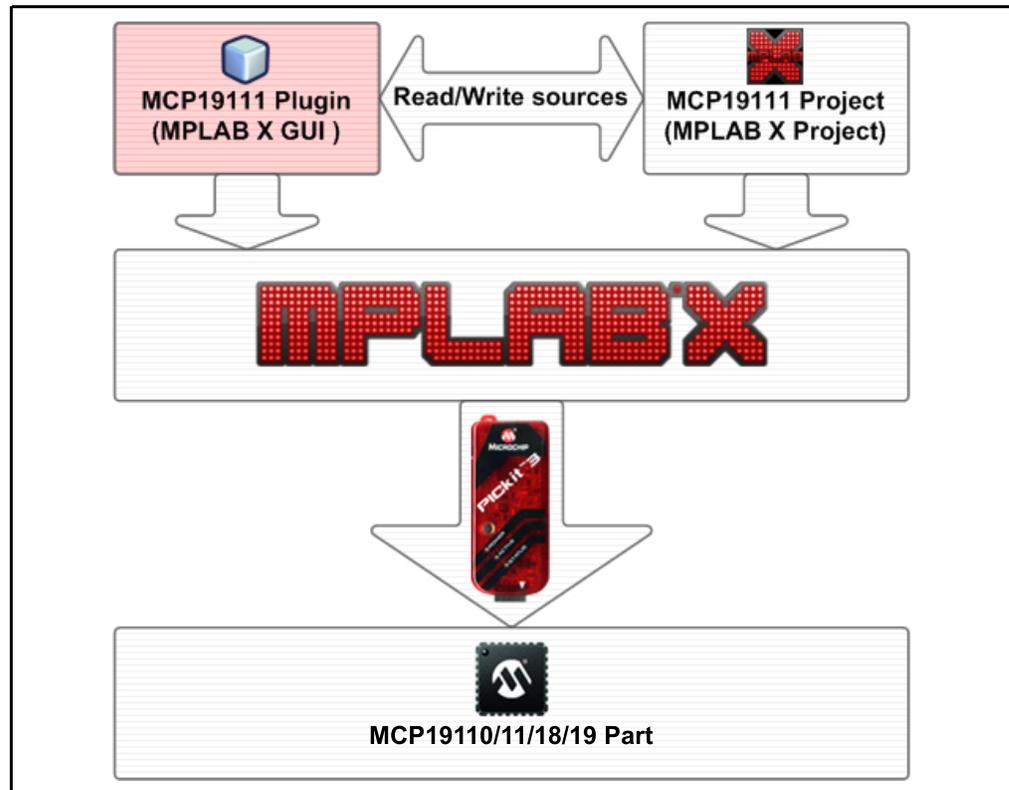
To summarize, the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In is used within the MPLAB® X Integrated Development Environment (IDE). No knowledge of the MPLAB X IDE is required but, as the user becomes more familiar with Microchip's software tools and device performance, the MPLAB X IDE offers a path to support more advanced control algorithms and configurations.

1.2   THE DEVELOPMENT SYSTEM'S COMPONENTS

1. **MCP19110/11/18/19 MPLAB® X IDE Graphical User Interface Plug-In:** This graphical user interface simplifies the configuration of the MCP19110/11/18/19. It is user-installed and resides within the MPLAB X IDE. This user's guide describes the plug-in installation procedure, as well as how to use it.

2. **MPLAB® X Integrated Development Environment (IDE):** This is a complete software development environment that links the software and hardware development. This is a free tool, available from Microchip, that supports device configuration, advanced programming, as well as debug support. The GUI resides inside the MPLAB X IDE.

3. **MCP1911X – Power Supply Firmware:** This firmware is provided by the plug-in. See **Section 2.3.1 "MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In Description"**. This is standard firmware that has been configured to work with this graphical user interface once it is opened as a project within MPLAB X IDE.

4. **MPLAB® XC8 Compiler:** The firmware described above is coded in C and thus requires a C-compiler. C-compilers are available for free from Microchip's website.

5. **MCP19111 – Power Supply Evaluation Board**: This board is available from Microchip and provides a method to evaluate the performance of the MCP19111 in the target end application.

6. **PICkit 3 In-Circuit Debugger/Programmer, etc.:** A programming tool is required to configure the evaluation board. We recommend the PICkit 3 or ICD3, which is available from microchipDIRECT.

In practice, the user modifies the GUI parameters to provide the features and performance needed in the end applications. The GUI modifies the firmware, compiles it with the XC8 C-compiler and then loads it, through the PICkit 3, to the MCP19111 Evaluation Board. The MCP19111 Evaluation Board will then perform as configured.

1.3   ROLE OF FIRMWARE

This section gives a brief overview of different tasks that may be accomplished by a MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In firmware.

1.3.1   Initialize the Internal Peripherals

At start-up, the firmware initializes the internal operating points of the device. These include, but are not limited to:

- switching frequency, phase shift, maximum duty cycle
- output voltage set point
- compensation parameters
- protection peripherals (overvoltage, undervoltage etc.)

This action is accomplished by writing specific values into the corresponding registers.

1.3.2   Handle Protection Events

Most integrated analog protection functions can interrupt the main program execution. This ensures that the product, and more specifically the firmware, can react to external events as fast as possible.

1.3.3   Soft-Start Ramp

When the output turns on, the device uses a voltage ramp in order to reach the output voltage target. This ramp is managed by the firmware by increasing the internal reference (OVCCON) step by step.

1.3.4   Environment Monitoring

The device can continually check its environment by using the internal analog-to-digital converter (ADC). It can then use this result to make any operating point adjustments. The firmware also handles the GPIO pins' states.

1.4   GRAPHICAL USER INTERFACE (GUI) ENVIRONMENT

The screen shot below provides a picture of MPLAB X IDE with the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In installed (bottom left) and the MCP19110/11/18/19 – Buck Power Supply Graphical User Inter-face Plug-In project opened (top left). More information is available in **Chapter 2. "Installation and Operation"**.
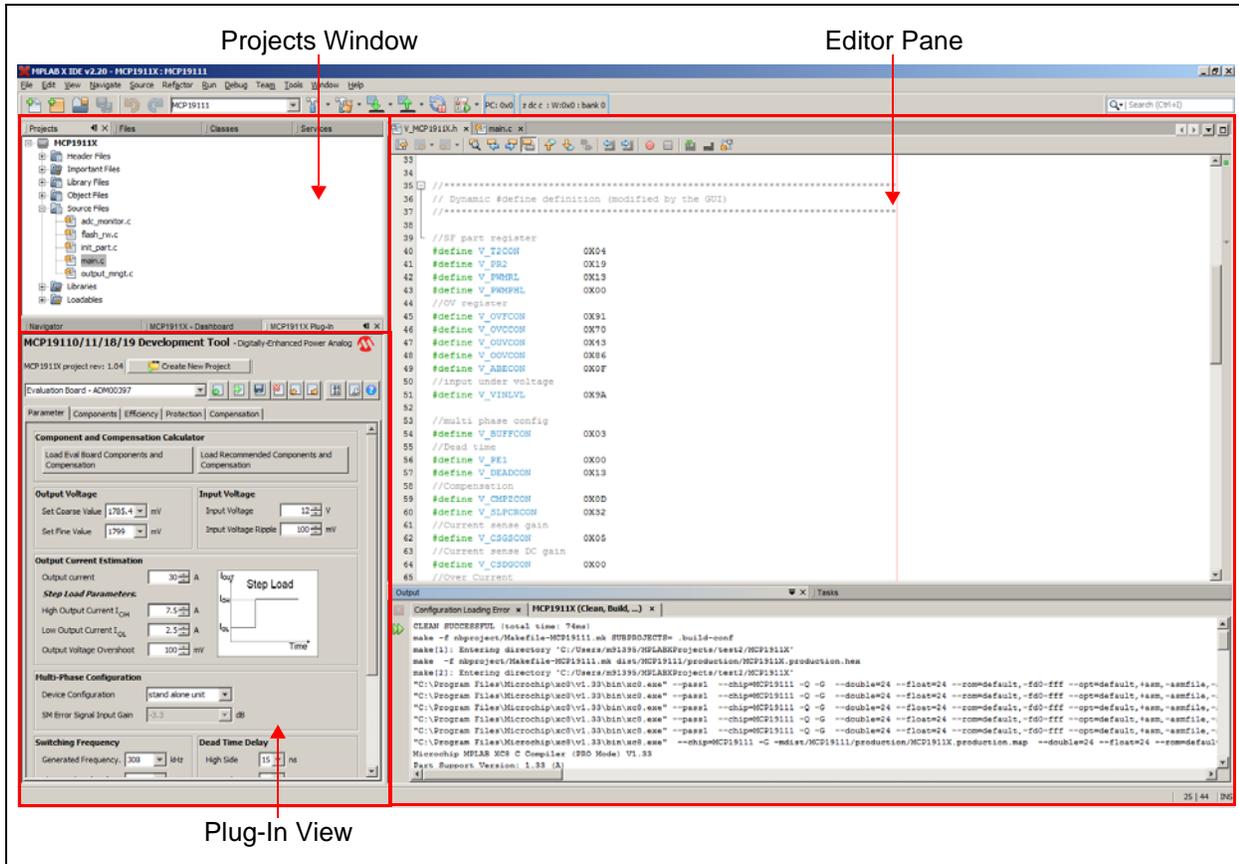

FIGURE 1-2:   *MCP19110/11/18/19 MPLAB X Plug-In User Interface Overview.*

> **Note:**   The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In is preset to be used with the MCP19111 Evaluation Board (ADM00397). However, it is possible to use the plug-in with another board.

Chapter 2. Installation and Operation

2.1 GETTING STARTED

2.1.1 Required Software

- MPLAB X IDE v2.20 or later
- MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In archive. See the MCP19110/11 or MCP19118/19 devices web pages for details. The archive contains the MCP19110/11/18/19 plug-in file (`com-microchip-mplab-mcp1911X-buckpowersupply.nbm`)
- MPLAB XC8 C Compiler (v1.33 or later)

2.1.2 Required Hardware

- Microchip PIC programmer/debugger (for example, PICkit 3 or ICD3)
- MCP19111 Evaluation Board (ADM00397) or another board containing an MCP19110/11/18/19 and a programming connector

> **Note:** If you are not using the standard MCP19111 Evaluation Board (ADM00397), then some of the predefined features may not be compatible with your configuration. The schematic of the MCP19111 Evaluation Board, as well as ***"MCP19111 Evaluation Board User's Guide"*** (DS52109), are available on the Microchip website. From the Microchip website, please search for the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In product page and review the software tools.

2.1.3 Software Installation

The following steps describe how to install the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In.

1. If MPLAB X IDE is already installed, go to Step 2. If not, download MPLAB X IDE (free) from www.microchip.com/mplabx and follow the MPLAB X IDE installation instructions.
2. If an XC8-compatible C-compiler is already installed in MPLAB X IDE, go to Step 3. If not, you can download a free version of Microchip's XC8 from www.microchip.com/mplabxc. The XC8 user's guide, installation instructions and download links are available on this page.
3. Download the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In Archive (*.zip) from www.microchip.com/mcp19111 under "Documentation & Software".
4. Unzip the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In archive, which contains the `com-microchip-mplab-mcp1911X-buckpowersupply.nbm` plug-in file.

