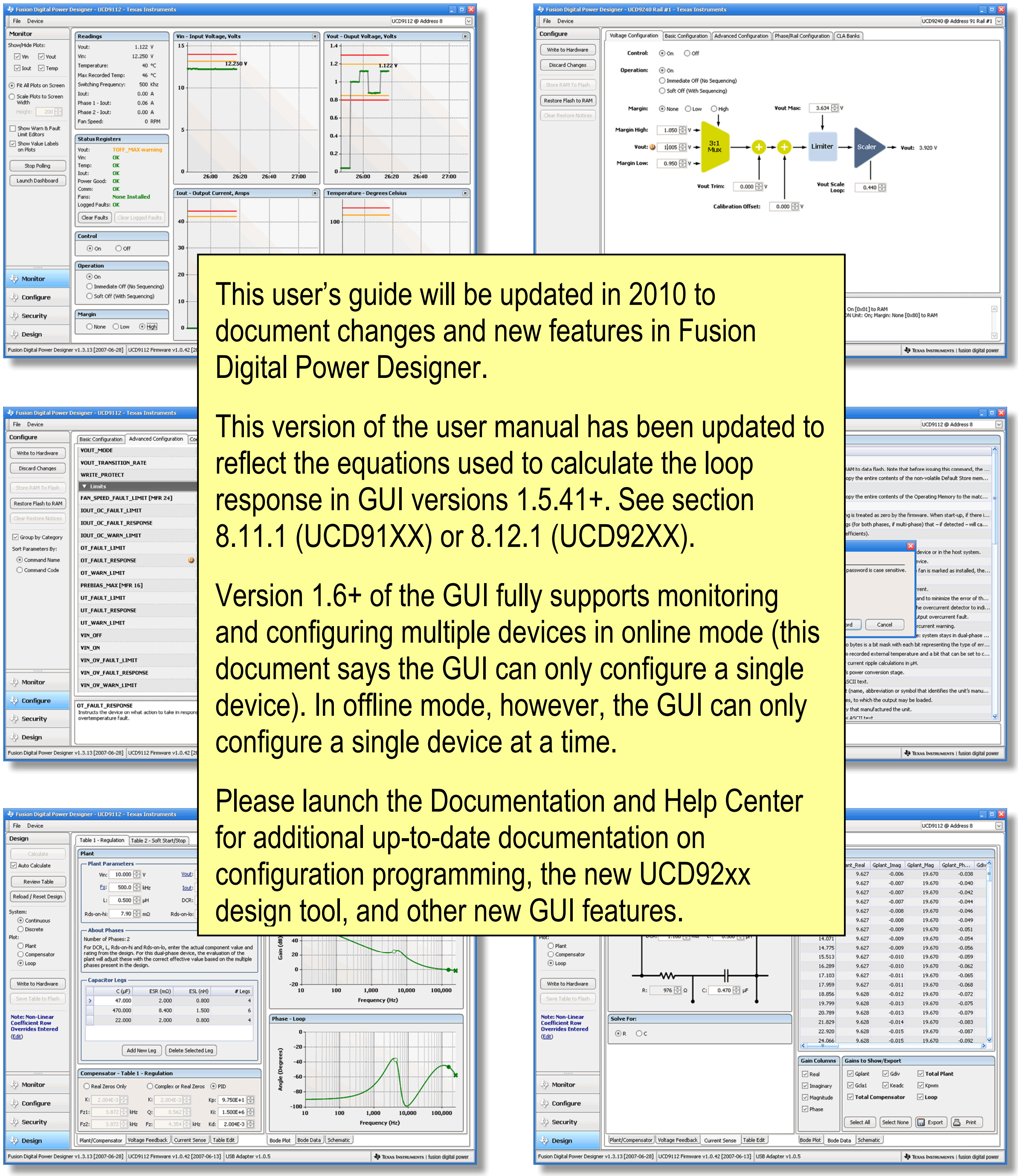
Fusion Digital Power Designer User's Guide

For Version 1.3.23 or Higher · User's Guide Last Updated on 15 September 2007

Documentation for the Microsoft Windows™ application used to monitor and configure Texas Instruments UCD91XX and UCD92XX PMBus™ digital power controllers.


Fusion Digital Power Designer - UCD9112 - Texas Instruments
Fusion Digital Power Designer - UCD9240 Rail #1 - Texas Instruments
Monitor
Configure
Security
Design
Vin - Input Voltage, Volts
Vout - Ouput Voltage, Volts
Iout - Output Current, Amps
Temperature - Degrees Celsius
Phase - Loop
Frequency (Hz)

This user's guide will be updated in 2010 to document changes and new features in Fusion Digital Power Designer.

This version of the user manual has been updated to reflect the equations used to calculate the loop response in GUI versions 1.5.41+. See section 8.11.1 (UCD91XX) or 8.12.1 (UCD92XX).

