MCP19111 - Buck Power Supply, Graphical User Interface User's Guide

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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).
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Derek Carlson
VP Development Tools

02-May-12
Date

NOTES:

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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 "DSXXXXXA", where "XXXXX" 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 MCP19111 - 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 MCP19111 - 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 MCP19111 - Buck Power Supply, Graphical User Interface Plug-In.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP19111 - 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 MCP19111 - Buck Power Supply, Graphical User Interface Plug-In. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP19111 Data Sheet –** “Digitally Enhanced Power Analog Controller with Integrated Synchronous Driver” (DS22331)
- **MCP19111 User’s Guide –** “MCP19111 Evaluation Board User’s Guide” (DS52109)
- **MCP19111 Programming Specification – *“MCP19111 Flash Memory Programming Specification”* (DS22336)**

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://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (March 2013)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP19111 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 MCP19111 MPLAB X IDE 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 MCP19111 - Buck Power Supply, Graphical User Interface User's Guide explains how to install and use the plug-in.

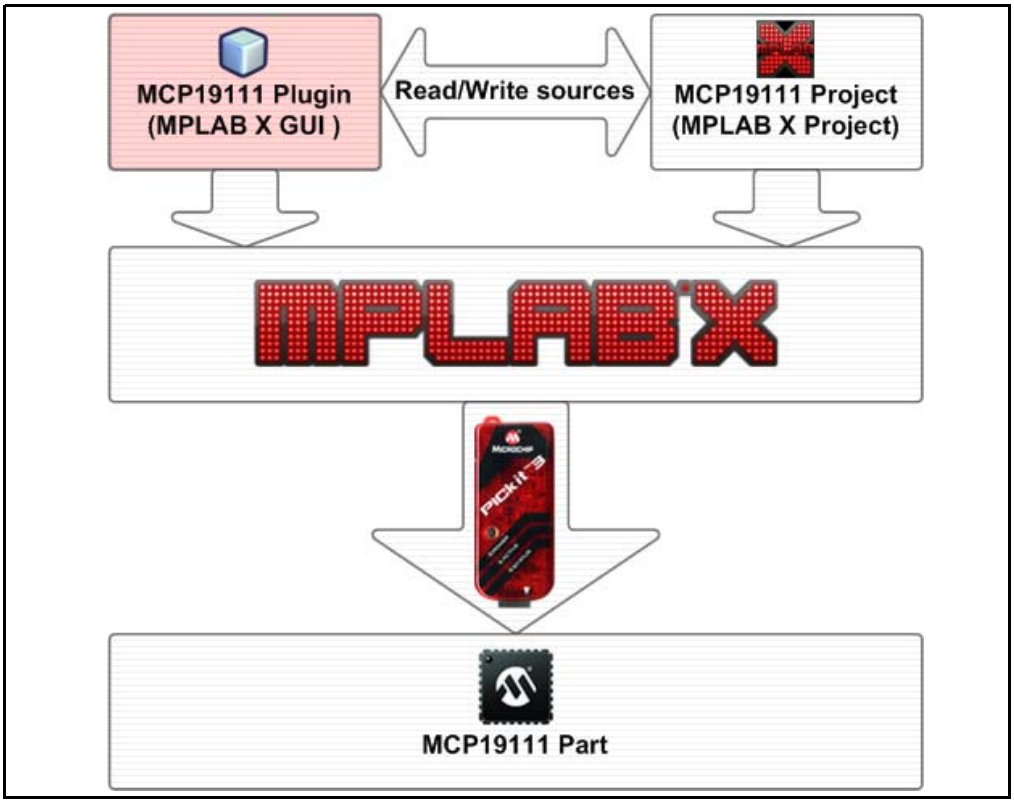

FIGURE 1-1: *General System Diagram.*

To summarize, the MCP19111 - Buck Power Supply, Graphical User Interface Plug-In is used within the MPLAB X 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.

1.1.1 The Development System's Components

1. **MCP19111 MPLAB® X IDE Graphical User Interface Plug-In:** This graphical user interface simplifies the configuration of the MCP19111. It is user-installed, and resides within the MPLAB X IDE (Integrated Development Environment). This user guide describes the plug-in installation procedure, as well as how to use it.
2. **MPLAB X - Integrated Development Environment:** 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. **MCP19111 - Power Supply Firmware:** This firmware is provided with the GUI installation files and instructions. This is standard firmware that has been configured to work with this graphical user interface. This firmware must be opened as a project within MPLAB X IDE; these instructions are provided within this document.
4. **XC8 Compiler** - The firmware, described above, is coded in C, and thus requires a C-compiler. Reduced-function C-compilers are available 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/etc.** - A programming tool is required to configure the evaluation board. We recommend the PICKIT 3, which is available from Microchip Direct.

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.

1.2 ROLE OF FIRMWARE

This section gives a brief overview of different tasks that may be accomplished using the standard, power supply firmware created for the MCP19111 device.

1.2.1 Initialize the Internal Peripherals

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

- Switching frequency, Phase shift, Max 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.

1.2.2 Handle Events

Most of the 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.

1.2.3 Handle Communication

The firmware also supports the serial communication interface, including PMBus™. It can read and write PMBus commands (see Note 1 in **Section 2.6.1 “Bench Test Tab”**).

1.2.4 Environment Monitoring

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

1.3 GRAPHIC USER INTERFACE (GUI) ENVIRONMENT

The screen shot below provides a picture of MPLAB X IDE with the MCP19111 - Buck Power Supply, Graphical User Interface Plug-in installed (bottom-left) and the MCP19111 Project opened (top-left). More information is available in **Chapter 2. "Installation and Operation"**.