5. The plug-in file must be installed in MPLAB X IDE. To install it, open MPLAB X IDE. From the menu bar, select Tools > Plugins.
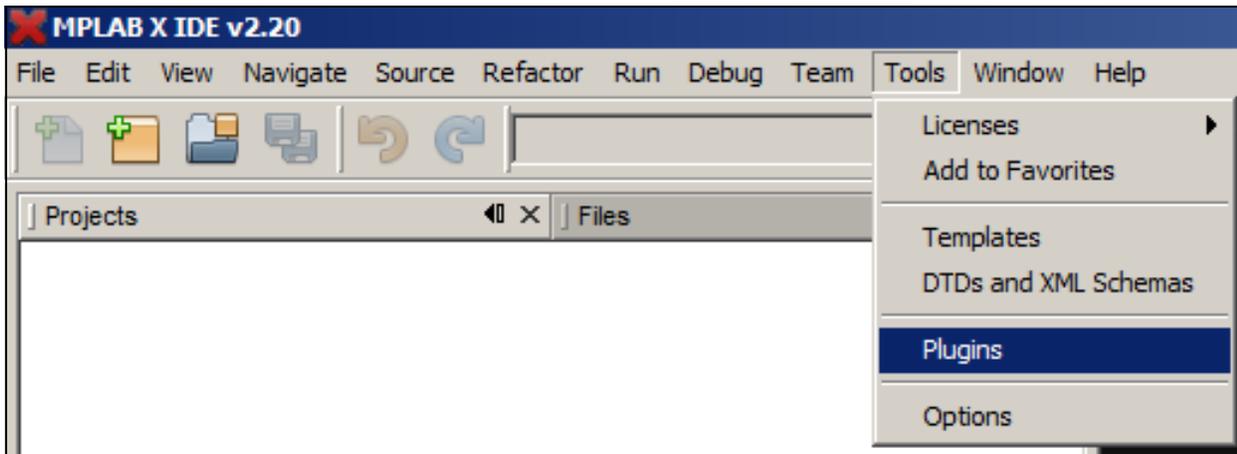
FIGURE 2-1: *Starting the Plug-In Installation.*

6. This opens a new Plugins window. Select the **Downloaded** tab and click on the **Add Plugins** button.
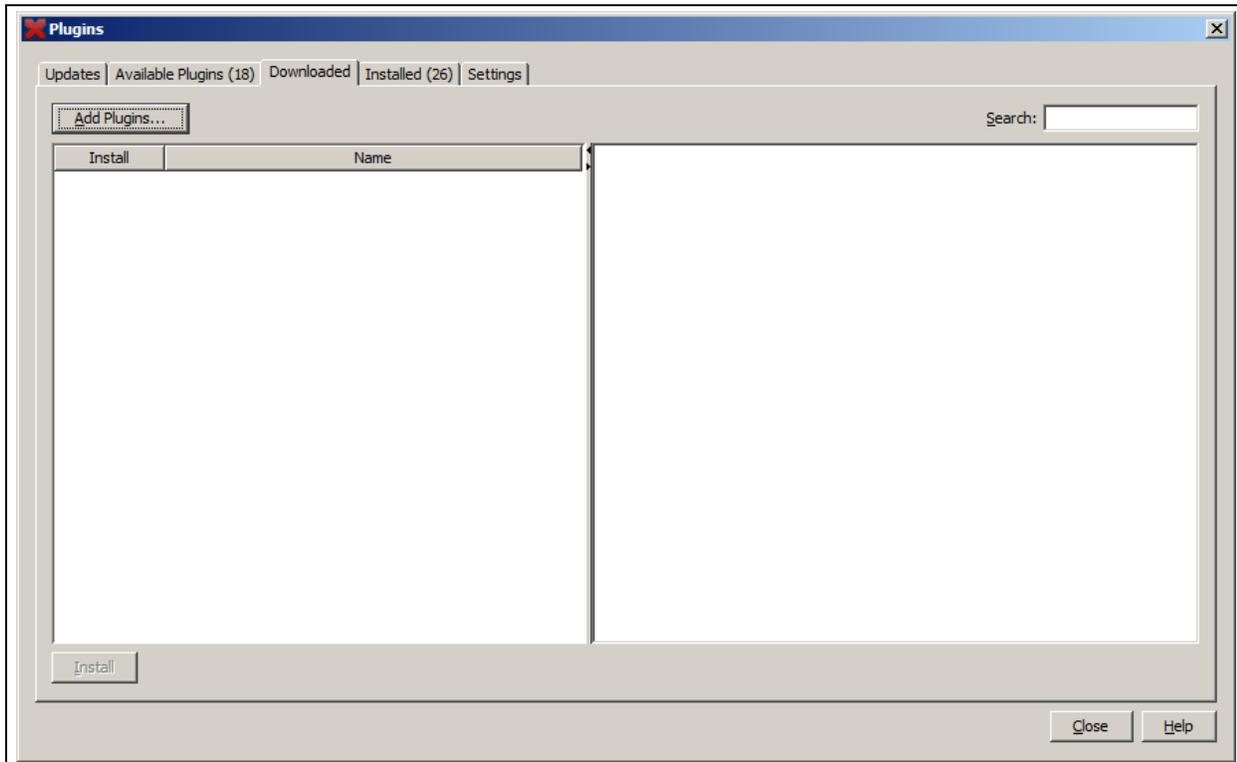
FIGURE 2-2: *The Plugins Window.*

7. Locate the `com-microchip-mplab-mcp1911X-buckpowersupply.nbm` file that was downloaded in the archive and click on **Open**. Then click on the **Install** button on the bottom left side of the window.
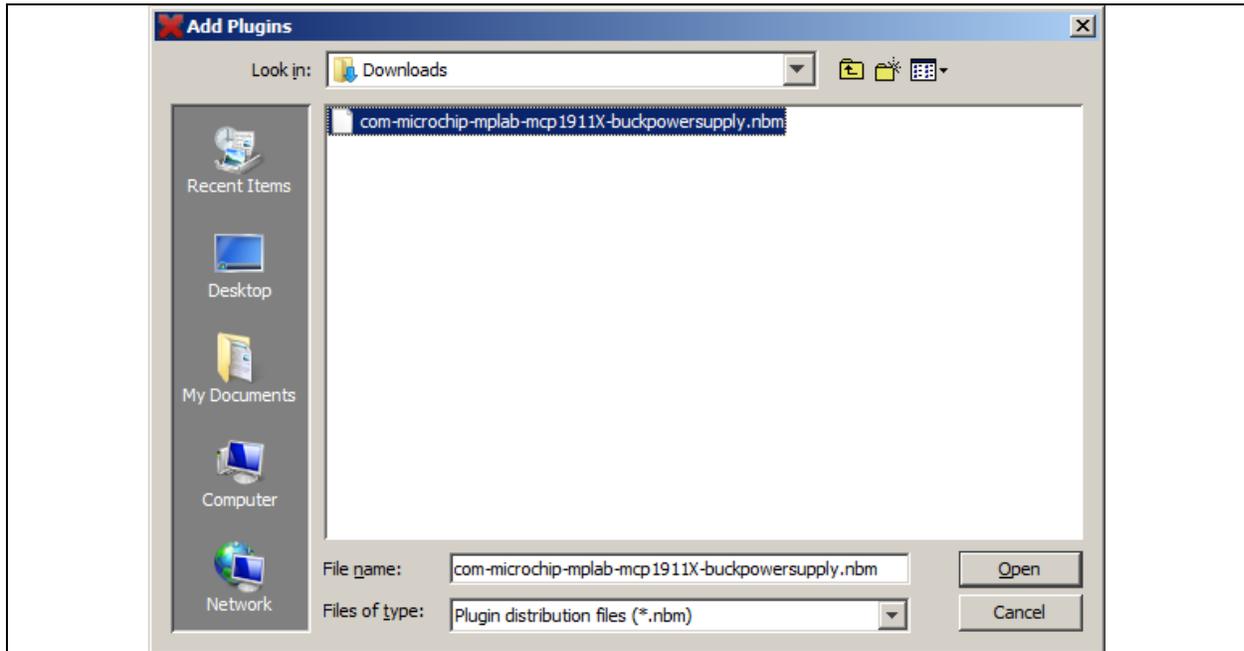
FIGURE 2-3: *Opening and Launching the Plug-In Installation File.*

8. This opens the "Plugin Installer" window. Click on **Next** to continue.
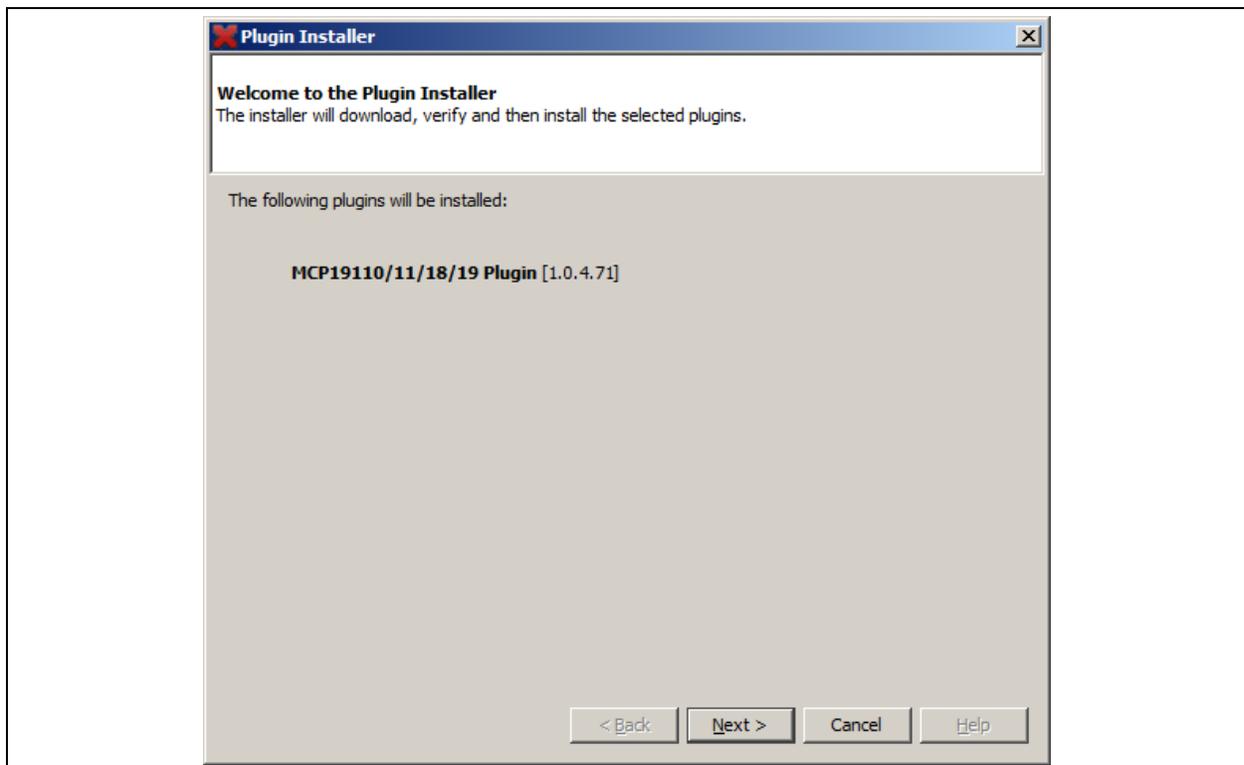
FIGURE 2-4: *The Plugin Installer Window.*