Version 1.6+ of the GUI fully supports monitoring and configuring multiple devices in online mode (this document says the GUI can only configure a single device). In offline mode, however, the GUI can only configure a single device at a time.

Please launch the Documentation and Help Center for additional up-to-date documentation on configuration programming, the new UCD92xx design tool, and other new GUI features.

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Mailing Address:

Texas Instruments
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1 About This User's Guide

1.1 Documented Program Version

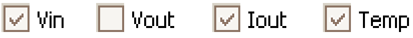
This user's guide describes Fusion Digital Power Designer version 1.3.23. As features are modified or added in the software, this document will be updated. Please refer to Section 3.3 for instructions on downloading the latest version of the software.

1.2 Conventions

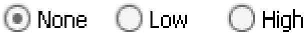
Any hexadecimal number will be prefixed by 0x. For example, 0xFF. Any other number should be assumed to be decimal.

1.3 User Interface Terminology & Tips

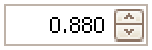
Checkbox
You can select any number of boxes.



Radio Button
You can only select one of the circles at a time. For example, clicking "High" will deselect "None."



Spin Edit
Used for numeric entry. You can type in a number directly or click the up and down arrows to increment or decrement the number. The up/down usually changes the last decimal place (adding or subtracting 0.001 in this example).



Widget
A generic term used to describe a user interface component such as a button or checkbox.

Disabled (Grayed Out)
You can not edit to the widget. This is usually because the GUI has determined that a particular item is a "don't care" or does not make sense given the setting of some other widget or PMBus command.

1.4 Providing Feedback on this User's Guide

Please contact your Texas Instruments representative to give feedback on this document or send e-mail to digitalpowerapplications@list.ti.com.

2 ABOUT FUSION DIGITAL POWER DESIGNER

2.1 Overview

Fusion Digital Power Designer is a Graphical User Interface (GUI) used to configure and monitor a Texas Instruments digital power controller, typically embedded on an Evaluation Module (EVM). The application – referred to as the GUI throughout this user's guide – uses the PMBus protocol to communicate with the controller over serial bus by way of a TI USB adapter.

Some of the tasks you can perform with the GUI include:

- Turn on or off the power supply output, either through the hardware control line or the PMBus OPERATION command.
- Monitor real-time data. Items such as input voltage, output voltage, output current, temperature, and warnings/faults are continuously monitored and displayed by the GUI.
- Configure the control law accelerator (CLA) coefficients through an interactive design tool.
- Configure common operating characteristics such as Vout, warning and fault thresholds, and switching frequency.

2.2 Supported TI Controllers

The GUI currently supports the following Texas Instruments digital power controllers:

- UCD9111
- UCD9112
- UCD9240

Other pre-production or special purpose controllers not listed above may also be supported.

At startup, the GUI scans all possible PMBus addresses and detects the first responding device. Based on the device found, the GUI configures its features and the list of PMBus commands it supports. For in-development products, the GUI may also configure itself differently depending on the firmware version it detects. The goal is for the customer to avoid the hassle of installing different versions of the GUI for different devices.

2.3 PMBus & the GUI

The GUI communicates with the device using the Power Management Bus (PMBus) protocol. PMBus uses the System Management Bus (SMBus) to communicate with a controller over serial bus. The PMBus specification defines the application layer while the SMBus standard defines the transport layer. This section gives a brief overview of some PMBus concepts that are used in the GUI. Visit www.pmbus.org and www.smbus.org for a more thorough description of PMBus and SMBus.

The PMBus protocol defines a set of standard commands that devices may support. A *command* represents an action a device is to perform or information it can read and/or write. A PMBus *parameter* is a special type of command. You can read a parameter to get information from the device and optionally write to a parameter to configure the device. Some parameters are read only while others support read and write. Parameters are referred to as variables in this user's guide. Another type of command is a *send byte* command. These are similar to function calls in a programming language: they instruct the device to do something.

Every command has a unique command code. These are shown in the GUI using hexadecimal notation. Command codes start at 0x00 and end at 0xFF. Commands are named using fairly descriptive labels, such as VOUT_COMMAND for the command that is used to set output voltage.

Manufacturers may define their own proprietary commands. Command codes 0xD0 through 0xFF are reserved for these manufacturer specific commands. Many of the UCD9xxx digital power controllers share a common set of manufacturer commands. In the PMBus specification, manufacturer commands have generic names such as MFR_SPECIFIC_00, MFR_SPECIFIC_01, and so on. TI manufacturer commands have more user friendly names assigned to them. For example, a TI manufacturer specific command to used control voltage tracking is named TRACKING_ENABLE instead of MFR_SPECIFIC_19.