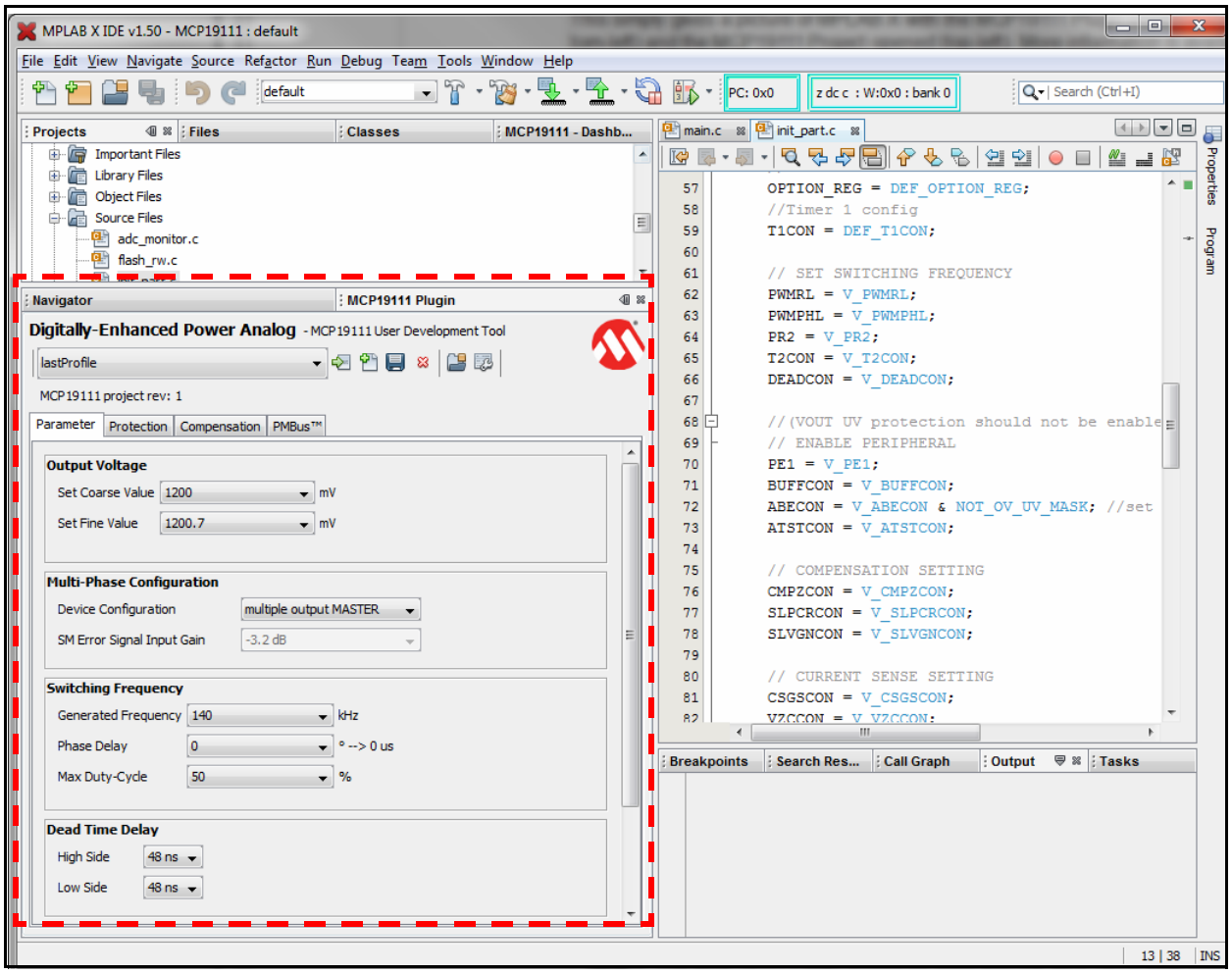

FIGURE 1-2: *User Interface Overview.*

> **Note:** The MCP19111 - Buck Power Supply, Graphical User Interface Plug-in should be used with the MCP19111 Evaluation Board (ADM00397) because the preset settings will be correctly adapted for this board. However, it is possible to use the plug-in with another board and the plug-in may be used in third party applications.

Chapter 2. Installation and Operation

2.1 GETTING STARTED

2.1.1 Required Software

- MPLAB X IDE (version 1.5 or later)
- MCP19111 – Buck Power Supply, Graphical User Interface Plug-In archive. See the MCP19111 device web page for details. The MCP19111 – Buck Power Supply, Graphical User Interface Plug-In archive contains:
  - MCP19111 – Buck Power Supply, Graphical User Interface Plug-In (`com-microchip-mplab-mcp19111-buckpowersupply.nbm`)
  - MCP19111 Project (MCP19111)

  Note: The MCP19111 GUI expects the MCP19111 project name to be MCP19111, it cannot be renamed.
- MPLAB® XC8 C Compiler (v1.11 or later)

2.1.2 Required Hardware

- Microchip PIC programmer/debugger (for example: PICKIT 3 or ICD3).
- MCP19111 Evaluation Board (ADM00397).

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 MCP19111 product page and review the software tools.

2.1.3 Software Installation

The following steps describe how to use the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In.

1. If MPLAB X is already installed, go to Step 2. If not, download MPLAB X from: www.microchip.com/mplabx, and follow the MPLAB X installation instructions.
2. If an XC8 compatible C-compiler, or an equivalent, is already installed in MPLAB X, go to Step 3. If not, you can download a free version of Microchip's XC8 from: www.microchip.com/mplabxc. The XC8 user guide, installation instructions, and download links are available on this page.
3. Download the MCP19111 - Buck Power Supply, GUI Plug-In Archive (*.zip) from www.microchip.com/mcp19111 under "Documentation & Software/Software".
4. Unzip the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In archive, and move the MCP19111 Project folder. The MCP19111 project folder may be placed in any folder. Open this file from the MPLAB X environment.

Note: When installed, MPLAB X IDE automatically creates a project folder. In Windows®, this folder can typically be found under *drive*`\Users\`*user_name*`\MPLABXProjects`.

5. The Plug-In file must be installed in MPLABX. To install the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In, open MPLAB X, then from the Menu bar, select -> Tools -> Plugins. This will open a new window. Select the **Downloaded** tab and then the **Add Plugins** button. Find the `com-microchip-mplab-mcp19111-buckpowersupply.nbm` file that was downloaded in the archive, and select **Open**. Then select the **Install** button on the bottom left side of the window.
6. This opens the "Plugin Installer" window. Select **Next** to continue. Review and **Accept** the License Agreement and select **Install**. If a window opens and indicates that the "MCP19111 Plugin is not signed", select **Continue**. Once the installation completes, select **Finish**, and then select **Close** to close the Plugins window.