9. Review and accept the License Agreement by checking the **I accept the terms in all of the license agreements** check box, then click on **Install**.
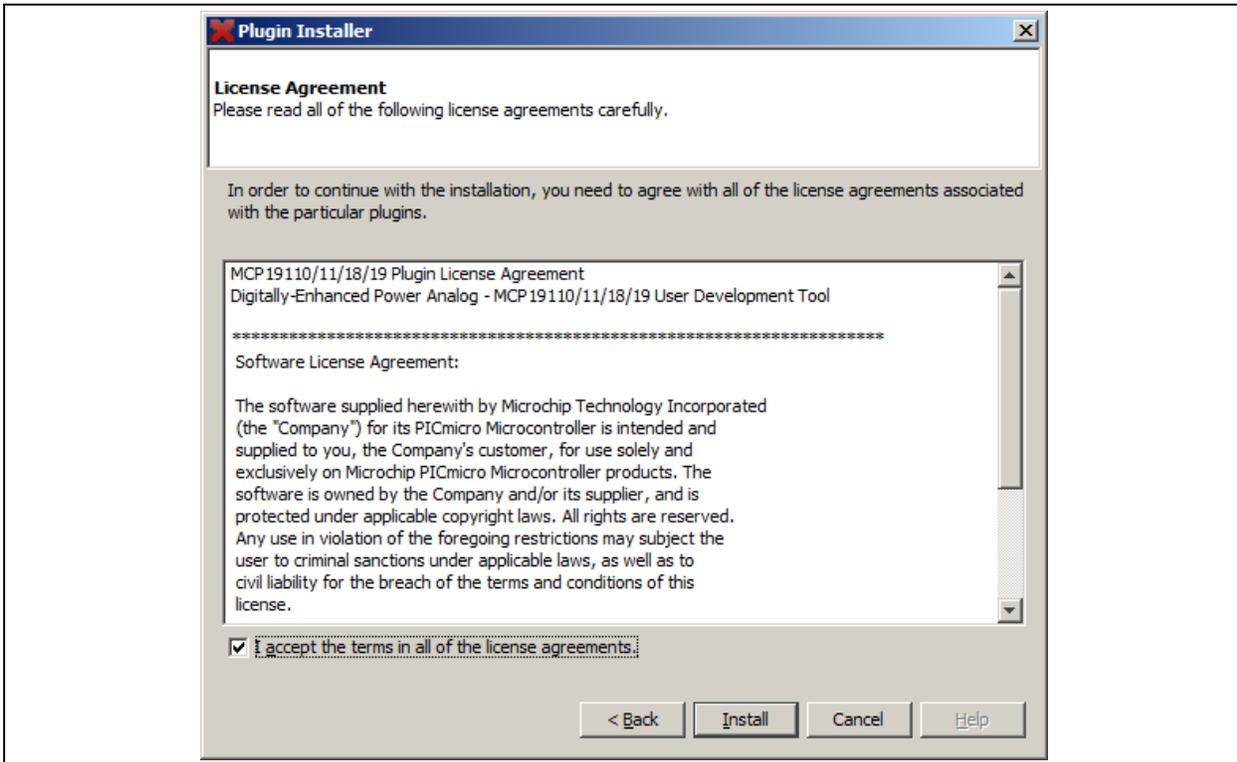
FIGURE 2-5: *Plug-In License Agreement.*

10. If a window opens indicating that the MCP19110/11/18/19 plug-in is not signed, click on **Continue**.
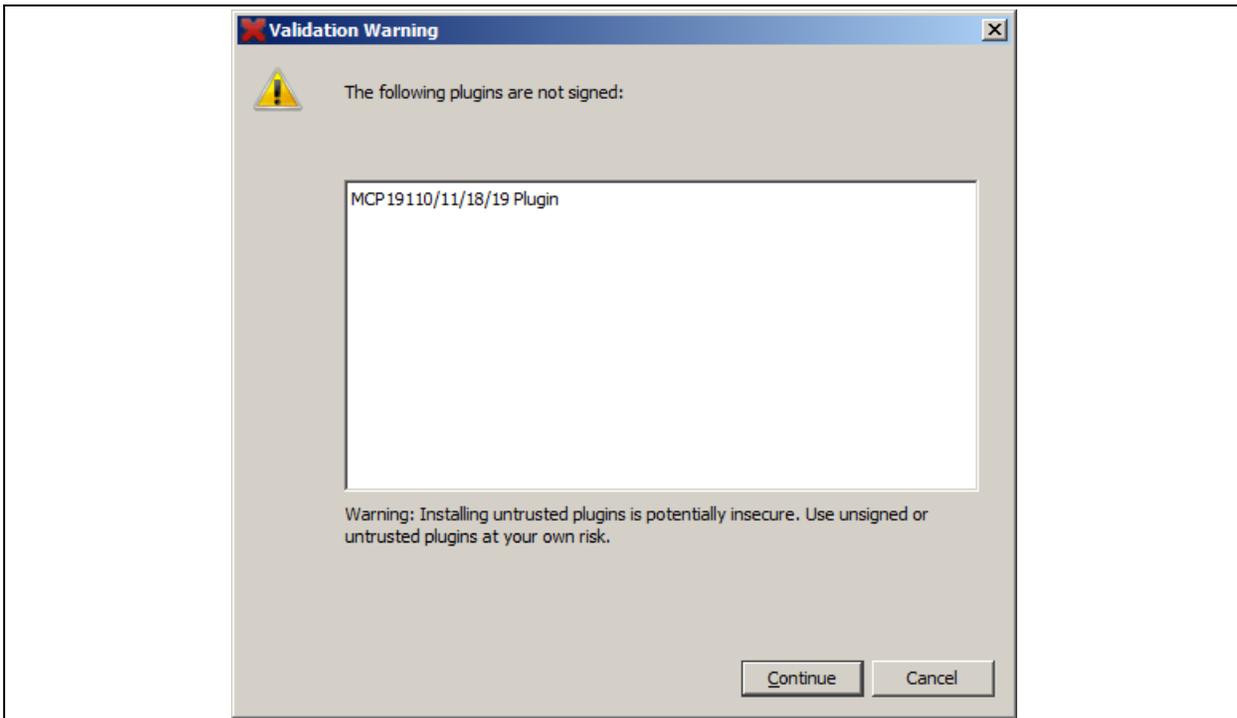
FIGURE 2-6: *Validation Warning Message.*

11. Once the installation completes, select **Finish** to close the Plugin Installer window. The installation requires the MPLAB X IDE to be restarted. Choose the option that best fits your needs. When done, the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In should be visible as displayed in Figure 2-8.
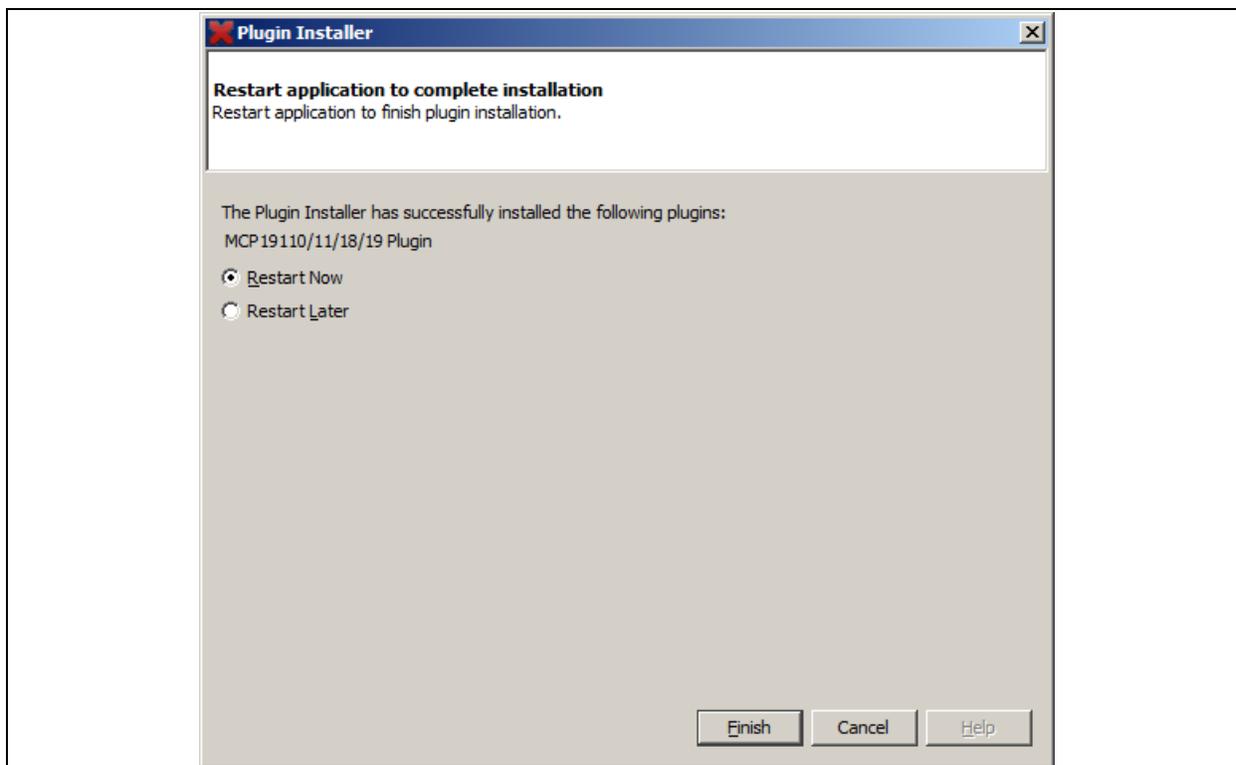
FIGURE 2-7:   *Plug-In Installation Complete.*

> **Note:** The MPLAB X IDE allows the windows to be configured in different ways. To adjust placement or orientation, use your mouse to click and hold the tabs you want to move, then drag them to the location you want.
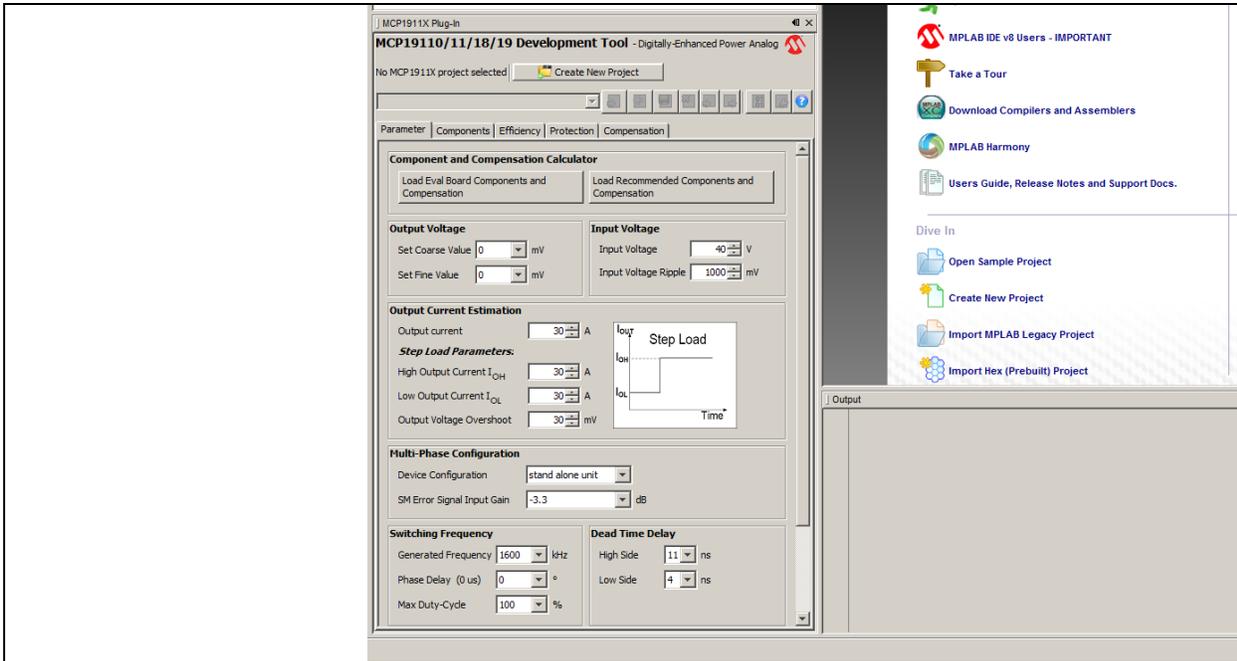
FIGURE 2-8:   *MCP19110/11/18/19 MPLAB X Plug-In Tab After Installation.*

The plug-in needs an MCP1911X project to work on in order to be enabled. Figure 2-8 shows the MCP19110/11/18/19 Plug-In GUI when no project is currently opened. If there are no MCP1911X projects, the plug-in can create a new MCP1911X project using the **Create New Project** button. This button will open a window that allows choosing the new project folder location. The MCP1911X project folder can be placed in any location. Once the project is created, it will be automatically opened by MPLAB X IDE.