Some commands may read or write different values depending on the converter phase you are interested in. For example, on a two-phase device like the UCD9112, READ_IOUT can be used to read the output current on phase 1, phase 2, or both phases (total current). Under the hood of the GUI, the PMBus PHASE command is used to tell the device which phase READ_IOUT should return. This happens seamlessly. The GUI identifies parameters like this by appending a label to the end of each "phased" command. For example, in the case of READ_IOUT on the UCD9112, you might see READ_IOUT_1, READ_IOUT_2, and READ_IOUT_ALL.

If a device supports multiple output rails, such as UCD92XX devices, most commands will operate on a specific output rail. For example, READ_VOUT returns the output voltage for a specific rail. Behind the scenes, the GUI uses the PMBus PAGE command to set which output rail a "paged" command operates on. Similar to PHASE, you don't have to set PAGE directly. The GUI will handle writing to it depending on what rail you are managing. Refer to your device's application notes to determine which commands are paged and which are not.

Some example commands are shown in the following table:

Command	Code	Description
ON_OFF_CONFIG	0x02	A read/write parameter. Configures the combination of CONTROL pin input and PMBus commands needed to turn the unit output on and off. Paged.
READ_VOUT	0x8B	A read-only parameter. Returns the measured output voltage. Paged.
READ_IOUT_1	0x8C	A read-only parameter. Output current for phase 1. Phased and paged.
READ_IOUT_ALL	0x8C	A read-only parameter. Total output current. Notice how the command code is the same as for READ_IOUT_1. Paged.
CLEAR_FAULTS	0x03	A send byte command. This instructs the device to clear any fault or warning bits that have been set in the various status registers the device maintains. Because this is a send byte, you do not actually read this command. Paged.
TRACKING_ENABLE [MFR 19]	0xE3	A read/write manufacturer parameter. This controls whether the voltage tracking feature is enabled on the UCD91XX. A tag such as "MFR 19" shown here is used in the GUI to indicate a parameter is a manufacturer command. In this case, 19 means this command uses the MFR_SPECIFIC_19 command slot. Paged.
MFR_LOCATION	0x9C	A read-write string parameter. Since this is global to a device, it is not paged.

2.4 Getting Device or Application Support

If you need assistance with the GUI or your digital power controller, please contact your Texas Instruments sales representative or send an e-mail to digitalpowerapplications@list.ti.com.

3 Getting Started

3.1 PC Requirements

The GUI requires the following:

- A PC running Windows XP
- Microsoft.NET Framework version 2.0

Microsoft.NET is the runtime application framework that the GUI uses. The GUI's installer will check to see if you have version 2.0 of .NET installed on your PC, and install it if necessary.

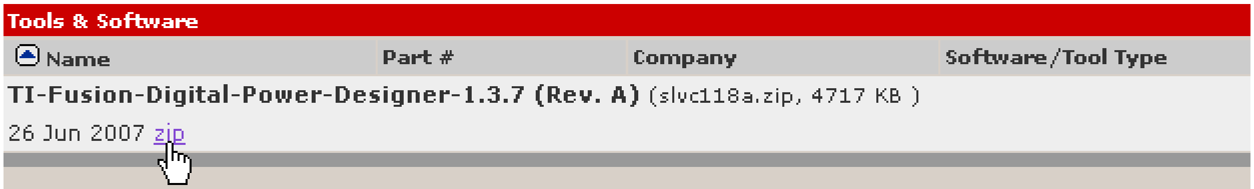
3.2 USB Adapter

The EVM is attached to the PC through a Texas Instruments serial bus adapter, part number HPA172[1]. You should have received this adapter with your EVM. The serial adapter must be running firmware v. 1.0.5 or higher. If your adapter's firmware does not meet this requirement, you will receive a warning message when you first start the GUI.

The GUI can be run in "Offline mode" without the serial bus adapter, which lets you edit an existing device configuration or experiment with a default "virtual device." See Section 10 for more information about the GUI's offline mode.

3.3 Download & Installation

The latest version of the Fusion Digital Power Designer can be found on the product page for supported digital controllers under the Tools & Software section. For example, http://focus.ti.com/docs/prod/folders/print/ucd9240.html.