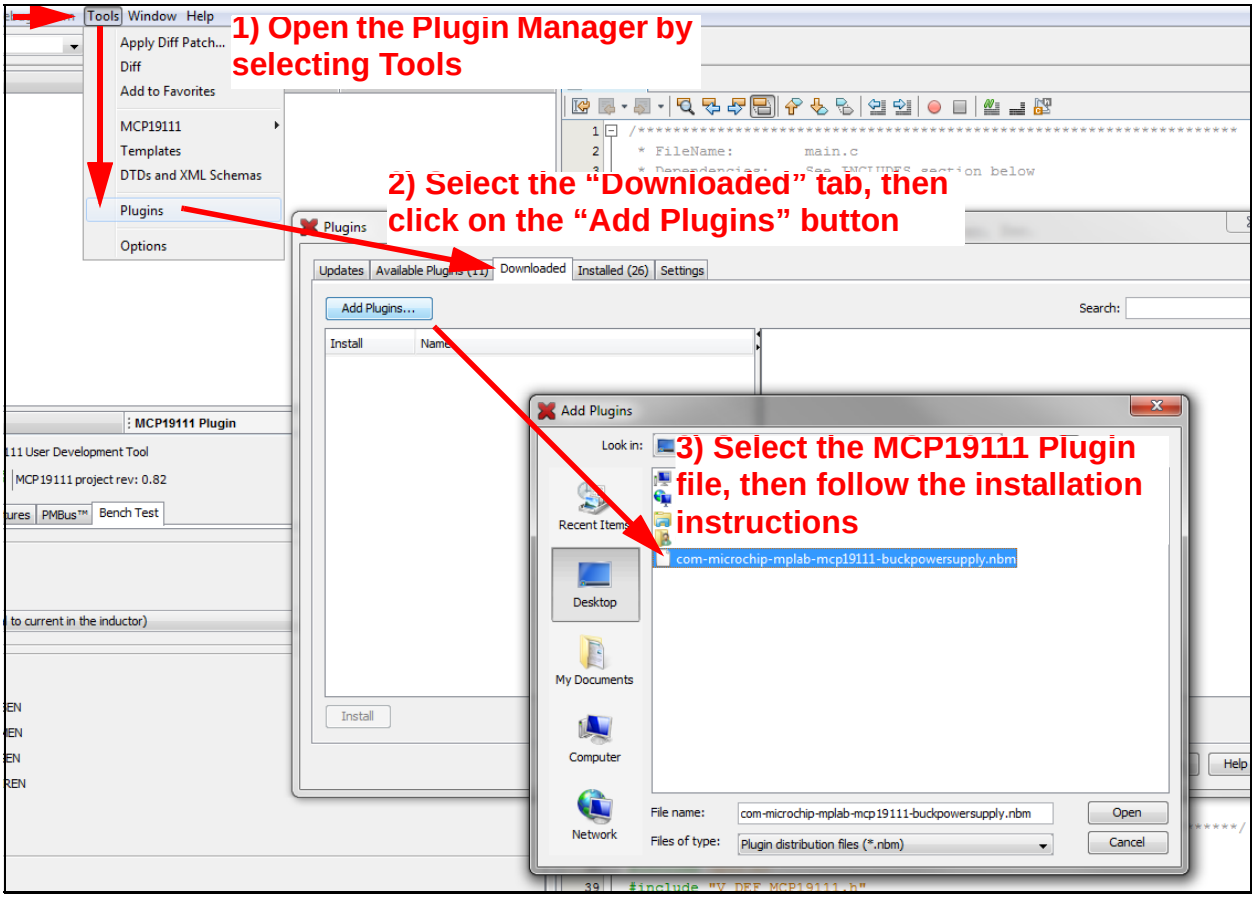

FIGURE 2-1: *MPLAB X Plug-In Manager View.*

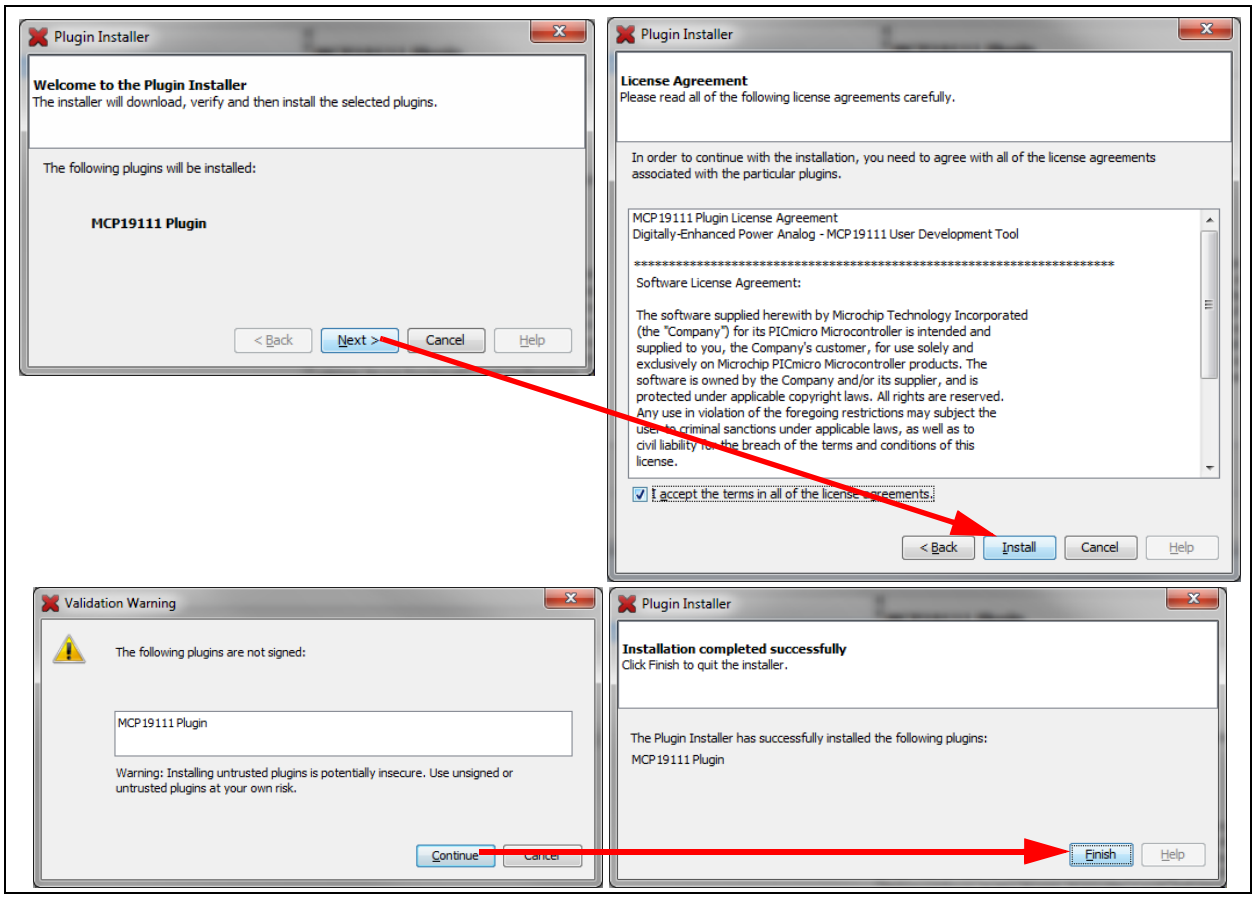

FIGURE 2-2: *MPLAB X Plug-In Installation.*

7. The installation requires a restart of MPLAB X. When done, the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In should be visible as displayed in Figure 2-3.

Note: The MPLAB X allows the windows to be configured in many different ways. To adjust placement or orientation, use your mouse to click and hold the tabs you want to move, and drag them to the location you want. A red box will appear as you move the window around the screen. This red box identifies valid placement locations.

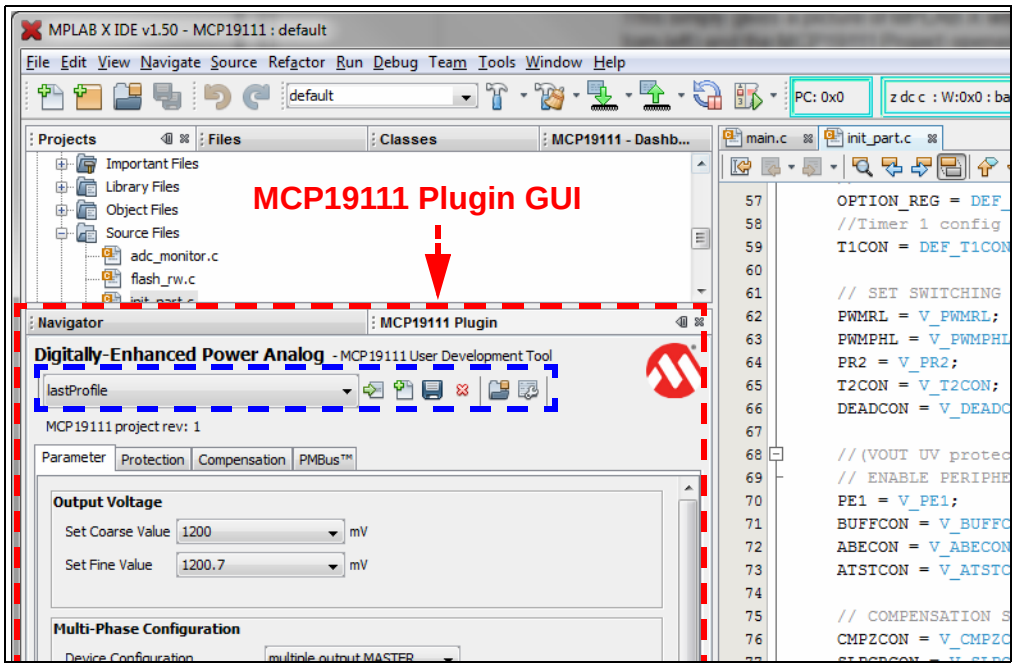

FIGURE 2-3: *MCP19111 MPLAB X Plugin Tab.*

8. Open the MCP19111 Project from the menu bar by selecting **File** > **Open Project**. Please ensure that the MCP19111 Project file is selected as the *main* project file. You can do this by right-clicking on MCP19111 in the "Projects" window, and selecting **Set as Main Project** from the drop-down menu.

   If the plug-in is not visible in MPLAB X, it can be displayed using the MPLAB X menu as described in Figure 2-4.

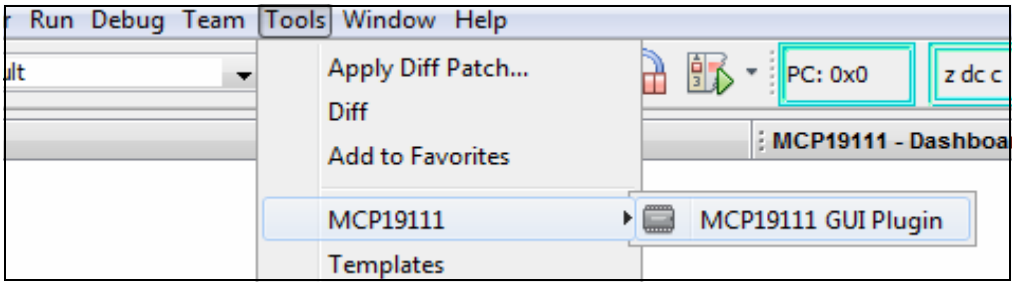

FIGURE 2-4: *How to Display the Plug-In.*

2.2 PROJECT CONFIGURATION

To see the project properties, right click on "MCP19111" inside the "Projects" window and select **Properties**. While the provided project should already be correctly configured to ensure proper hardware and software configuration, please ensure that the correct hardware tool (PICKIT3) and C-complier (XC8) are highlighted in the "Hardware Tool" and "Compiler Toolchain" windows, respectively. Figure 2-6 shows an example of how to select these tools. This section describes a list of settings that should be checked before beginning to use the tools.