To update an existing project, go to *File>Open Project*. In the Open Project window that opens, browse to the location of your project and click on the **Open Project** button, as shown in Figure 2-9.

> **Note:** The plug-in will be enabled if the project is compatible with the opened plug-in.
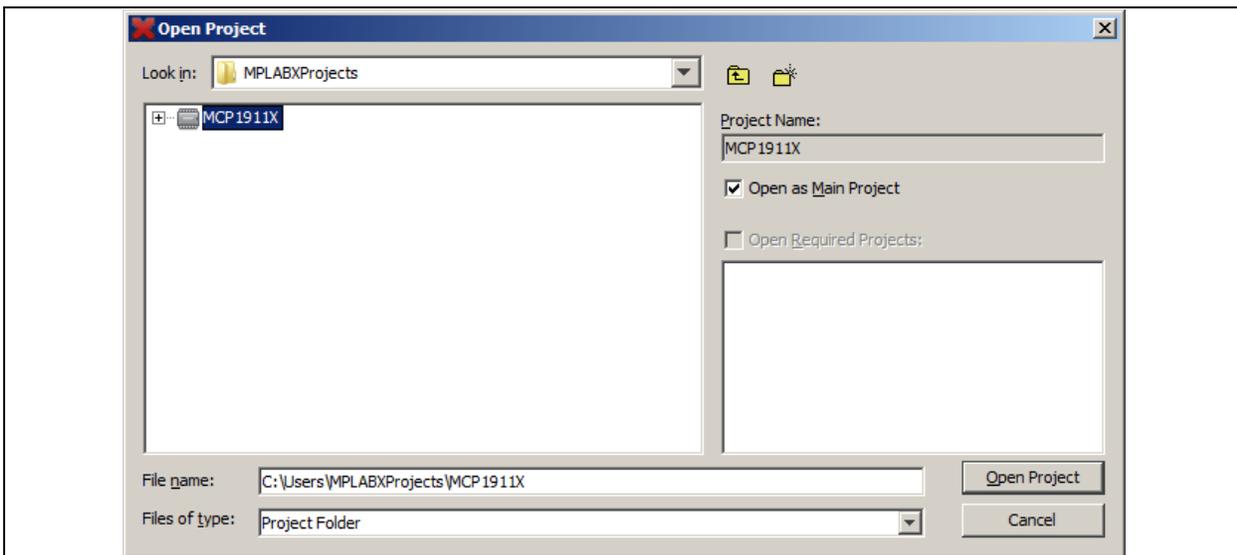
FIGURE 2-9:   *The Open Project Window.*

> **Note 1:** If multiple projects are opened on MPLAB X IDE, the plug-in will work on the project selected as "Main Project". The main project can be changed by right clicking on the desired project, then choosing "Set as Main Project" from the Projects view.
>
> **2:** If the plug-in is not visible in MPLAB X IDE, it can be displayed using the MPLAB X IDE menu, as shown in Figure 2-10.
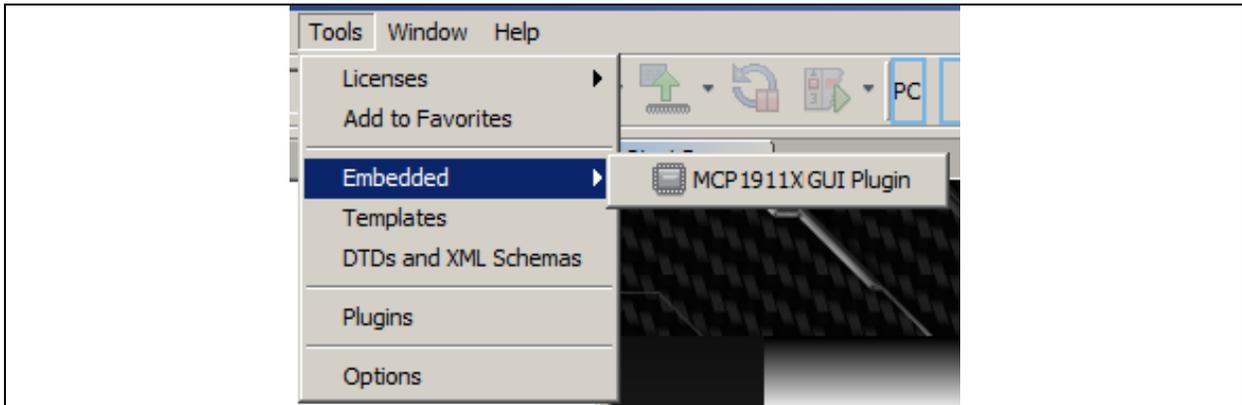
FIGURE 2-10: *Displaying the Plug-In.*

2.2   PROJECT CONFIGURATION

To display the project properties, right click on the project name inside the Projects view and select **Properties**, as shown in Figure 2-11. While the provided project should already be correctly configured to ensure proper hardware and software configuration, please ensure that the correct hardware tool (PICkit 3 or ICD3) and C-compiler (XC8) are highlighted in the Hardware Tool and Compiler Toolchain windows, respectively. Figure 2-13 shows an example of how to select these tools. This section describes a list of settings that must be checked before beginning to use the tools.
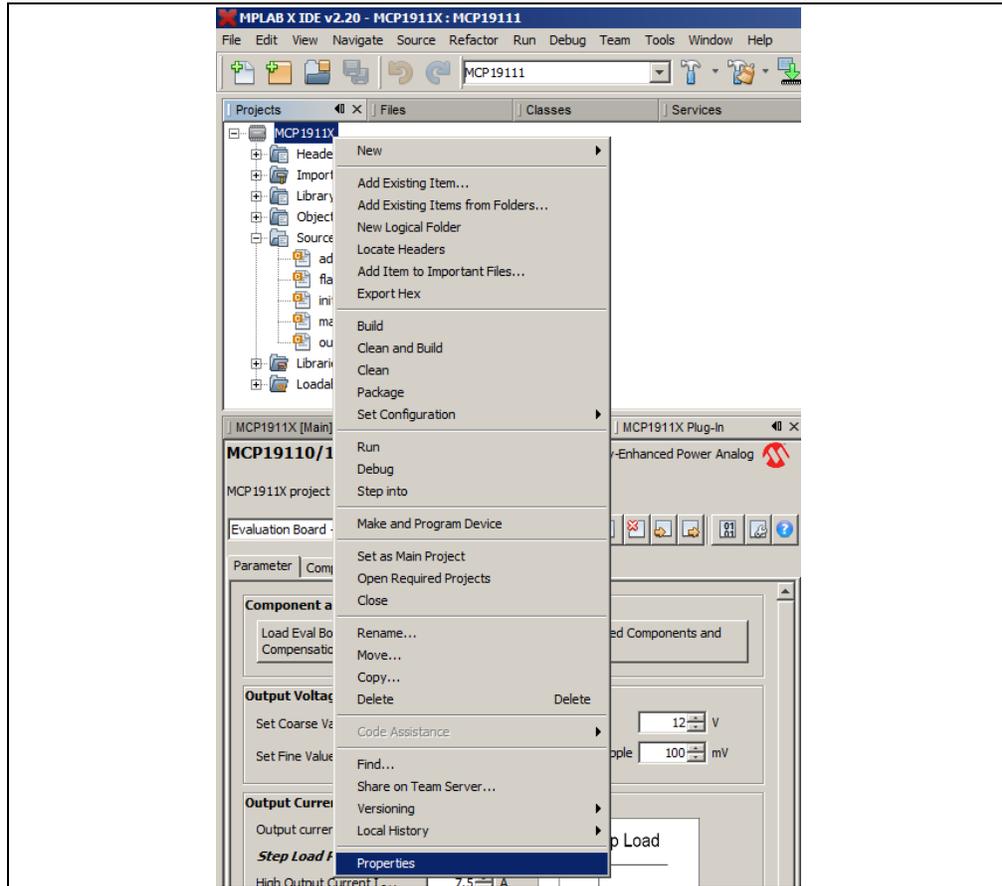
FIGURE 2-11:   *Selecting Properties in the Projects View.*

FIGURE 2-12:   *PICkit 3.*
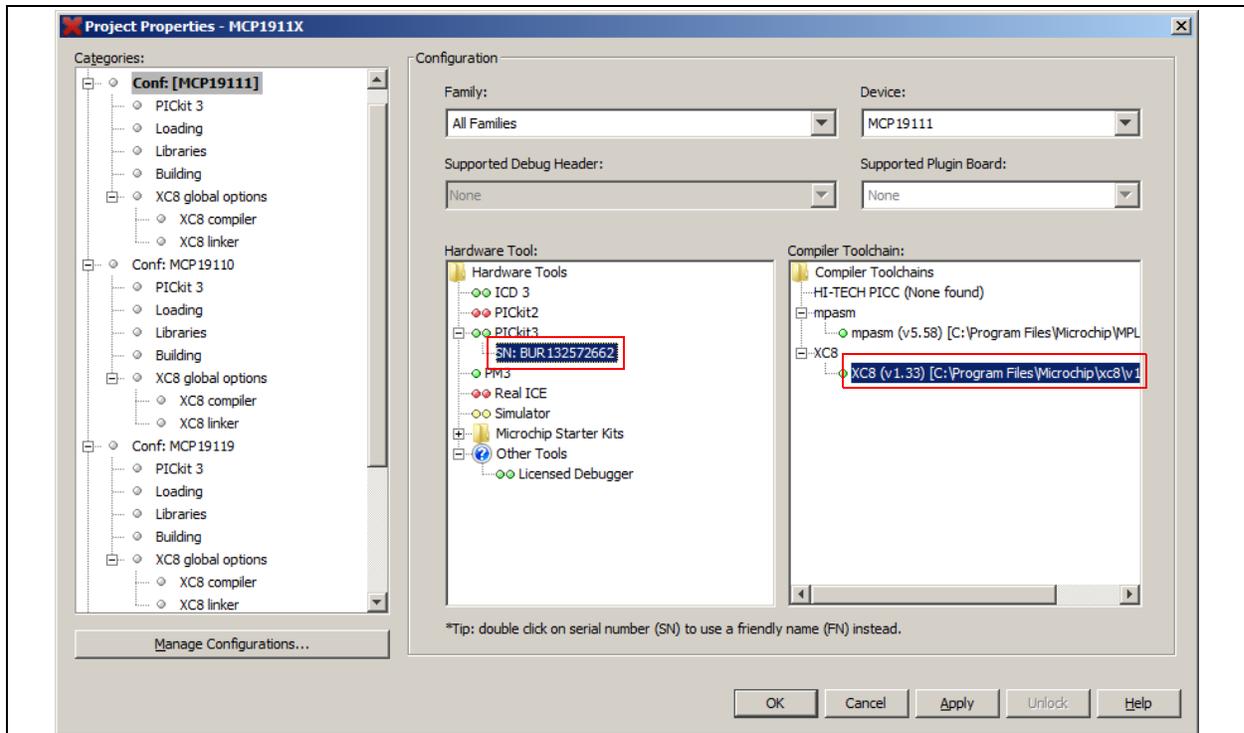
FIGURE 2-13: *Project Properties View.*

There are additional important properties of the MCP1911X project shown in the following screen shots. Please note that each device's version has its own set of properties. Please ensure to set the properties for the correct targeted device. For instance, to set the properties of an MCP19110 device, follow the "Conf:[MCP19110]" branch on the tree view from the project properties window (Figure 2-13).