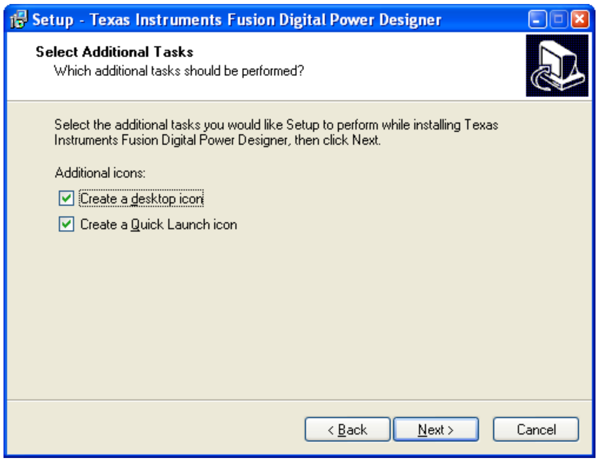
Tools & Software

Name	Part #	Company	Software/Tool Type
TI-Fusion-Digital-Power-Designer-1.3.7 (Rev. A) (slvc118a.zip, 4717 KB) 26 Jun 2007 zip			

Figure 1 GUI Download on UCD92XX Product Page

Download the ZIP file to your hard drive. You do not need to unzip the ZIP: you can launch the installer from within WinZip or similar ZIP utility.

Once you have started the installer, you will normally want to accept all of the installation defaults. You may want to review the following install form, however:



Setup - Texas Instruments Fusion Digital Power Designer

Select Additional Tasks

Which additional tasks should be performed?

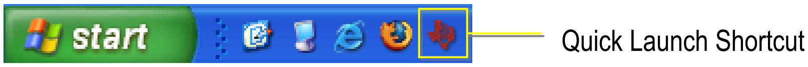
Select the additional tasks you would like Setup to perform while installing Texas Instruments Fusion Digital Power Designer, then click Next.

Additional icons:

☑ Create a desktop icon

☑ Create a Quick Launch icon

The previous form in the installer controls whether GUI "shortcuts" are added to the desktop and quick launch area. The quick launch area is the area next to the Start menu which contains shortcuts to commonly used applications.



3.4 Starting the GUI

When you launch the GUI, it attempts to find a supported device attached to the PMBus. The following sequence is followed:

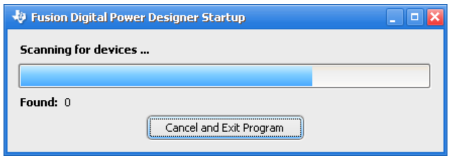
1. The GUI looks for an attached USB serial bus adapter.

2. The GUI sends SMBus commands to the "broadcast" address 11 telling any devices that are in ROM mode to execute their program (go to flash mode). While this is not necessary for production devices such as the UCD9112, it may be necessary for in-development products that are set to boot to ROM mode.

   Currently, the UCD92XX execute program command is sent first (send byte command code 0xF0) and then the UCD91XX version is sent (send byte command code 0x08).

3. The GUI scans addresses 1 through 127 for an attached device. It does this by reading a special manufacturer command, DEVICE_ID, on each address. This parameter contains information about the device, including part number and firmware version. Address 12 is skipped because this is reserved for use in the SMBus Alert Response Protocol.

4. While the scanning process occurs, you will see a dialog box:

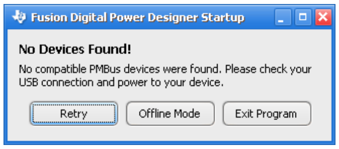


Fusion Digital Power Designer Startup

Scanning for devices ...

Found: 0

5. If a supported device can not be found, you will see this error message:



Fusion Digital Power Designer Startup

No Devices Found!

No compatible PMBus devices were found. Please check your USB connection and power to your device.

Double check your USB adapter connection and power to your device and click *Retry* if you would like to retry the scan.

Offline mode allows you to use most of the GUI's features while not electrically connected to a device. It is described in more detail in Section 9.

When the GUI finds a device it makes a note of the address in it's preferences. The next time you launch the GUI, it will see if a device is still at this address before scanning the address range 1 through 127. This speeds up GUI startup.

Currently, the GUI will stop scanning for devices after finding the first device. A future release of the GUI will support managing multiple devices concurrently.

3.4.1 Connection Troubleshooting Tips

Problem	Resolution
The scan never occurs. The GUI immediately comes up with the error form. When retry is clicked, the error form reappears immediately.	This usually indicates the USB serial adapter is not attached to the PC or is malfunctioning. Verify that the green LED on the serial adapter is ON. If it is not, unplug the adapter, power off your device, reconnect the adapter, and then power on your device.
The GUI scans each address, but can not find the device	Verify that power is on to the device. Try re-applying power to the EVM. Also, try resetting the USB adapter as described above.

3.5 Program Preferences

Many aspects of the GUI are configurable. Your settings are maintained in a preference file on your PC. Some common preferences include:

- GUI window size and location
- Show/hide status of various components of the interface, such as charts in the monitoring task
- The input parameters for your last design

The GUI does not maintain the state of the hardware configuration in its preferences. It does, however, provide a powerful feature to export a device's parameters and design to a separate file. This file, called a project file, can be loaded at a later date and even edited offline. See Section 9 Project Files and Section 10 Offline Mode.