FIGURE 2-5: *PICKIT3.*

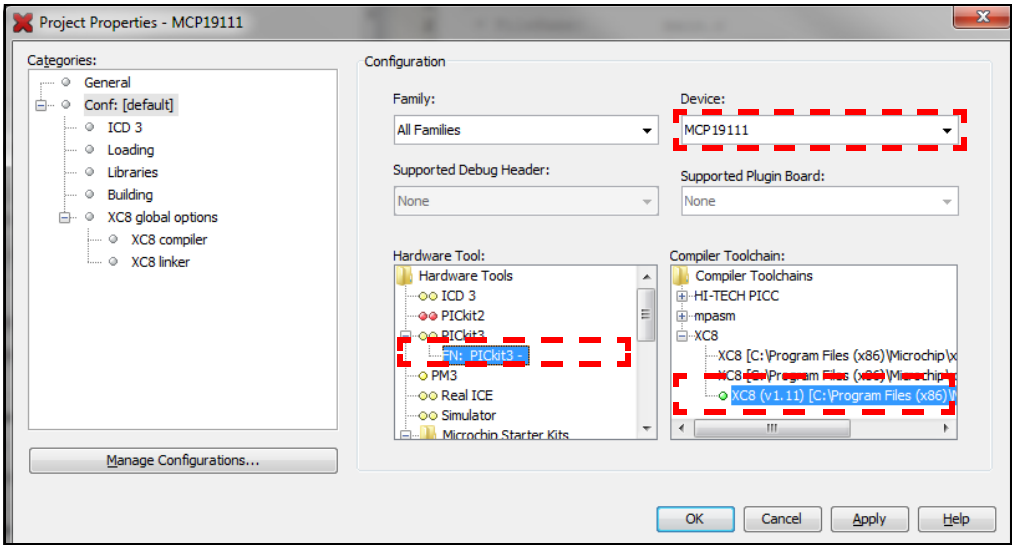

FIGURE 2-6: *Project Properties View.*

The following settings should already be set as they are embedded in the MCP19111 Project. There are some important properties of the MCP19111 Project shown in the following screen captures.

- The “Freeze Peripherals” feature must be disabled to use the debug mode (Unchecked = Disabled).

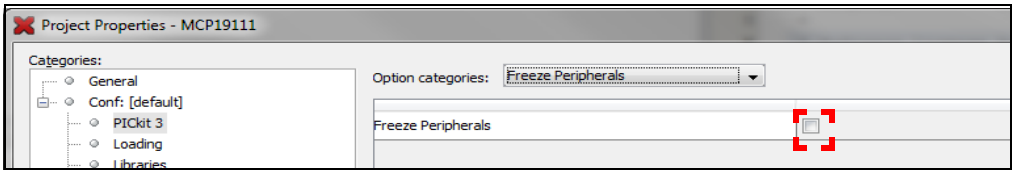

FIGURE 2-7: *Project Properties: Freeze Peripherals.*

- The programmer should not power the device.

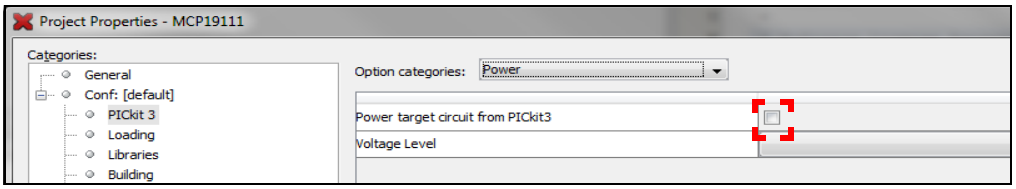

FIGURE 2-8: *Project Properties: Power Configuration.*

- The "Calibrate oscillator" peripherals feature must be disabled to use the debug mode.

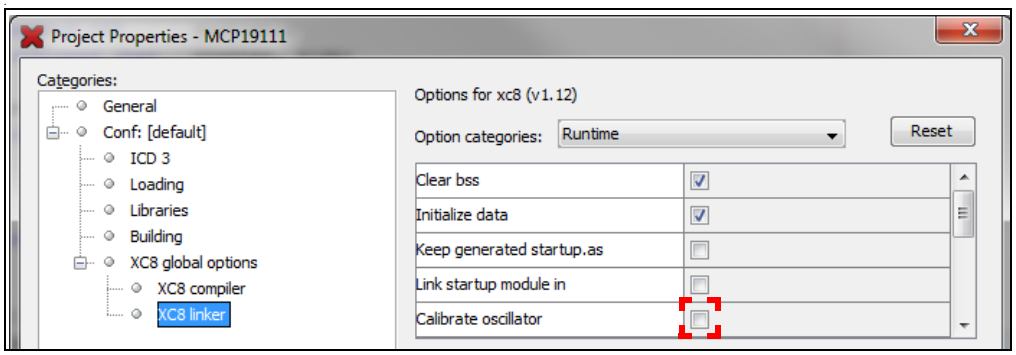

FIGURE 2-9: *Project Properties: Calibrate Oscillator.*

2.3 GUI TAB DESCRIPTIONS

This section shows the GUI tabs provided by the MCP19111 MPLAB X Plug-In. These tabs are used to modify the firmware of the MCP19111 Project. Refer to the MCP19111 Data Sheet for more information on product configuration.

2.3.1 Parameter Tab

The **Parameter** tab is used to set the main features of the part, as shown in Figure 2-10.