- The "Freeze Peripherals" option must be disabled to use the debug mode (to disable it, deselect the check box).
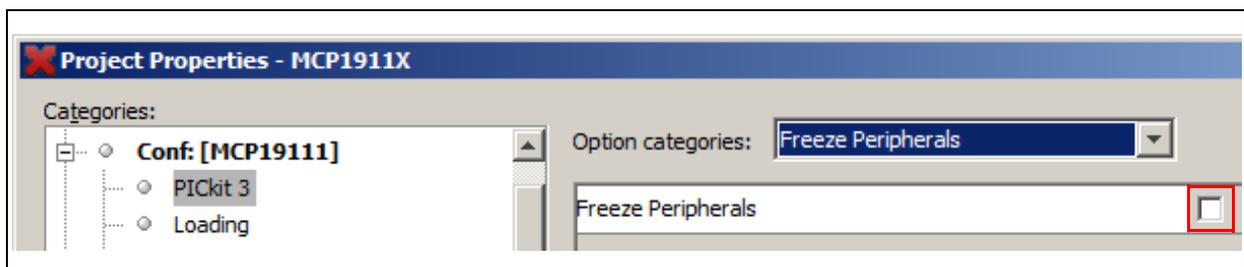
FIGURE 2-14: *Project Properties – Freeze Peripherals.*

- The programmer should not power the device. Therefore, please ensure the "Power target circuits from PICkit3" option under the Power option category is not enabled. The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In shall be powered by V_{IN}.
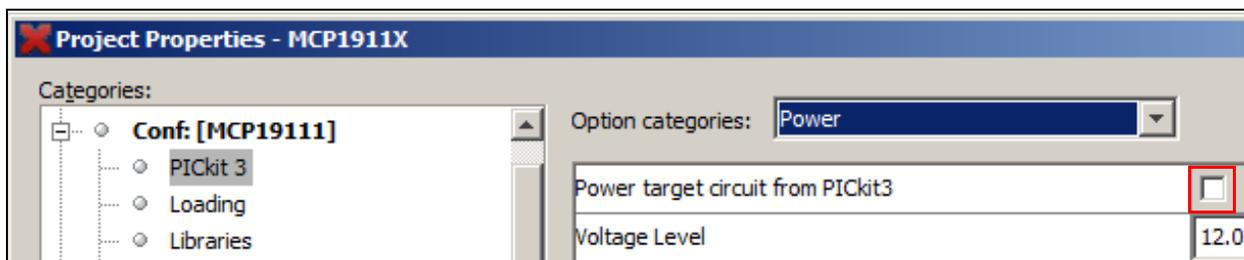
FIGURE 2-15: *Project Properties – Power Configuration.*

- To use the debug mode, the "Calibrate oscillator" peripheral option under the Runtime option category must be disabled.
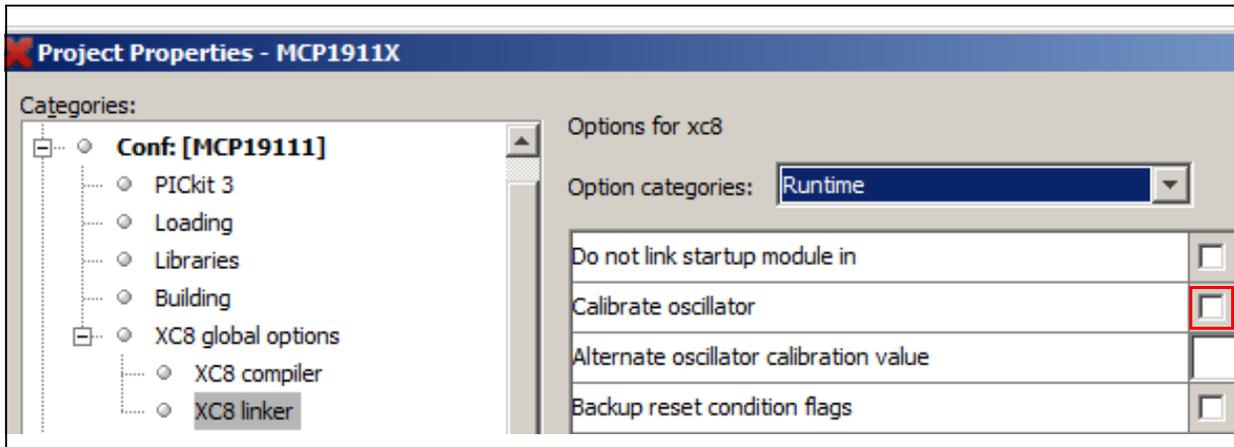
FIGURE 2-16: *Project Properties – Calibrate Oscillator.*

2.3   PLUG-IN FEATURES

At this point, you should be able to set your desired parameters through the GUI (see **Section 2.4 "GUI Tab Descriptions"**). This section describes the actions provided by the plug-in and the basic MPLAB X IDE options that allow programming or debugging the part.

2.3.1   MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In Description

Figure 2-17 shows the actions provided by the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In.
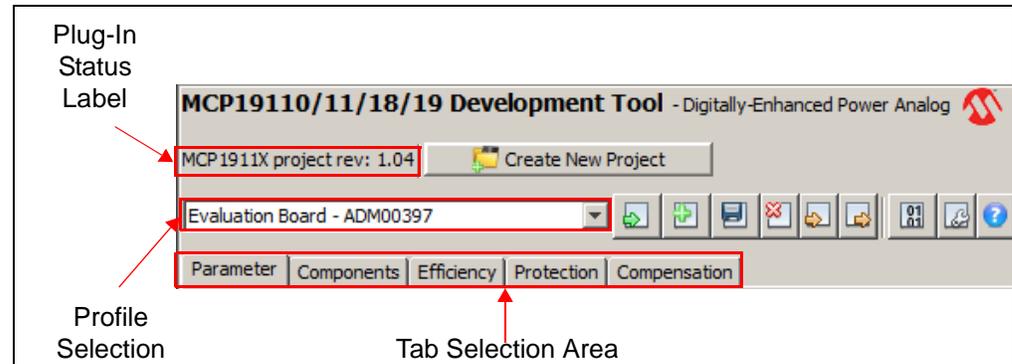
FIGURE 2-17:   *MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In Actions.*

The plug-in status label describes if the plug-in has detected an MCP1911X project to work on. It also displays the project firmware version. If no projects are detected, the plug-in will not be enabled.

The **Create New Project** button allows creating a new MCP1911X project. Once pressed, a window will allow selecting the project folder location. The plug-in will automatically open the project and set it as the main project. This button is available at any time.

The **Profile Selection** drop-down menu is used to select the desired profile to act on as described below. A profile is a set of firmware parameters that contains the whole MCP19110/11/18/19 settings (output voltage, switching frequency, etc.). The user can load, create, save, delete, import and export a firmware profile for the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In.

The **Load Profile** button (⊡) will restore all values from the selected profile into the GUI. This action will override the user's current changes if they were not saved. A message box will appear to remind this to the user before the current values are replaced.

The **Create Profile** button (⊡) will ask the user for a profile name. When set, the plug-in will create the new profile with the current settings from the GUI.

The **Save Profile** button (▤) is used to store the current data from the GUI into the selected profile.

> **Note:** The user cannot modify the default evaluation board profile because it is protected.

The **Delete Profile** button (▨) will delete the selected profile. The evaluation board profile cannot be removed because it is used as a working starting point profile.

The **Import Profile** button (▣) allows reading a profile file (.cfg). The plug-in will read all the values in the file and will update the values on the GUI.

The **Export Profile** button (▣) is used to create a file from a profile. This file can be imported by another MCP19110/11/18/19 Plug-In installation.

The **Open Firmware Folder** button (▦) opens the folder containing the compiled firmware (commonly called .hex file). This compiled firmware can be used directly to program the part.

> **Note:** Before taking the compiled firmware file, make sure it is up-to-date. Use the MPLAB X IDE **Clean and Build** button (see **Section 2.3.2 "MPLAB X IDE Actions"**) to generate a new firmware based on the current GUI settings.

The **Expert Mode** button (▣) allows switching the GUI in Expert mode, which enables the features described in **Section 2.5 "Advanced Mode"**.

The **Help** button (❔) will open a web browser to the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In official page. This page contains all the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In user's guides and application notes.

The tab selection area contains several tabs displaying the MCP1911X project settings. These tabs are described in **Section 2.4 "GUI Tab Descriptions"**.

2.3.2 MPLAB X IDE Actions

MPLAB X IDE provides standard commands to compile, program or debug the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In. This section describes the most common commands.
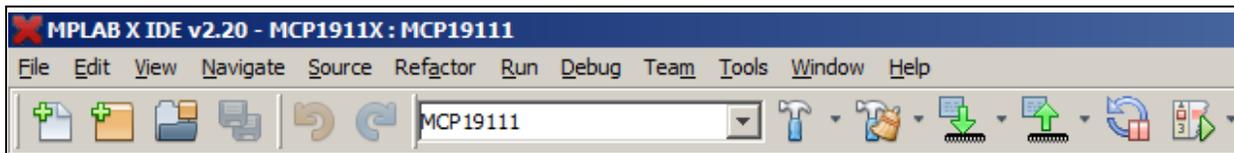
FIGURE 2-18: *MPLAB X IDE Actions.*

The **Clean and Build** button (🖼 ⁻) allows compiling the MCP1911X project. This may be useful to verify that the code syntax is still correct after a source code change or to verify the memory usage of a firmware. This option is available without a PICkit or ICD programmer.

The **Program Part and Run** button (🔽 ⁻) compiles the project source code, programs the part and executes the code. Before programming, ensure that the programmer is correctly installed and connected. In addition, the evaluation board must be powered with at least 6V input. If this is the first time the programmer has been used, the environment may prompt on which programmer you want to use.

The **Program Part and Debug** button (🔽 ⁻) does the same thing as the Program Part and Run but you can additionally control the firmware. If the part is programmed in Debug mode, it will not restart automatically after a power-off.

The **Device Selection** drop-down menu allows selecting the targeted device: MCP19110, MCP19111, MCP19118 or MCP19119. When the MCP19110/18 is selected, the Enable pin can move to another available pin because not all MCP19111/19 pins are available on the MCP19110/18 and device. This selection actually selects a project properties set. The project contains a set of properties for each device version, but only one is used depending on the device selection. After a device selection, please make sure that the selected project properties are correctly set according to **Section 2.2 "Project Configuration"**.
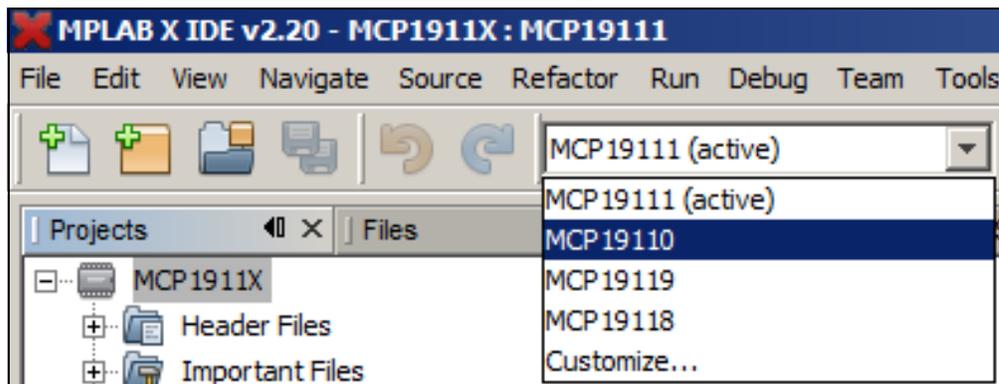
FIGURE 2-19: *Drop-Down Menu Example*