Preferences are stored in a file named prefs.xml under the folder the application was installed in. For example, C:\Program Files\Texas Instruments Fusion Digital Power Designer\data\prefs.xml. Preferences are global for a particular installation of the GUI on your PC. So if two people share the same PC, such as in a laboratory, they will share GUI preferences.

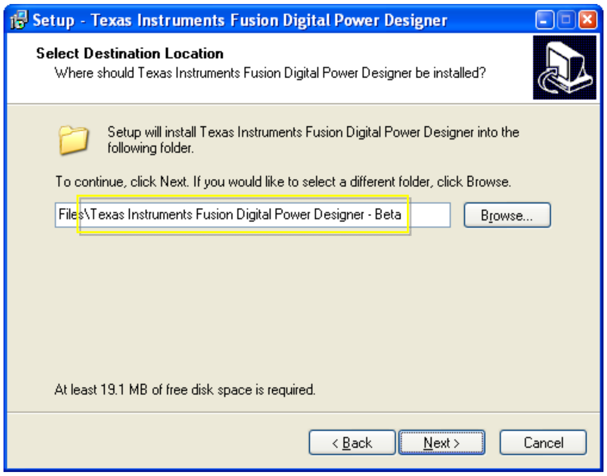
3.6 Upgrading the GUI

When upgrading to a new release of the GUI, there is no need to un-install the current installed version first. In fact, doing so will remove your program preferences, and is not recommended. The GUI installer will take care of updating all necessary files. Your program preferences will not be modified by the installer.

3.7 Multiple Installations of the GUI

You *can* install different versions of the GUI on same the PC. Because the preferences are stored within the program folder as described in Section 3.5, each version of the GUI installed on your PC will have its own set of preferences.

When you install a second copy of the GUI, you need to ensure the name of the folder for the additional copy is named different from the default folder name, "Texas Instruments Fusion Digital Power Designer." The easiest way to do this is to append something descriptive to the folder name. For example, in the following example " – Beta" was appended to the installation folder pathname:



Select Destination Location

Where should Texas Instruments Fusion Digital Power Designer be installed?

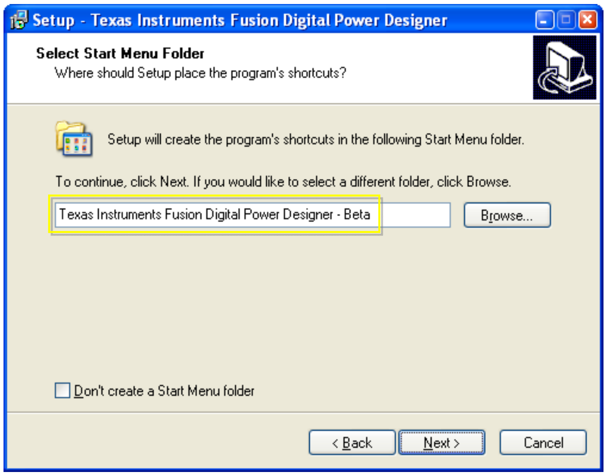
Setup will install Texas Instruments Fusion Digital Power Designer into the following folder.

To continue, click Next. If you would like to select a different folder, click Browse.

Files\Texas Instruments Fusion Digital Power Designer - Beta

At least 19.1 MB of free disk space is required.

You will also need to rename the Start Menu folder that gets created. Again, " – Beta" has been appended to the default:



Select Start Menu Folder

Where should Setup place the program's shortcuts?

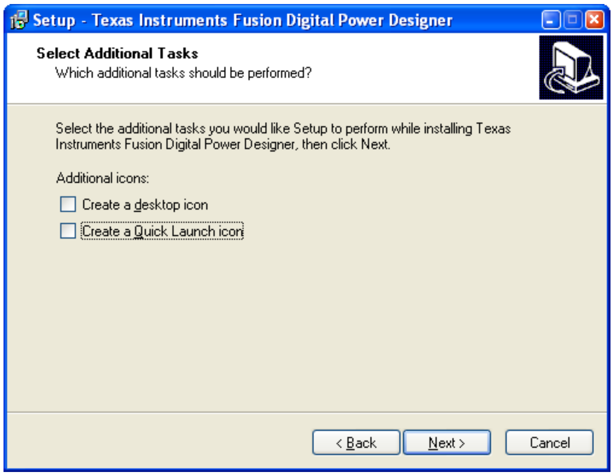
Setup will create the program's shortcuts in the following Start Menu folder.

To continue, click Next. If you would like to select a different folder, click Browse.

Texas Instruments Fusion Digital Power Designer - Beta

□ Don't create a Start Menu folder

Finally, you'll need to decide whether you want to install desktop or quick launch shortcuts for this version of the GUI. These shortcuts will overwrite any existing shortcuts. In the "beta" example used here, it is probably best to skip the creation of shortcuts:



Setup - Texas Instruments Fusion Digital Power Designer

Select Additional Tasks

Which additional tasks should be performed?