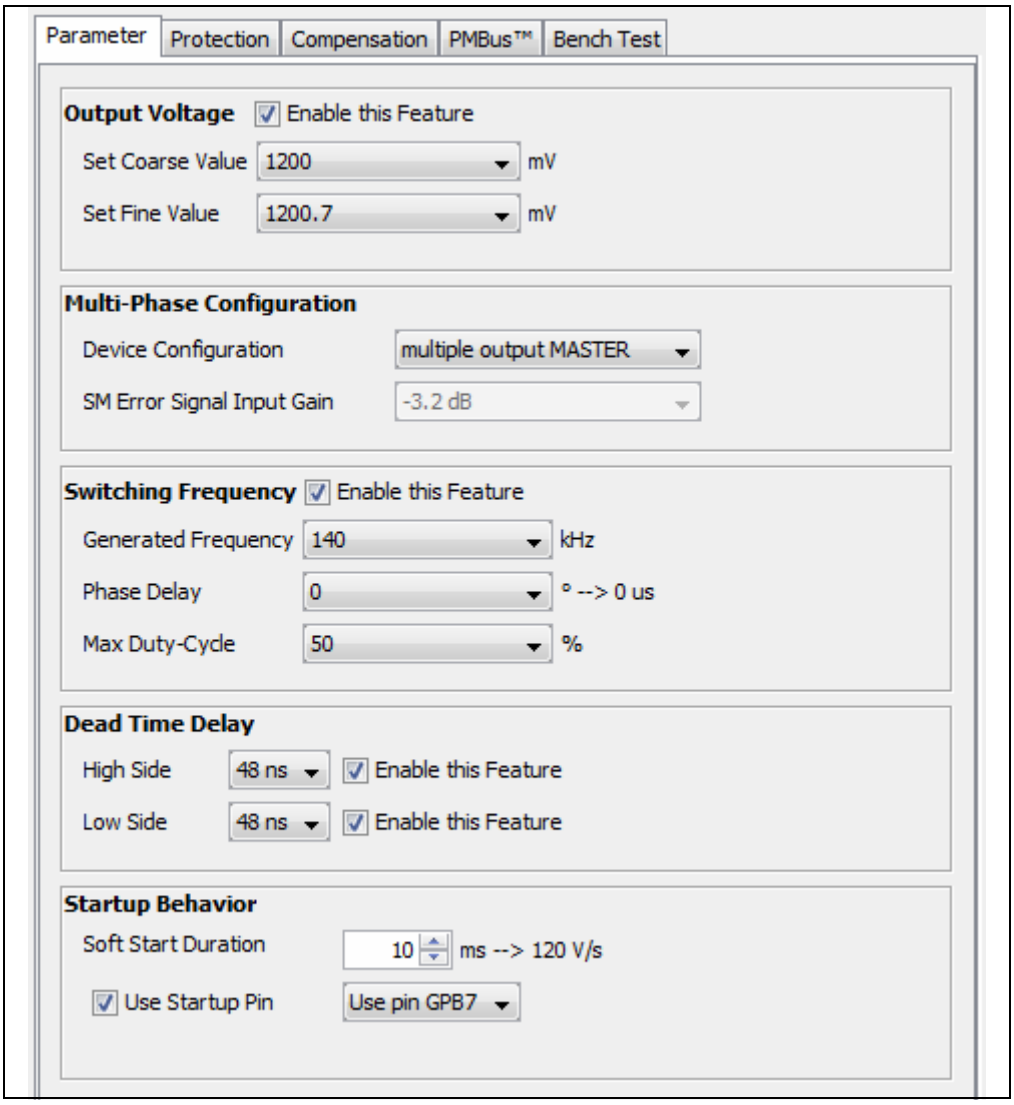

FIGURE 2-10: *Parameter Tab.*

2.3.1.1 OUTPUT VOLTAGE

The output voltage of the MCP19111 device is user programmable over the range of 0.5V to 3.6V. The '**Set Coarse Value**' is translated for the OVCCON register, while the '**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 MCP19111 Data Sheet for more information.

2.3.1.2 MULTI-PHASE CONFIGURATION

The Multi-Phase Configuration changes the value loaded into the BUFFCON register. The MCP19111 has the ability to operate as:

1. A stand alone unit:
   The device is configured to run as a stand-alone converter. No external clock or error signals are necessary. For a single evaluation board, this is the option that should be used.

2. A 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 MCP19111 devices. When selected, the device is configured as the MASTER, and its CLOCK is 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.
3. A multiple output slave unit:
   For this option, the CLKPIN is configured as a 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.
4. A 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 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.
5. A 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 is 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 multi-phase slave's error input signal gain can be dynamically changed so that the multiple power trains will share the load current equally. The multi-phase slave's error input signal gain 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.

2.3.1.3 SWITCHING FREQUENCY

The switching frequency of the MCP19111 is generated by using a single edge of the 8 MHz internal clock. The MCP19111 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 a whole number between 5 and 80. The MCP19111 has the option of allowing the switching frequency to be tuned. The tuning is accomplished by loading the OSCTUNE register.

The phase of the MCP19111 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.

2.3.1.4 DEAD TIME DELAY

In the MCP19111, the dead time is adjustable from 4 ns to 64 ns for the low side and 11 ns to 71 ns for the high side, in 4 ns steps. The values for t_{DEAD-1} and t_{DEAD-2} need not be the same. The desired drive signal dead time is configured through the GUI by configuring the Driver Dead Time Control Register (DEADCON) as shown in Figure 2-11.

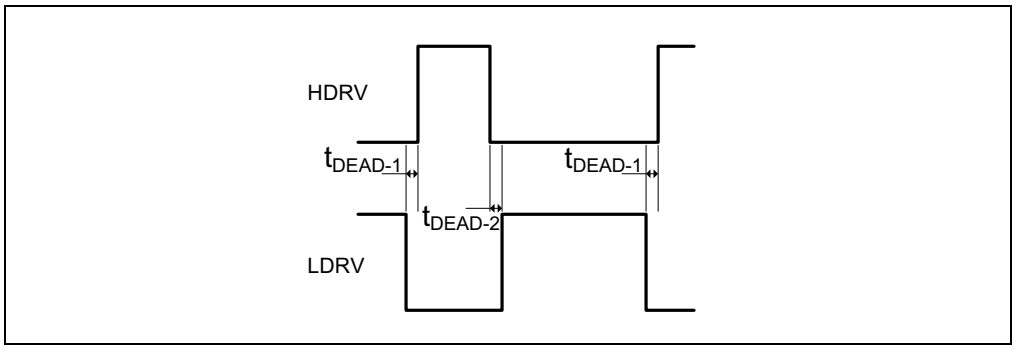

FIGURE 2-11: *Dead Time Description.*

2.3.1.5 START-UP BEHAVIOR

The Soft Start duration control on TMR1L and TMR1H to achieve the soft start ramp time. Each time the timer TMR1 overflows, the OVCCON will increase its value, so the output voltage set point will be increased in 16 mV steps. Soft Stop is implemented in the same way.

If a startup pin is used, the selected pin will be set by using the definition `V_NUM_EN_PIN` from `V_DEF_MCP19111.h`.
When a startup 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 startup pin in connected to the button **BT1** of the MCP19111 Evaluation Board (ADM00397). If the startup pin is enabled, the part will start switching only after pressing the button **BT1**. Pressing the button while the part is switching will stop it.

2.3.2 Protection Tab

The **Protection** tab is used to set the protections features, as shown in Figure 2-12.

2.3.2.1 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 via firmware. The GUI does provide the option to disable the output if either an under- or overvoltage event occurs.

2.3.2.2 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 firmware.

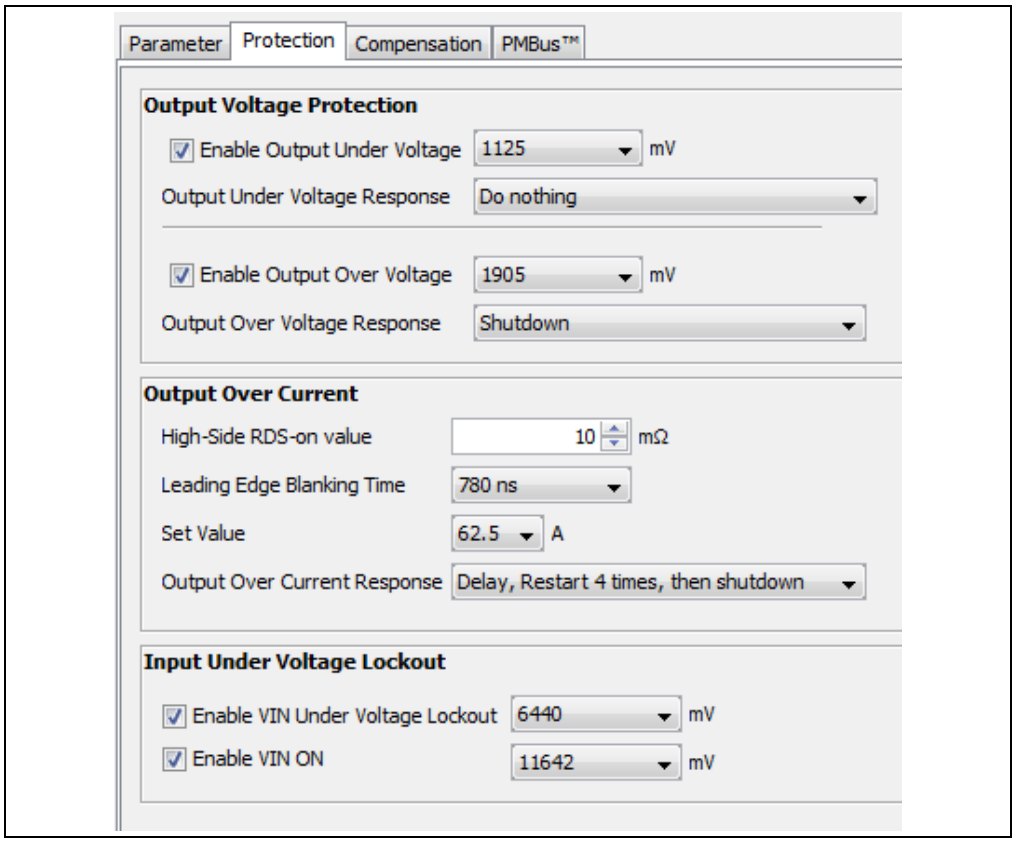

FIGURE 2-12: *Protection Tab.*

2.3.2.3 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 MCP19111 is allowed to turn on. The UVLO enable bit is also contained in this register. The available range for this setting is from 4V to 32V.