The figure below shows a second method which allows selecting the device version by right clicking on the project from the Projects view.
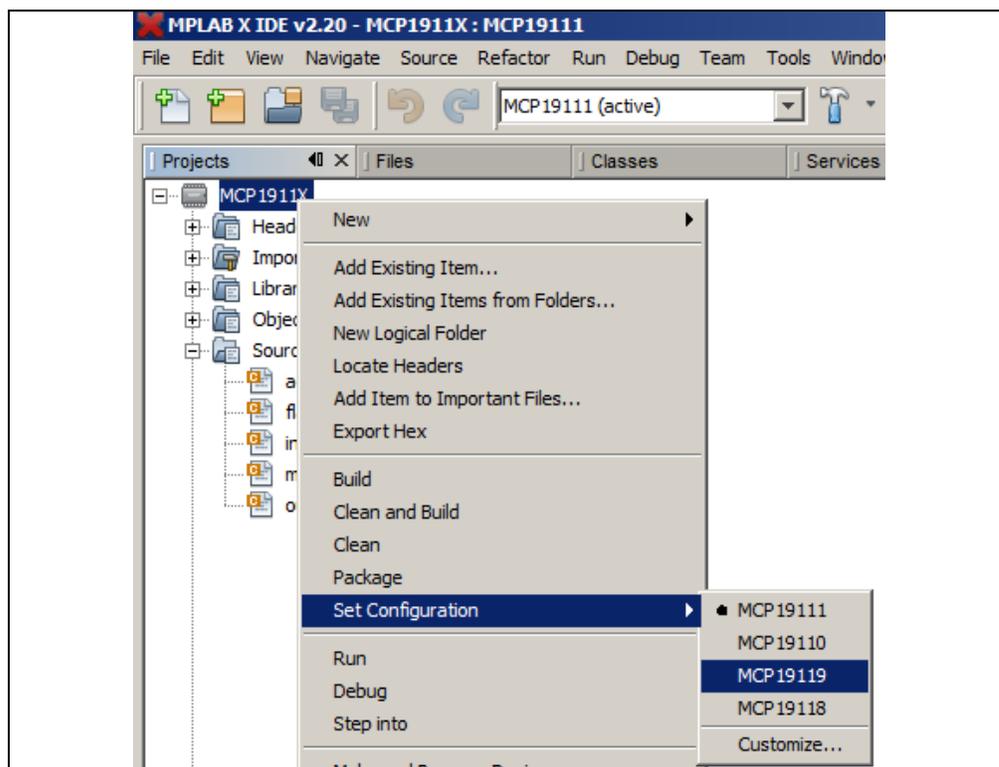
FIGURE 2-20: *Changing Targeted Device Using Right-Click on Project Example.*

2.4   GUI TAB DESCRIPTIONS

This section shows the GUI tabs provided by the MCP19110/11/18/19 MPLAB X Plug-In. These tabs are used to modify the firmware of the MCP1911X project. As soon as a new option has been set from the GUI, the firmware will be updated and can be directly programmed. Please also refer to the MCP19110/11 or MCP19118/19 data sheet for more information on the product configuration.

Placing the cursor over settings controls or labels will give a brief description of what these particular settings do. See the example in Figure 2-21.
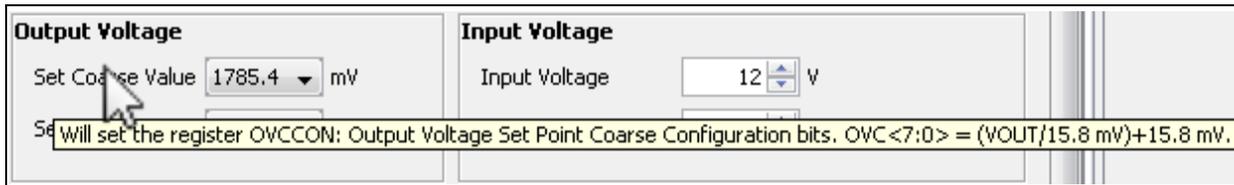
FIGURE 2-21:   *Tooltip Text Example.*

2.4.1   Parameter Tab

The **Parameter** tab is used to set the main features of the part, as shown in Figure 2-22.
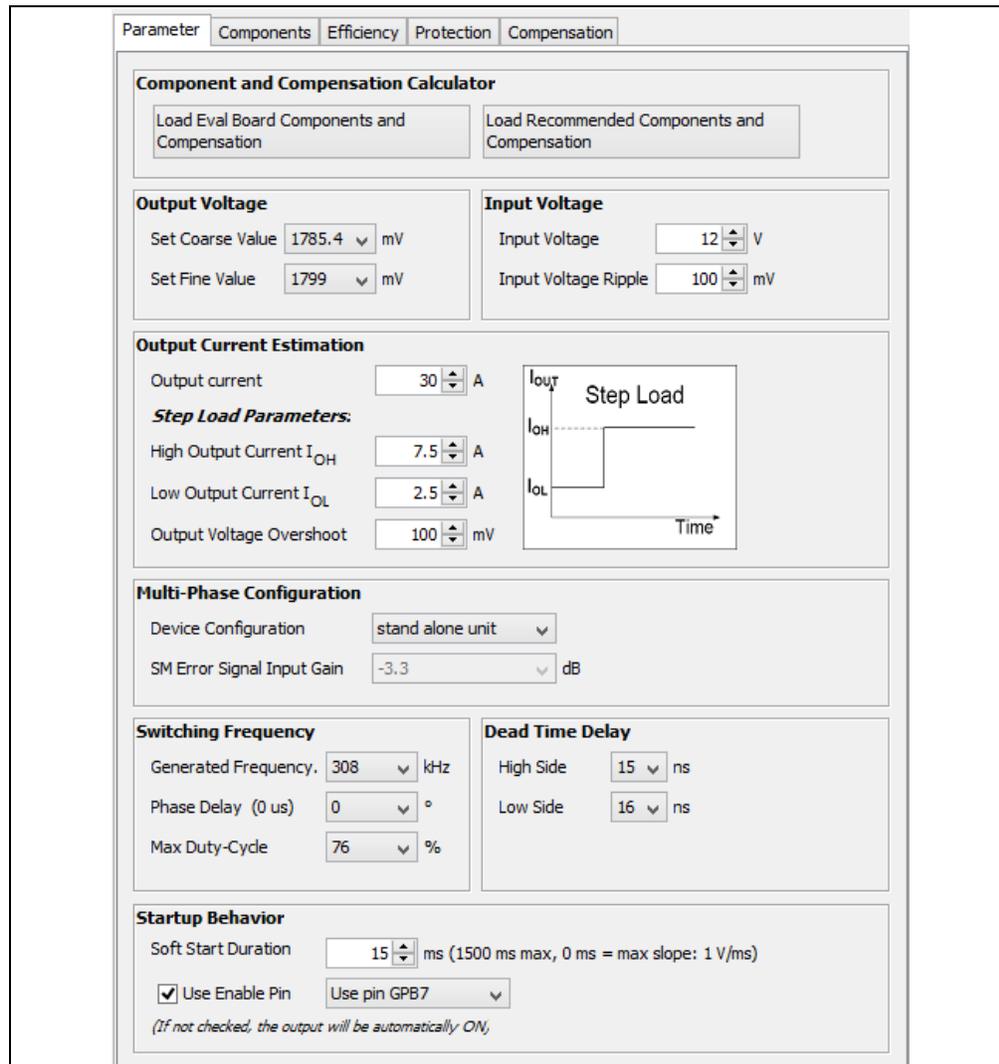
FIGURE 2-22:   *The Parameter Tab.*

2.4.1.1   OUTPUT VOLTAGE

The output voltage of the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In device is user-programmable over the range of 0.5V to 3.6V. The value set for "Set Coarse Value" is translated for the OVCCON register, while the value set for "Set Fine Value" is translated for the OVFCON register. The OVCCON DAC is an 8-bit DAC that coarsely adjusts the output voltage set point. The OVFCON DAC is a 5-bit DAC that finely adjusts the output voltage set point. Refer to the Electrical Characteristics table in the MCP19110/11 or MCP19118/19 data sheet for more information.

2.4.1.2   INPUT VOLTAGE

The "Input Voltage Ripple" section defines the input capacitance and its equivalent series resistance (ESR) necessary to meet the specified input ripple requirement.

### 2.4.1.3   OUTPUT CURRENT ESTIMATION

The parameters under "Step Load Parameters" are used to define the dynamic performance of the system and indicate the amount of output capacitance needed to achieve the desired transient response. The MCP19110/11/18/19 control system uses an analog peak current mode control. The load step is defined as the load current step from high output current to low output current.

The next step requires entering the size of the overshoot desired for this load step. Larger load current steps and smaller output voltage overshoot result in larger output capacitance and lower ESR to minimize the overshoot leading to a higher system cost.

2.4.1.4   MULTI-PHASE CONFIGURATION

The "Multi-Phase Configuration" section changes the value loaded into the BUFFCON register. The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In has the ability to operate as shown in Table 2-1.

TABLE 2-1:   OPERATION MODES FOR THE MCP19110/11/18/19 – BUCK POWER SUPPLY GRAPHICAL USER INTERFACE PLUG-IN

Operation Mode	Description
Stand-alone unit	The device is configured to run as a stand-alone converter. No external clock or error signals are necessary. This is the option that should be used for a single evaluation board.
Multiple output master unit	This option is used when the user desires multiple output voltages. In order to do this, the system must have multiple MCP19110/11/18/19 devices. When selected, the device is configured as the MASTER and its CLOCK is the output on the CLKPIN. The devices configured as slaves use this signal for synchronization. All other peripherals remain the same as those for the stand-alone unit.
Multiple output slave unit	For this option, the CLKPIN is configured as an input and should be connected to the CLKPIN of the multiple output master. All other peripherals remain the same as those for the stand-alone unit.
Multi-phase master unit	This option should be used when the user desires multiple power trains to share the load current. In this case, the output of each power train is connected to the same output rail. Like the multiple output master, its CLOCK is the output on the CLKPIN. The devices configured as multi-phase slaves use this signal for synchronization. The EAPIN is also configured as an output which feeds the output of the error amplifier to the multi-phase slave unit for regulation. All other peripherals remain the same as those for the stand-alone unit.
Multi-phase slave unit	For this option, the CLKPIN is configured as an input pin and should be connected to the CLKPIN of the multi-phase master. The EAPIN is configured to be an input pin and should be connected to the output of the multi-phase master's amplifier. Since the master and slave error amplifier offsets are slightly different from part to part, the error input signal gain of the multi-phase slave can be dynamically changed so that the multiple power trains will share the load current equally. The error input signal gain of the multi-phase slave will load the values into the SLVGNCON register and add gain to the error amplifier signal provided by the multi-phase master. The available gain range is from -3.2 dB to 3.0 dB. All other peripherals remain the same as those for the stand-alone unit.

2.4.1.5   SWITCHING FREQUENCY

The switching frequency of the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In is generated by using a single edge of the 8 MHz internal clock. The MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In switching frequency is set by configuring the PR2 register. The programmable range of the switching frequency is from 100 kHz to 1.6 MHz. The maximum allowable HDRV duty cycle is adjustable and is controlled by the PWMRL register. The available switching frequencies below 1.6 MHz are defined as F_{SW} = 8 MHz/N, where N is an integer number between 5 and 80.

The phase of the MCP19110/11/18/19 slave devices may be shifted from the MASTER clock through the PWMPHL register. The GUI can be used to configure this delay for a slave device.

The switching frequency of the converter determines the efficiency, the transient response, the size and the cost of the design. The switching frequency should be carefully evaluated to optimize the design to the performance goals.