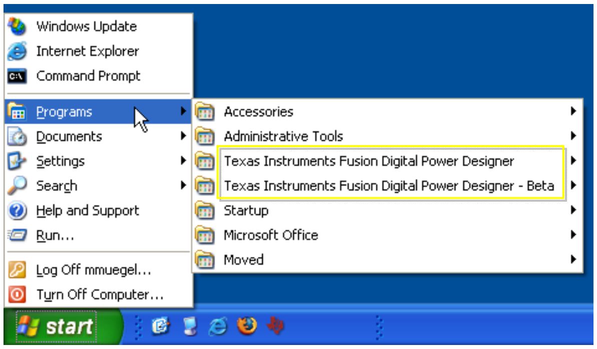
Select the additional tasks you would like Setup to perform while installing Texas Instruments Fusion Digital Power Designer, then click Next.

Additional icons:

□ Create a desktop icon

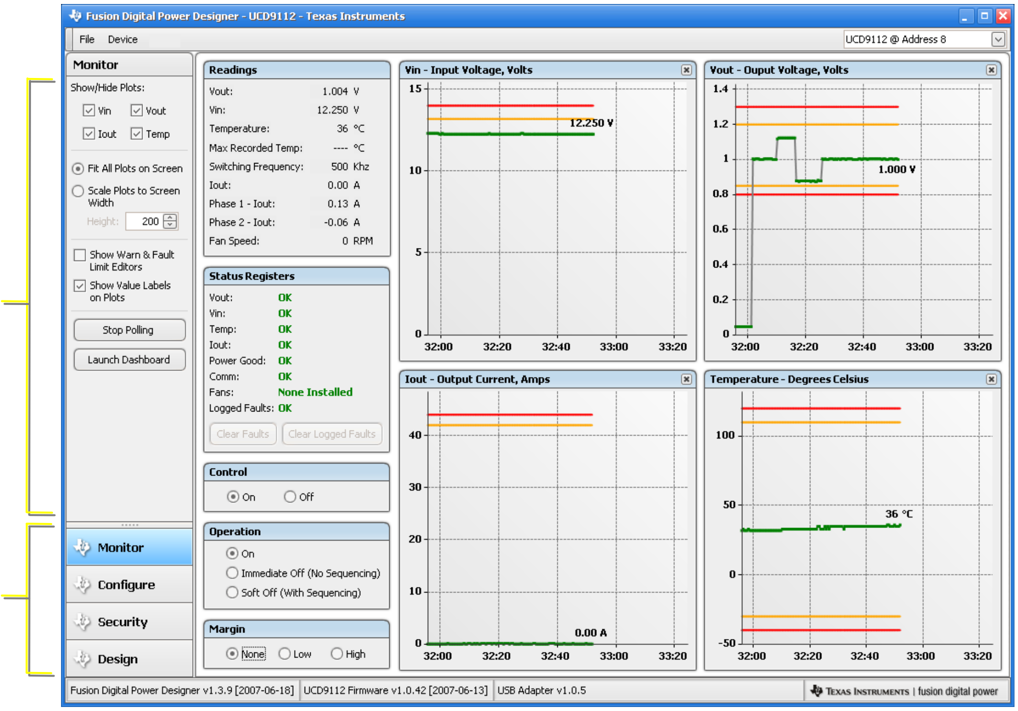
□ Create a Quick Launch icon

Using this technique, you'll be able to launch either version of GUI from the Start Menu:



4 USER INTERFACE OVERVIEW

GUI functions are grouped together into tasks that can be selected by clicking the button on the lower left side of the form:



Show/Hide Plots:

☑ Vin ☑ Vout

☑ Iout ☑ Temp

● Fit All Plots on Screen

○ Scale Plots to Screen Width

Height: 200

□ Show Warn & Fault Limit Editors

☑ Show Value Labels on Plots

Readings

Vout: 1.004 V
Vin: 12.250 V
Temperature: 36 °C
Max Recorded Temp: ---- °C
Switching Frequency: 500 Khz
Iout: 0.00 A
Phase 1 - Iout: 0.13 A
Phase 2 - Iout: -0.06 A
Fan Speed: 0 RPM

Status Registers

Vout: OK
Vin: OK
Temp: OK
Iout: OK
Power Good: OK
Comm: OK
Fans: None Installed
Logged Faults: OK

Control

● On ○ Off

Operation

● On
○ Immediate Off (No Sequencing)
○ Soft Off (With Sequencing)

Margin

● None ○ Low ○ High

Fusion Digital Power Designer v1.3.9 [2007-06-18] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