A second setting, VIN ON, can be used to introduce hysteresis on the input measurement. The part will start switching at the VIN ON value, but stop switching at the VIN undervoltage lockout value.

2.3.3 Compensation Tab

The **Compensation** tab is used to set the compensation parameters, as shown in Figure 2-13.

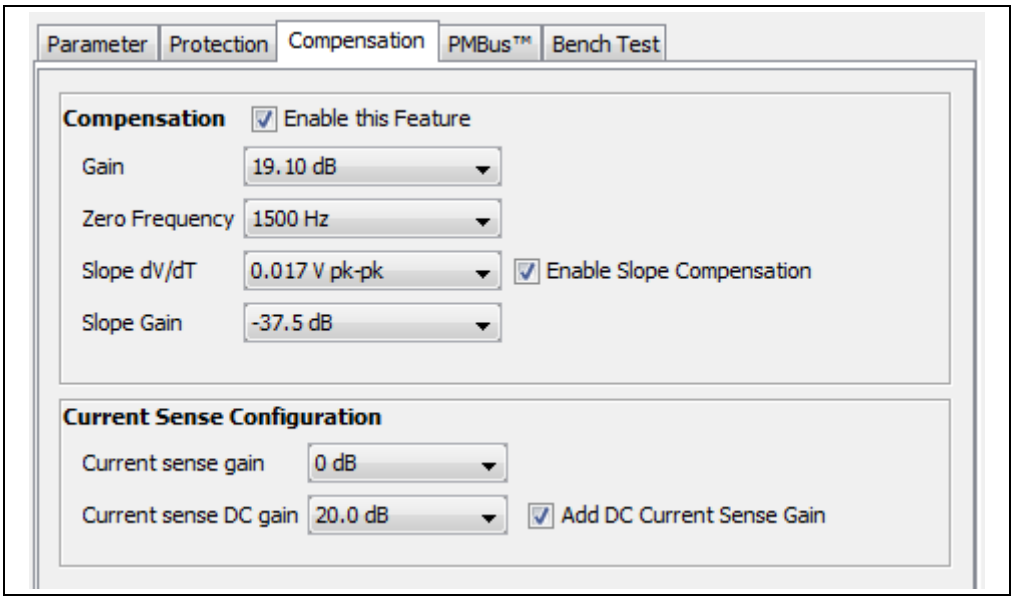

FIGURE 2-13: *Compensation Tab.*

2.3.3.1 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 and 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 $0.017V_{pk-pk}$ to $1.250V_{pk-pk}$, as measured for a 50% duty cycle waveform.

The current is measured across the inductor by using an 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 gain that can be set is from 0 dB - 22.5 dB and has a step size of 1.5 dB.

2.3.4 PMBus Tab

Before reviewing this section, it is helpful to have a working knowledge of the PMBus protocol. The PMBus specifications are available at http://pmbus.org/specs.html.

The firmware from the MCP19111 Project supports the most commonly used PMBus commands, including PEC checksum. The **PMBus** tab allows modification of the default hard-coded value of several PMBus commands.

The MCP19111 – Buck Power Supply, Graphical User Interface Plug-In also uses the values from the other tabs to configure the default values of the related PMBus command. This tab cannot be used for sending or receiving commands. Other tools are available on the Microchip MCP19111 web page for controlling the part through a PMBus interface.

Figure 2-14 shows the **PMBus** tab.

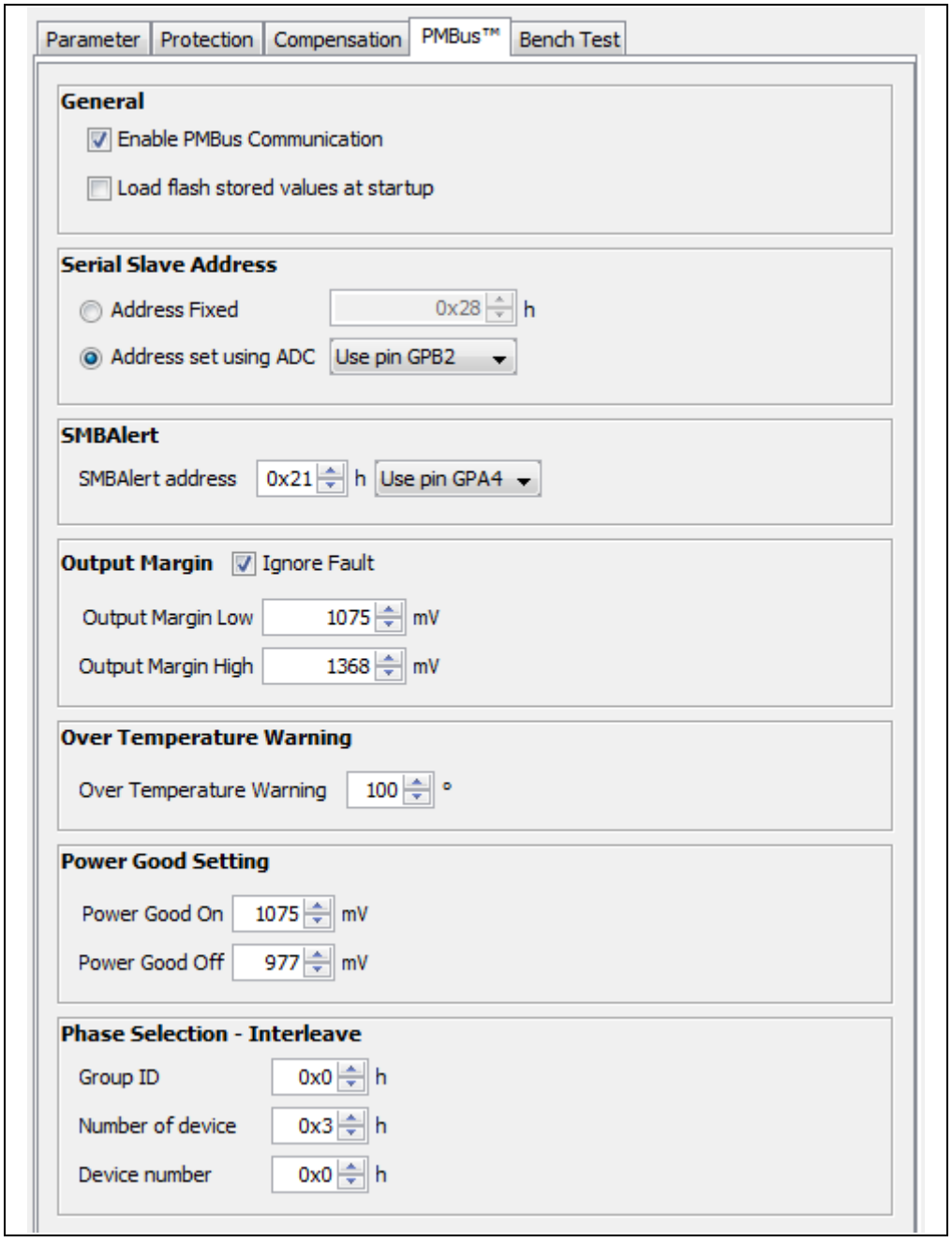

FIGURE 2-14: *PMBus Tab.*

2.3.4.1 ENABLE PMBUS COMMUNICATION

To use the PMBus communication, check the corresponding box under the '**General**' field. If this option is enabled, then all commands will be applied to the part at start-up. This will overwrite the basic startup configuration.