2.4.1.6   DEAD TIME DELAY

In the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In, the dead time is adjustable from 4 ns to 64 ns for the low side and from 11 ns to 71 ns for the high side, in 4 ns steps. The values for t_{DEAD}-1 and t_{DEAD}-2 do not need to be the same. The desired drive signal dead time is configured through the GUI by configuring the DEADCON register, as shown in Figure 2-23.
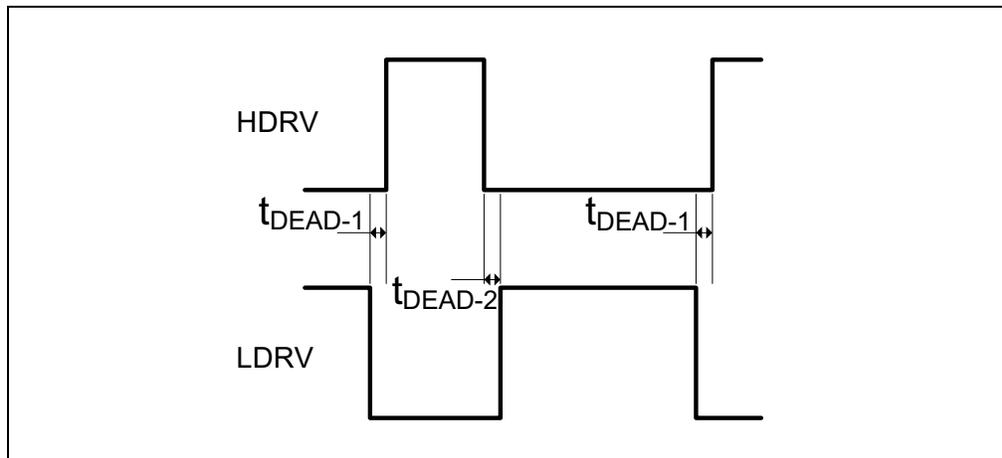
FIGURE 2-23:   *Dead Time Description.*

2.4.1.7   START-UP BEHAVIOR

The Soft Start duration control on TMR1L and TMR1H registers to achieve the soft start ramp time. Each time the TMR1 timer overflows, the OVCCON will increase its value, so the output voltage set point will be increased in 15.8 mV steps. Soft Stop is implemented the same way.

If a start-up pin is used, the selected pin will be set by using the `V_NUM_EN_PIN` from the `V_MCP1911X.h` definition. When a start-up pin is defined and enabled, the selected pin will automatically be configured as an input and the internal pull-up will be enabled. By default, the start-up pin is connected to the BT1 button of the MCP19111 Evaluation Board (ADM00397). If the start-up pin is enabled, the part will start switching only after pressing the BT1 button. Pressing the button while the part is switching will stop it.

2.4.2   Components Tab

The **Components** tab is used to set the component of a system in order to compute the best compensation setting and the efficiency of the system. This tab contains a button allowing to load the value of the MCP19111 Evaluation Board (ADM00397) components. A second button allows loading the best component value depending on the parameters set in the **Parameter** tab. They represent component values that meet the design goals. These recommended values are displayed on the right of the current values. See Figure 2-24 below.

Microchip's MCP87050 and MCP87018 MOSFETs were used for the high-side and low-side switches. The MOSFET's ON resistance (R_{DSON}) and gate charge are both critical parameters for design analysis. The low-side MOSFET body diode characteristics are also a key parameter for estimating the efficiency of the converter. Refer to the MOSFETs' data sheets for more information.

The diode conduction time is the estimated amount of time when the current is flowing through the low-side switch body diode. This time can be adjusted by using the MCP19110/11/18/19 dead time adjust setting. The inductor DC resistance and the ESR of the input and output capacitors are also used for efficiency and control system calculations. Refer to the component data sheets for more information on these values.

FIGURE 2-24:   *The Components Tab.*

2.4.3 Efficiency Tab

The **Efficiency** tab represents the calculated efficiency using the component parameters. A good idea is to vary the critical values to see the effect on the system efficiency. For example, increasing the switching frequency results in lower efficiency. Optimizing the high-side MOSFET results in higher efficiency for specific operating conditions. Lower-resistance high-side MOSFETs do not always result in the highest efficiency. If the switching losses are much larger than the conduction losses for the high-side MOSFET, a MOSFET with higher R_{DSON} and lower gate charge or capacitance may be a better choice for the operating conditions of interest. See Figure 2-25.
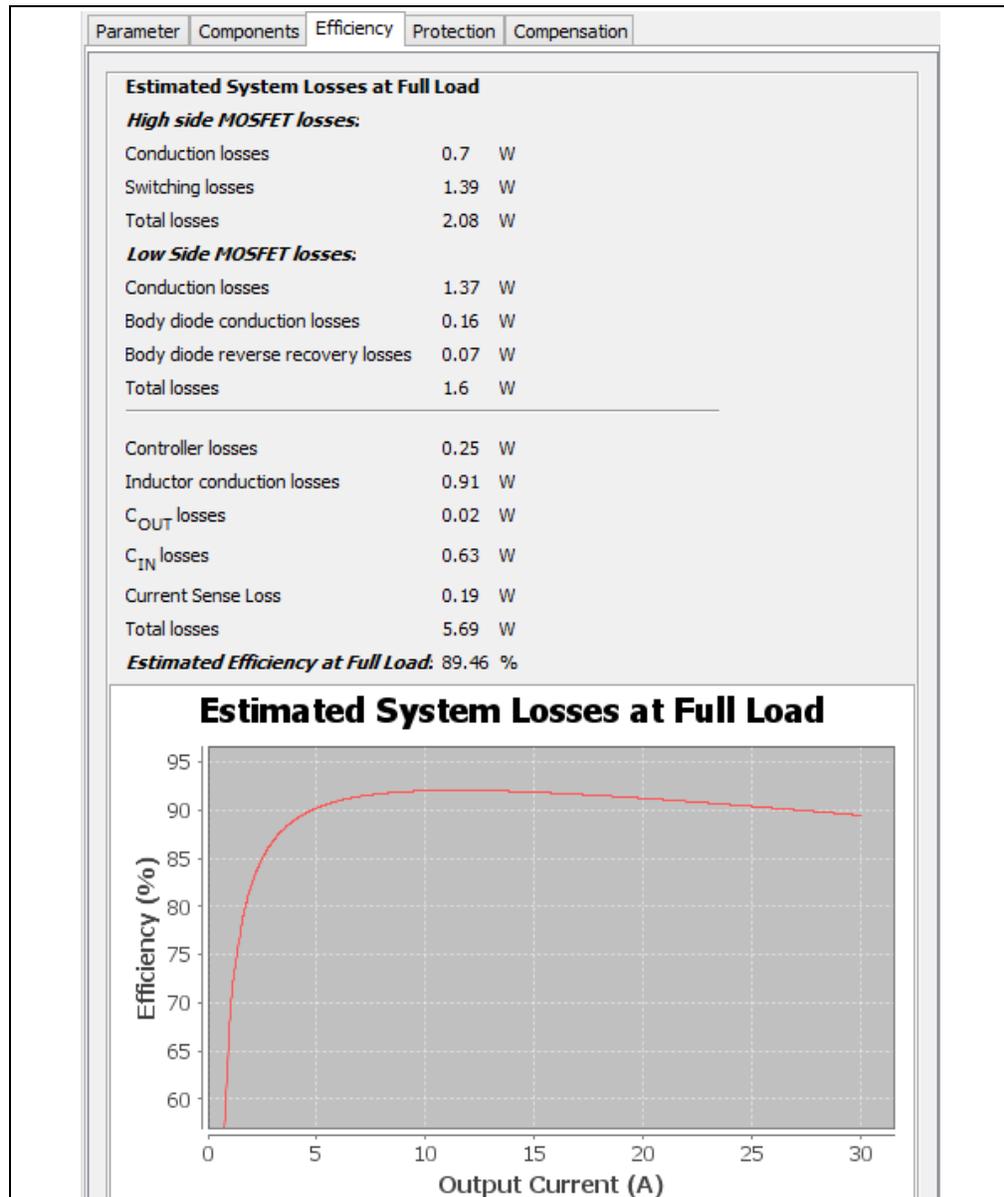

FIGURE 2-25: *The Efficiency Tab.*

2.4.4 Protection Tab

The **Protection** tab is used to set the protections features, as shown in Figure 2-26.

FIGURE 2-26: The Protection Tab.

2.4.4.1 OUTPUT UNDERVOLTAGE AND OVERVOLTAGE

The "Output Voltage Protection" value acts on the OUVCON and OOVCON registers for the desired threshold. These registers hold the digital values that set the DAC voltage levels at which the output undervoltage and overvoltage are detected. The ABECON register is used to activate or deactivate the protection. The available range for these settings is from 0.0V to 3.84V. When an output overvoltage or output undervoltage occurs, an interrupt flag is set, allowing virtually any action to be taken through the firmware. The GUI does provide the option to disable the output if either an undervoltage or overvoltage event occurs.

2.4.4.2 OUTPUT OVERCURRENT

The GUI acts on the OCCON register. This register contains the digital value (OOC<4:0>) that sets the DAC voltage level, at which the output overcurrent state is detected. The voltage drop across the high-side power MOSFET is measured and compared to the OOC<4:0> value. Leading edge blanking is applied to this current measurement. The amount of leading edge blanking time is controlled by the OCLEB<1:0> bits in the OCCON register. The overcurrent Enable bit is also contained in the OCCON register. The available range for this setting will depend on the high-side R$_{DSON}$ value but the GUI will automatically scale the settings based on the R$_{DSON}$ value. When an overcurrent event is detected, the high-side drive will immediately turn off and skip the next clock cycle. An internal flag will also be set, so other desired actions may be taken through the firmware.

2.4.4.3   INPUT UNDERVOLTAGE LOCKOUT

The GUI is used to configure the VINLVL register for input undervoltage lockout (UVLO) protection. This register sets the DAC voltage level, which sets the input undervoltage lockout threshold. When the input voltage is above this value, the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In is allowed to turn on. The UVLO Enable bit is also contained in this register. The available range for this setting is 4V to 32V.

2.4.5   Compensation Tab

The **Compensation** tab is used to set the compensation parameters. This tab shows the tools/elements that are used to design the system's analog control loop. The Gain and Zero Frequency drop-down menus from the "Compensation" section set the position of the zero used to compensate the control system. Changes in the system dynamic performance result from changing the location of the system zero and gain. The next rows show the slope compensation needed for peak current mode control. Increasing the level of slope compensation reduces the influence of the current feedback relative to the influence of the voltage feedback. Over-compensation can introduce instability; under-compensation can introduce voltage ripple. The "Current sense gain" and "Current sense DC gain" cells are used to set the gain of the current sense signal. The calculated system crossover frequency and phase margin are also displayed. The higher the crossover frequency, the faster the system responds to transients. Higher switching frequency and lower inductance enable a higher crossover frequency while sacrificing efficiency. Phase margin greater than 45 degrees is recommended. See Figure 2-27.
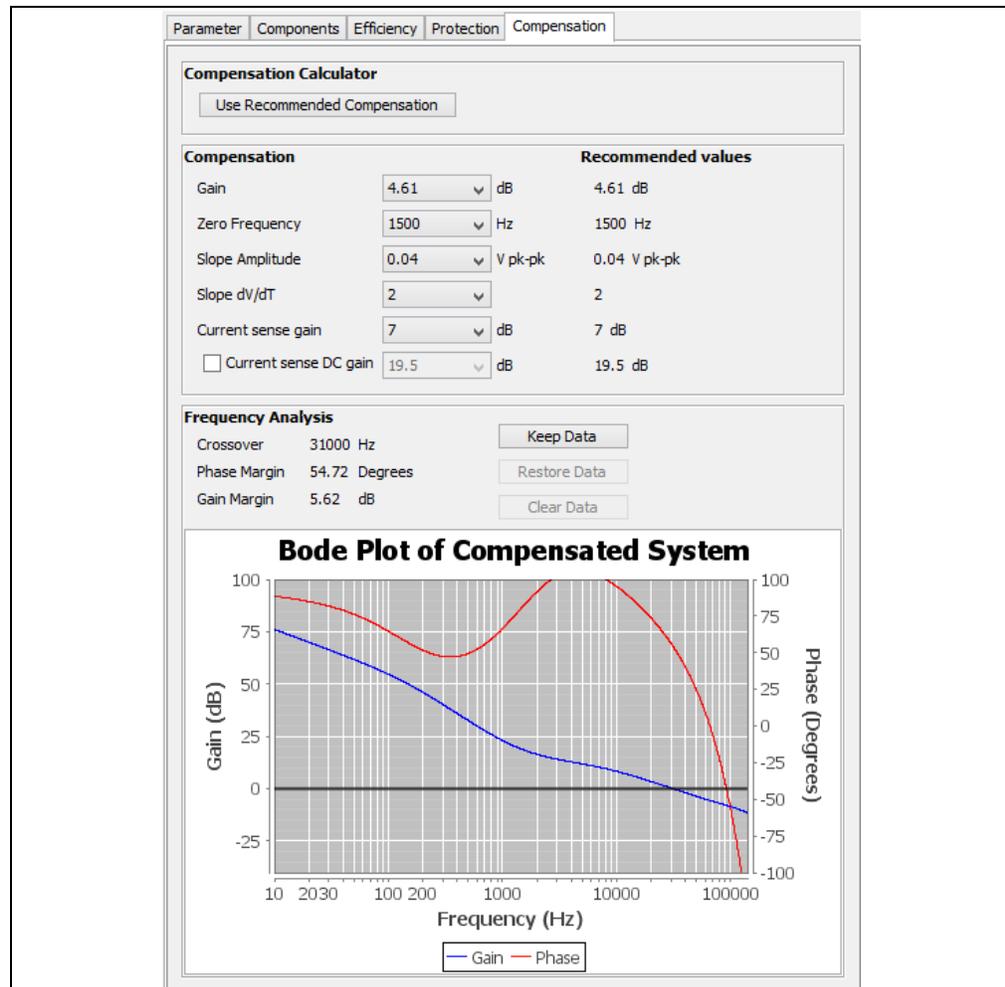