Control Current Task
This area changes as you select a new task

Tasks
Click a button to select a new task; the current task is highlighted

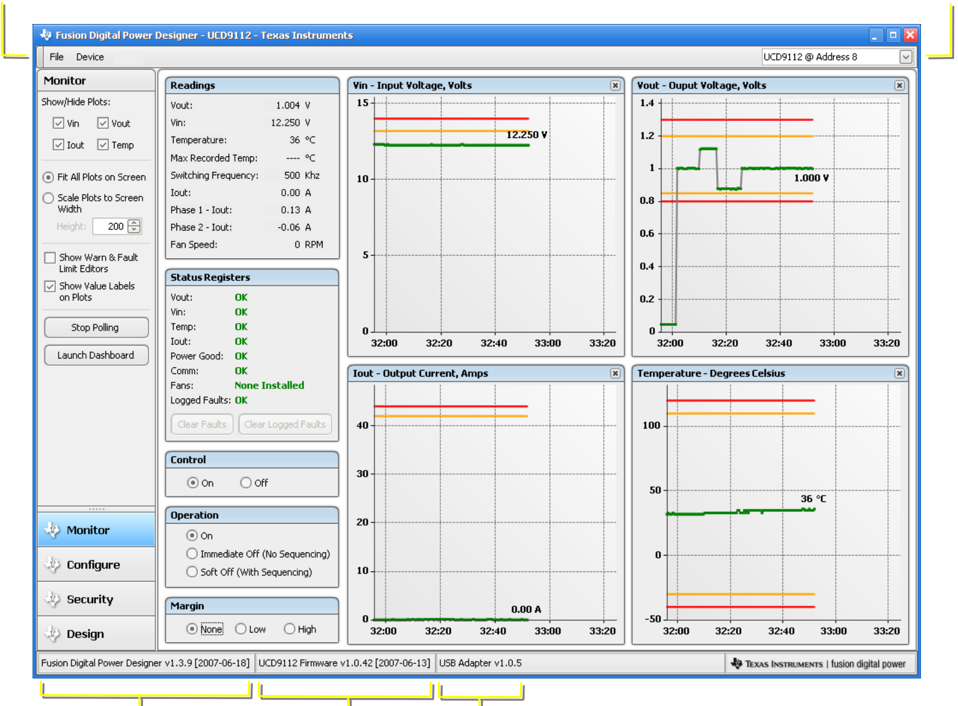
Each task will be described in a separate chapter in this user's manual:

Task	Description
Monitor	Readings of important device data is plotted and displayed. Real-time data is continuously polled from the device in the background, updating the readings and plots.
Configure	View and optionally modify parameters the device supports.
Security	Select digital controllers support fine grained command write/execute protection. This task is used to configure security for the device.
Design	Evaluate the predicted power supply performance and compute the digital loop coefficients for the device through an interactive design tool. Once a satisfactory loop response has been achieved, the coefficients may be written to the device.

There are a few other items that are always visible in the GUI:

Menu
Some menu items are duplicated in other parts of the GUI

Device/Rail Selector
Shows what device and, optionally, output rail you are currently monitoring and configuring.



☑ Vin ☑ Vout
☑ Iout ☑ Temp

● Fit All Plots on Screen
○ Scale Plots to Screen Width
Height: 200

□ Show Warn & Fault Limit Editors
☑ Show Value Labels on Plots

Readings

Vout:	1.004 V
Vin:	12.250 V
Temperature:	36 °C
Max Recorded Temp:	---- °C
Switching Frequency:	500 Khz
Iout:	0.00 A
Phase 1 - Iout:	0.13 A
Phase 2 - Iout:	-0.06 A
Fan Speed:	0 RPM

Status Registers

Vout:	OK
Vin:	OK
Temp:	OK
Iout:	OK
Power Good:	OK
Comm:	OK
Fans:	None Installed
Logged Faults:	OK

Control: ● On ○ Off

Operation: ● On ○ Immediate Off (No Sequencing) ○ Soft Off (With Sequencing)

Margin: ● None ○ Low ○ High

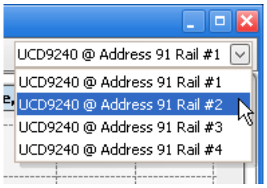
Fusion Digital Power Designer v1.3.9 [2007-06-18] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

USB Adapter Version
Must be 1.0.5 or greater

Firmware Version Number & Build Date
Build date is in YYYY-MM-DD format

GUI Version Number & Build Date
Build date is in YYYY-MM-DD format

If you have a device attached that is configured for more than one rail – a typical configuration on the UCD9240 – click the device/rail selector to monitor and configure a different output rail. For example:



UCD9240 @ Address 91 Rail #1

UCD9240 @ Address 91 Rail #1
UCD9240 @ Address 91 Rail #2
UCD9240 @ Address 91 Rail #3
UCD9240 @ Address 91 Rail #4

This will switch the GUI from rail #1 to rail #2.