Note: The firmware's program memory usage will significantly increase when the PMBus stack is enabled. It is recommended to use the XC8 v1.11 PRO version to avoid memory space limitations. The PRO version uses up to 40% less memory than the LITE version. See Figure 2-15 for enabling the PRO version.

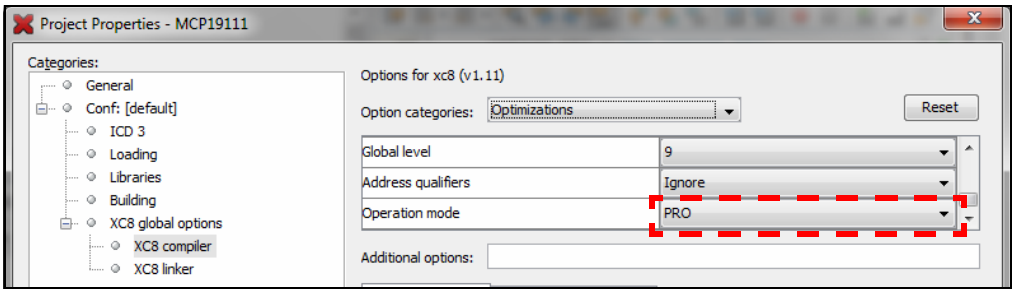

FIGURE 2-15: *XC8 v1.11 Compiler Set in PRO Mode.*

2.3.4.2 LOAD FLASH STORED VALUES AT STARTUP.

If this option is enabled the firmware will load all command values from the internal flash memory at start-up. All PMBus commands will then be applied to the part, thus overwriting the basic start-up configuration. The firmware supports read and write commands in Flash.

2.3.4.3 SLAVE SERIAL ADDRESS

The MCP19111 may be configured to set a fixed serial I^2C address or alternatively set an address that is read from the ADC at start-up. The pin selected to be read will automatically be set as an input in analog mode. Only the first eight most significant bits of the ADC value are used to define the serial address. The MCP19111 Evaluation Board uses a resistor divider on the GPB2 pin to define the address.

2.3.4.4 SMBALERT

A device can signal the host that it wants to talk, via the SMBALERT line. The host processes the interrupt and simultaneously accesses all devices through the Alert Response Address (ARA).

This part allows a second fixed serial I^2C address to be set in order to respond to a host ARA broadcast request. The default pin on the MCP19111 Evaluation Board for the SMBAlert is GPA4. This pin is connected to the serial connector on the board.

Table 2-1 provides details of the included PMBus commands.

Table 2-1: PMBus™ Commands

Code	Command Name	Write Byte	Read Byte	Storable in Flash	Default Value	Exponent (for linear)	Comment
1	OPERATION	1	1		128		Support operations are: Enable/disable output, margin high and margin low (with or without fault)
2	ON_OFF_CONFIG	1	1	Yes	31		Support configs. are: Output always ON, Output on using analog pin or/and digital command
3	CLEAR_FAULTS	0	0				
17	STORE_DEFAULT_ALL	0	0				
18	RESTORE_DEFAULT_ALL	0	0				
21	VOUT_COMMAND	2	2	Yes	1230	0	Linear data with exponent given by VOUT_MODE command
32	VOUT_MODE	1	1		22		VOUT_MODE specifies all V_{OUT} related commands in linear format with exponent of -8. The V_{OUT} range is from 0V to 4080V.
37	VOUT_MARGIN_HIGH	2	2	Yes	1400	0	Linear data with exponent given by VOUT_MODE command
38	VOUT_MARGIN_LOW	2	2	Yes	1100	0	Linear data with exponent given by VOUT_MODE command
50	MAX_DUTY	2	2	Yes	100	0	Range is from 0 to 100%
51	FREQUENCY_SWITCH	2	2	Yes	150	0	Range is from 100 kHz to 1600 kHz
53	VIN_ON	2	2	Yes	12	-2	Range is from 4V to 32V
54	VIN_OFF	2	2	Yes	10	-2	Range is from 4V to 32V
55	INTERLEAVE	2	2	Yes	0	0	
64	VOUT_OV_FAULT_LIMIT	2	2	Yes	1500	0	Linear data with exponent given by VOUT_MODE command.
65	VOUT_OV_FAULT_RESPONSE	1	1	Yes	4		Supported responses are: Do nothing, Restart, Restart 4 times then shutdown, Delay then Restart, Delay Restart 4 times then shutdown, Shutdown
68	VOUT_UV_FAULT_LIMIT	2	2	Yes	1000	0	Linear data with exponent given by VOUT_MODE command.
69	VOUT_UV_FAULT_RESPONSE	1	1	Yes	4		Supported responses are : Do nothing, Restart, Restart 4 times then shutdown, Delay then Restart, Delay Restart 4 times then shutdown, Shutdown

Table 2-1: PMBus™ Commands

Code	Command Name	Write Byte	Read Byte	Storable in Flash	Default Value	Exponent (for linear)	Comment
70	IOUT_OC_FAULT_LIMIT	2	2	Yes	40	-1	The range of this value will depend on the RDS_ON of the high-side external MOS-FET. The voltage drop across high-side MOSFET range is from 150 to 646mV. In order to allow the PMBus com-mand to be set in Amper, the firmware has to know the RDS_ON value of the external MOSFET so the definition V_SETTING_RON in the firm-ware helps with this. This V_SETTING_RON can also be modified by the GUI.
71	IOUT_OC_FAULT_RESPONSE	1	1	Yes	4		Supported responses are : Do nothing, Restart, Restart 4 times then shutdown, Delay then Restart, Delay Restart 4 times then shutdown, Shutdown
81	OT_WARN_LIMIT	2	2	Yes	100	0	Range is from -50°C to 170°C
94	POWER_GOOD_ON	2	2	Yes	1100	0	Linear data with exponent given by VOUT_MODE command
95	POWER_GOOD_OFF	2	2	Yes	1000	0	Linear data with exponent given by VOUT_MODE command
97	TON_RISE	2	2	Yes	9	-4	Range is from 1ms to 20ms
121	STATUS_WORD	0	2		0		Handle: VIN undervoltage, POWER_GOOD, Over tem-perature warning, I_{OUT} over current fault
122	STATUS_VOUT	0	1		0		Handle: V_{OUT} under/over volt-age
126	STATUS_CML	0	1		0		Handle: Invalid/Unsupported Command; Invalid/Unsupported Data Packet Error Check Failed, Other Communication Fault
136	READ_VIN	2	2		14.4	-2	Linear data
139	READ_VOUT	2	2		1248	0	Linear data with exponent given by VOUT_MODE com-mand
141	READ_TEMPERATURE_1	2	2		1.5	0	Linear data
152	PMBUS_REVISION	0	1		1	0	
252	REVISION	0	2		258		First octal: device type id = 1, Second octal: dev rev ID = 2

2.4 POSSIBLE ACTIONS

At this point, you should be able to set your desired parameters through the GUI (see **Section 2.3 "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.

2.4.1 MCP19111 – Buck Power Supply, Graphical User Interface Plug-In Actions

Figure 2-16 shows the actions provided by the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In.

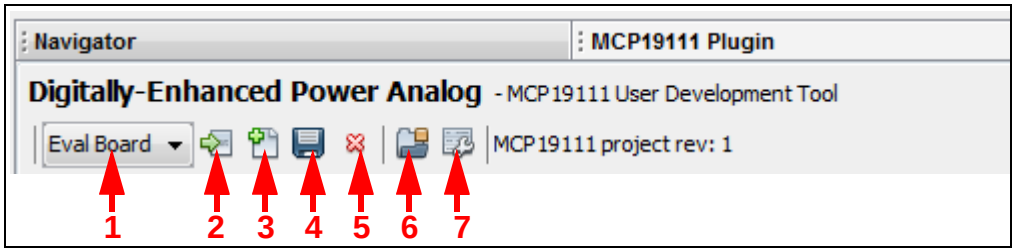

FIGURE 2-16: *MCP19111 – Buck Power Supply, Graphical User Interface Plug-In Actions.*

Note: Your GUI may differ slightly from the above picture. Please see **Section 2.6 "Advanced Mode"** for additional information.