FIGURE 2-27:   *The Compensation Tab.*

2.4.5.1 COMPENSATION

The "Compensation" values set the CMPZCON register. This register contains the bits that set the compensation gain (CMPZG<3:0>) and the zero frequency (CMPZF<3:0>). The available range of values for the zero frequency is from 1500 Hz to 35300 Hz, while the gain is adjustable from 36.15 dB to 0 dB.

The SLPCRCON register controls the slope compensation ramp that is subtracted from the error amplifier output. The four SLPS <3:0> bits control the slew rate of the ramp. The four SLPG<3:0> bits control the amplitude of the ramp signal. The available amplitude range is from 0.017 V$_{PK-PK}$ to 1.250 V$_{PK-PK}$, as measured for a 50% duty cycle waveform.

The current is measured across the inductor by using a resistor-capacitor (RC) in parallel and extracting the inductor current information from the voltage across the capacitor. This very small voltage, plus the ripple, is amplified by the current gain amplifier. The amount of gain is controlled by the CSGSCON register. The range of the gain that can be set is from 0 dB to 22.5 dB and has a step size of 1.5 dB.

2.4.5.2 COMPUTED RECOMMENDED VALUES

There are two automated features to complete the Compensation tab values. The **Load Eval Board Components and Compensation** feature sets this tab to the default values that are standard on the MCP19111 Evaluation Board (ADM00397). This feature is used as a reset to restore the analyzer back to the original evaluation board component values. The **Load Recommended Components and Compensation** feature automatically fills in the tab with the calculated values. This feature is used to evaluate changes in key parameters quickly (such as switching frequency, inductance, output capacitance and ESR, MOSFET parameters, etc.).

2.4.5.3 BODE PLOT OF COMPENSATED SYSTEM

A bode plot displays the system gain and phase curve over frequency. Crossover, phase margin and gain margin are also displayed. The curves and the data are updated automatically.

The **Keep Data** button allows keeping the current curves and data. This allows changing any parameter and comparing the different performance to the kept curves and data.

The **Restore Data** button will restore the kept data in place of the current GUI value.

The **Clear Data** button will remove the displayed kept curves and data. After pressing this button, there is no more kept data to restore.

> **Note:** The **Restore Data** and **Clear Data** buttons are enabled only after the **Keep Data** button has been used.

2.5 ADVANCED MODE

The Advanced mode can be activated using the Export Mode button (![icon]) on the plug-in. When this mode is enabled, the following changes appear:

- Apart from the common tabs, the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In GUI has a new **Bench Test** tab allowing certain peripherals to be disabled or output internal signals using the test multiplexer of the IC.
- Two new toolbar buttons will be displayed.

2.5.1 New MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In Actions for Advanced Mode
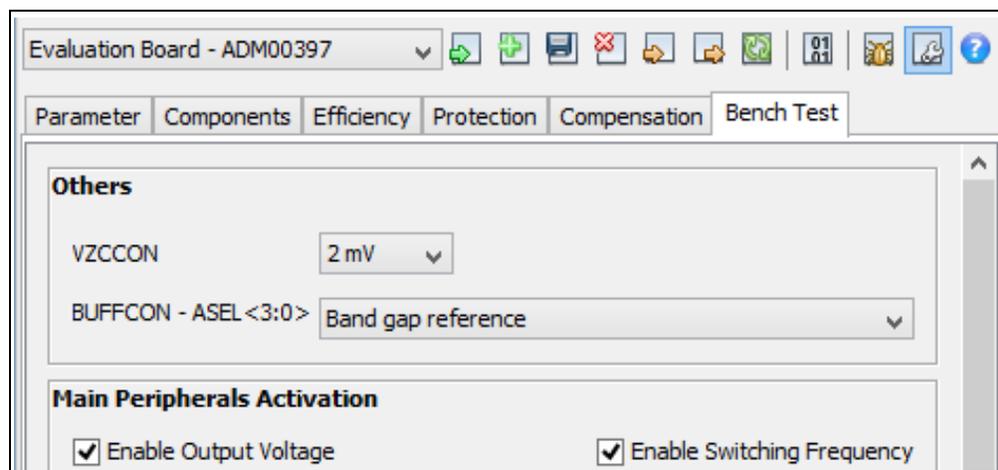
FIGURE 2-28:   Actions for Advanced Mode.

The **Refresh GUI** button (![icon]) is used to refresh the GUI values from the project sources. This can be used if the project source files are modified externally to the GUI.

The **Update Values in Debug Mode** button (![icon]) allows the part to be updated with the latest GUI values while it is still running. This option is only available when the part is running in Debug mode. For some values, such as the output voltage, this function does not directly write into the corresponding register but rather to an intermediate variable. This variable is then used by the main program to change the output voltage using a specified ramp. Another important point is that this feature only acts on the values specified in the **Parameter**, **Protection**, **Compensation** and **Bench test** (in Advanced mode) tabs.

2.5.2   Bench Test Tab
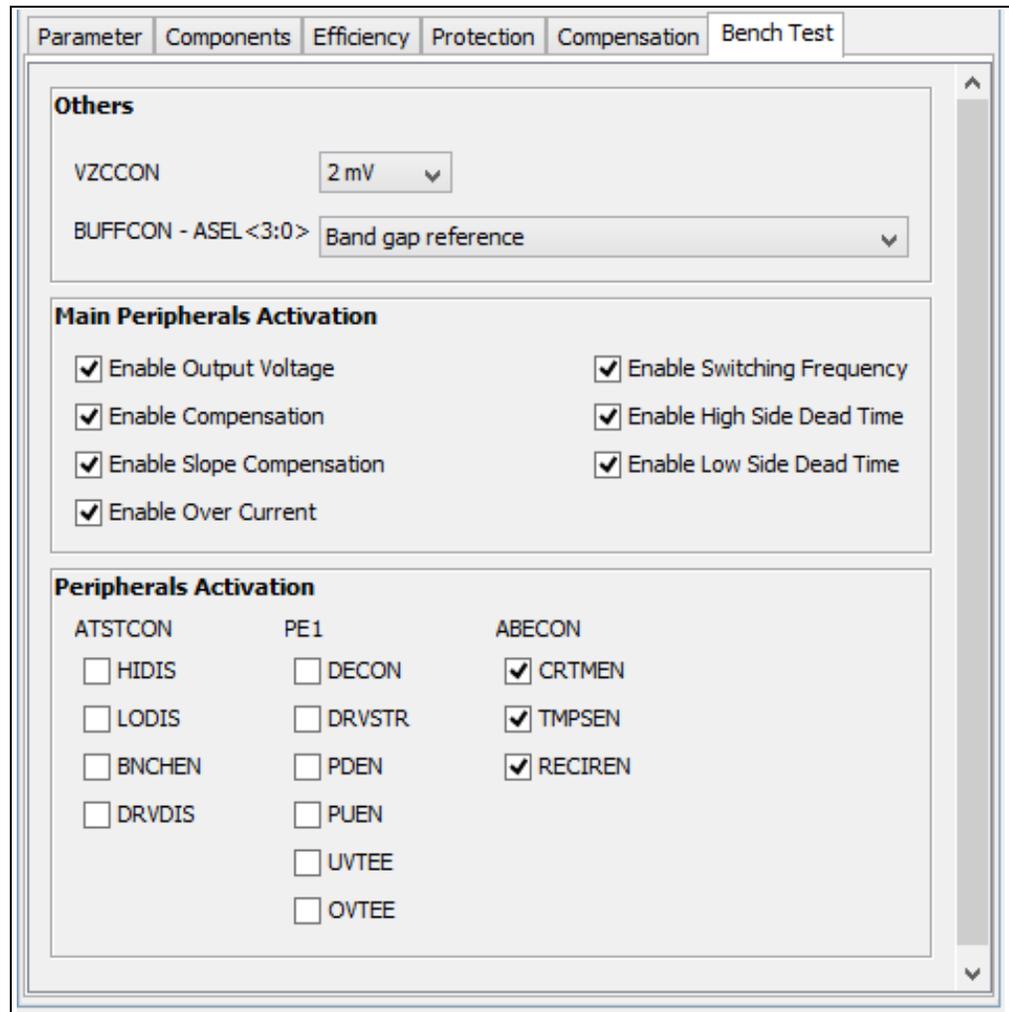
FIGURE 2-29:   *The Bench Test Tab.*

The Advanced mode displays a new tab on the MCP19110/11/18/19 – Buck Power Supply Graphical User Interface Plug-In, the **Bench Test** tab, shown in Figure 2-29.

The parameters under the "Others" section control the VZCCON register and the BUFFCON - ASEL register. The ASEL bits are used to select a desired internal signal and connect it to the GPA0 pin as an analog output. It also requires that the BNCHEN check box under the "Peripherals Activation" section is enabled.

The check boxes under the "Peripherals Activation" section are used to enable or disable the peripherals that cannot be controlled directly from the other tabs.

2.6   HOW CAN THE CODE BE MODIFIED?

Before editing the code, it is useful to understand how the plug-in interacts with the project source to avoid conflicts.

The GUI plug-in writes to the `V_MCP1911X.h` file. This file contains definitions where the name starts with a "V_" and defines a byte value.

Example: `#define V_TMR1 0x99`

In order to maintain the functionality of the firmware, these types of definitions cannot be modified and they must keep their original name. The settings displayed by the GUI are saved/read directly to/from the project sources after any changes in the GUI parameters.

This file also generates some conditional definitions in order to activate/deactivate several firmware features. Example: in `V_MCP1911X.h`:

```
#if (V_NUM_EN_PIN < PIN_DISABLED)
#define EN_PIN_EN    0X01
```

If `V_NUM_EN_PIN ≥ PIN_DISABLED`, the `EN_PIN_EN` will not be defined.

Then in `main.c`:

```
#ifdef EN_PIN_EN
    EN_PIN_WPU = 1; //weak pull-up enable
    EN_PIN_IO = 1; //input state
    EN_PIN = 0;
    EN_PIN_INT_EN = 1; //interrupt enable
#endif
```

If the user inserts code between the `#ifdef EN_PIN_EN` and `#endif`, the code may not be included at the compilation. Below is a summary of the project modification permissions to keep the plug-in working with the project.

- New source files can be added.
- Existing source files can be removed or modified, except for `V_MCP1911X.h`, which cannot be removed. If some code is removed from the existing file, some features provided by the GUI may not respond correctly.
- The project name can be modified.
- The project folder name can be modified.

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Fax: 45-4485-2829

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Fax: 33-1-69-30-90-79

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