1. The **profile selection** combo box has the ability to recreate previous GUI settings. The user can create, save and load a profile of settings for the MCP19111. The **profile selection** combo box is used to select the desired profile to either save or load.
2. 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 the user of this before replacing the current values. At the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In startup, the last profile selected will automatically be selected.
3. 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. This profile will be available on a restart of the MPLAB X IDE.
4. The **save profile** button is used to store the data from the GUI into the selected profile. When the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In or MPLAB X IDE is closed, the GUI parameters will automatically be saved in the selected profile.

   Warning: The user cannot modify the default Evaluation Board profile because it is protected.
5. 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.
6. The **open firmware folder** action opens the folder containing the compiled firmware (commonly called hex file). This compiled firmware can be used directly to program the part.

   Warning: Before taking the compiled firmware, make sure it is up-to-date. Use the MPLAB X programming button (see **Section 2.4.2 "MPLAB X Actions"** above) to generate a new firmware based on the GUI settings.

7. Advanced Mode. This button will enable additional features which are convenient for detailed testing and for setting the PMBus commands. See **Section 2.6 "Advanced Mode"** for more information.

Note:	An external profile may be uploaded into the MPLAB X IDE project by taking the `.cfg` file and placing it into the "Profile" folder located inside of the desired project folder. This is also where all of the created profiles reside.

2.4.2 MPLAB X Actions

MPLAB X IDE provides standard commands to compile, program or debug the MCP19111. This section describes the most common commands.

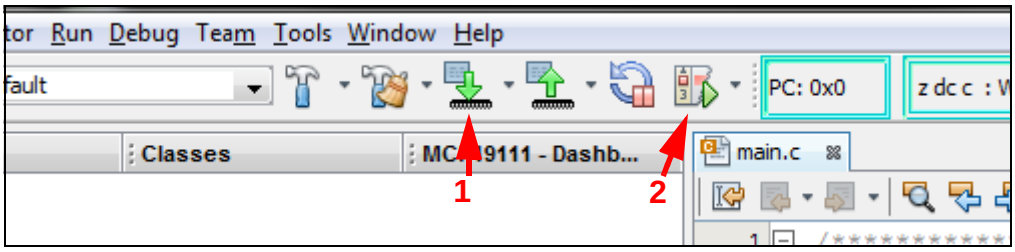

FIGURE 2-17: *MPLAB X Actions.*

1. The **Program Part and Run**. This option 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.
2. The **Program Part and Debug**. This 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.

2.5 HOW CAN I MODIFY THE CODE?

2.5.1 Introduction

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 file `V_DEF_MCP19111.h`. 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.

WARNING
This file also generates some conditional definitions, in order to activate/deactivate several firmware features.

Example:

in V_DEF_MCP19111.h:

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

If V_NUM_EN_PIN >= PIN_DISABLED, 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
```

In conclusion, if the user inserts code between the `#ifdef EN_PIN_EN` and `#endif`, the code may be not included in the compiler.

From the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In stand point, it is not permissible to remove or modify the location of any definitions included in the `V_DEF_MCP19111.h` file. If definitions are removed, the code may no longer function properly.

2.6 ADVANCED MODE

The Advanced mode can be activated using the appropriate action (see **Section 2.4.1 "MCP19111 – Buck Power Supply, Graphical User Interface Plug-In Actions"**). When this mode is enabled, the following changes appear:

- The common MCP19111 – Buck Power Supply, Graphical User Interface Plug-In GUI tabs have new options that allow certain peripherals to be disabled.
- The Bench Test tab appears (see **Section 2.6.1 "Bench Test Tab"**).
- Two new possible actions provided by the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In appear. (see **Section 2.6.2 "New MCP19111 – Buck Power Supply, Graphical User Interface Plug-In Action for Advanced Mode"**.)

2.6.1 Bench Test Tab

The Advanced mode displays a new tab on the MCP19111 – Buck Power Supply, Graphical User Interface Plug-In called Bench Test tab. Figure 2-18 shows this tab.

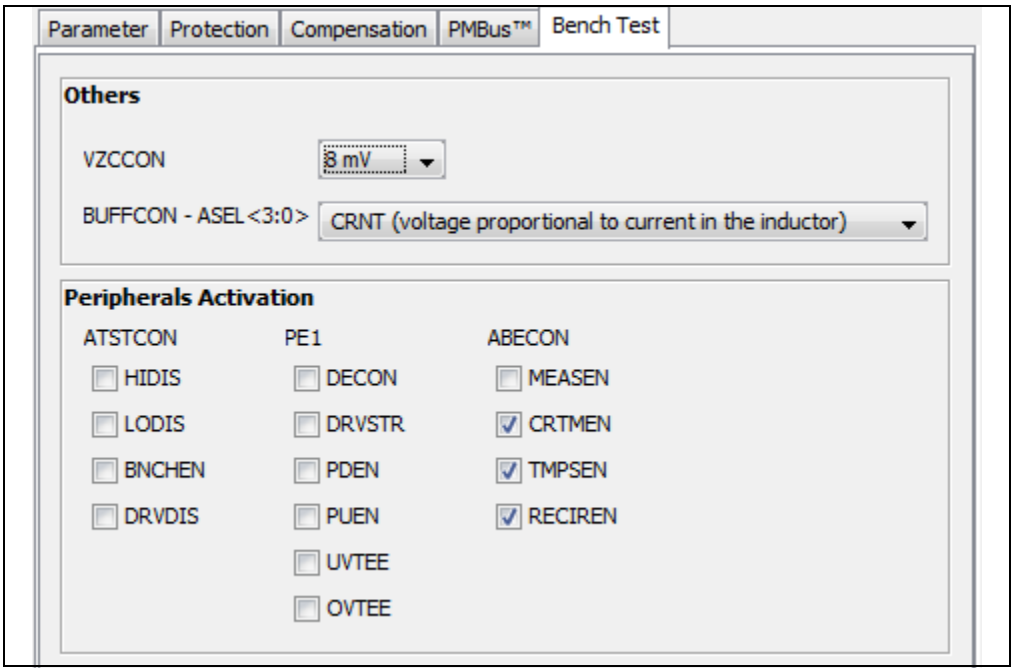

FIGURE 2-18: *Bench Test Tab.*

"Others" parameters control the VZCCON register and the BUFFCON - ASEL register. The ASEL bits are used to select the desired internal signal and connect it to a GPIO pin as an analog output. GPA0 is selected for this purpose, and it requires that BNCHEN be enabled (see Peripherals Activation below). The Peripherals Activation check boxes are used to enable or disable the peripherals that cannot be controlled directly from the other tabs.

Note 1:	Placing the cursor over any of the peripheral's activation names will give a brief description of what the particular bit does.

2.6.2 New MCP19111 – Buck Power Supply, Graphical User Interface Plug-In Action for Advanced Mode

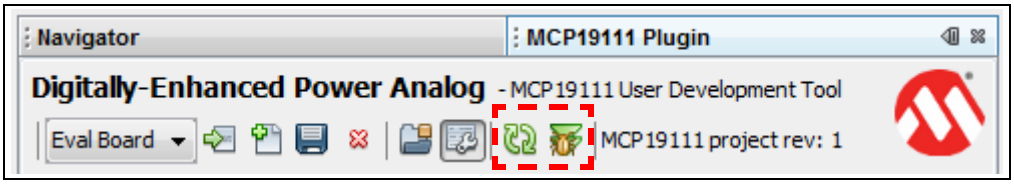

FIGURE 2-19: *Actions for Advanced Mode.*

1. The **refresh GUI** button is used to refresh the GUI values from the project sources. This can be used if the project source files are modified external to the GUI.
2. The **update values in debug mode** button 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 tabs **Parameter**, **Protection**, **Compensation** and **Bench test (in Advanced mode)**.

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