Some items are global to a device and not managed on a per-rail basis. An obvious example is READ_VIN. This parameter reads the input voltage and will not vary as you change the selected output rail.

In a future release of the GUI, the device/rail selector will be used to switch between different devices that are on the same PMBus (for example, three UCD9240 controllers). Currently the GUI only lets you configure a single device at a time.

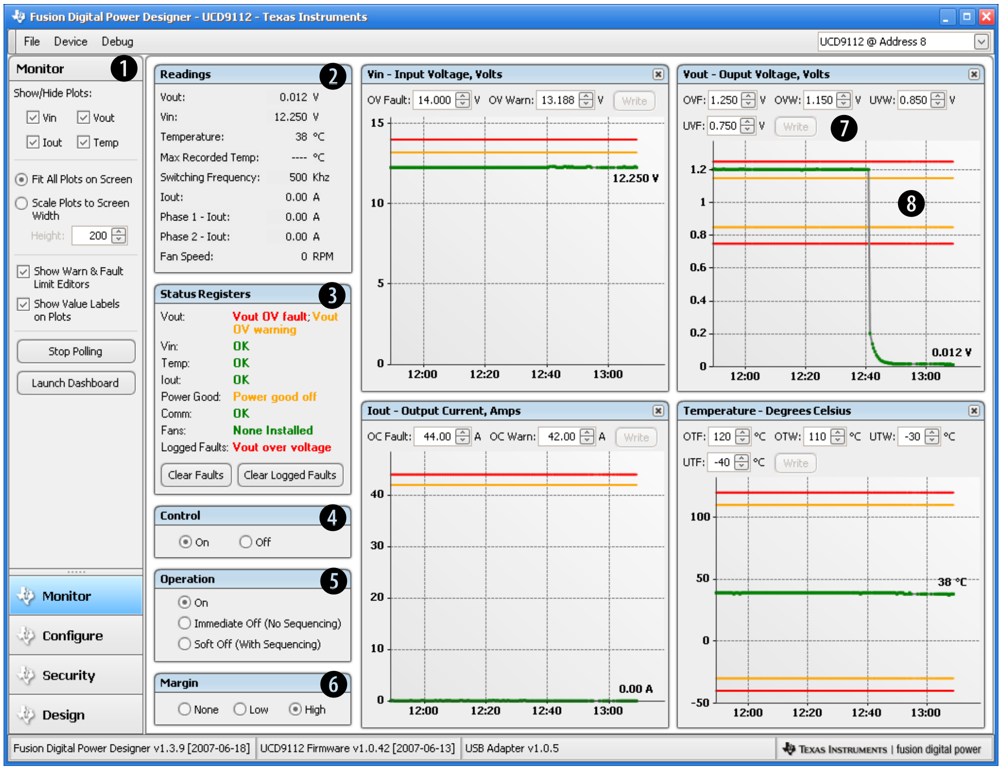
5 MONITORING

The Monitor task provides real-time monitoring of the device. During normal operation, the GUI collects data from the device in the background. The GUI “polls” the device, meaning it periodically reads certain operational data. The GUI’s polling interval is 500 milliseconds. Note that this is a true interval, and not a delay between polling cycles. If it took 200 msec to perform a polling cycle, the GUI will pause 300 msec before starting its next cycle.

Polling occurs in a separate Windows thread, and will not interfere will other activities, such as device configuration.

5.1 Monitor Components

Below is a sample monitoring screen for a UCD9112:



Fusion Digital Power Designer - UCD9112 - Texas Instruments

UCD9112 @ Address 8

Monitor 1

Show/Hide Plots: ☑ Vin ☑ Vout ☑ Iout ☑ Temp

● Fit All Plots on Screen

○ Scale Plots to Screen Width

Height: 200

☑ Show Warn & Fault Limit Editors

☑ Show Value Labels on Plots

Readings 2

Vout:	0.012 V
Vin:	12.250 V
Temperature:	38 °C
Max Recorded Temp:	---- °C
Switching Frequency:	500 Khz
Iout:	0.00 A
Phase 1 - Iout:	0.00 A
Phase 2 - Iout:	0.00 A
Fan Speed:	0 RPM

Status Registers 3

Vout:	Vout OV fault; Vout OV warning
Vin:	OK
Temp:	OK
Iout:	OK
Power Good:	Power good off
Comm:	OK
Fans:	None Installed
Logged Faults:	Vout over voltage

Control 4

● On ○ Off

Operation 5

● On

○ Immediate Off (No Sequencing)

○ Soft Off (With Sequencing)

Margin 6

○ None ○ Low ● High

Vin - Input Voltage, Volts

OV Fault: 14.000 V OV Warn: 13.188 V

Vout - Ouput Voltage, Volts 7

OVF: 1.250 V OVW: 1.150 V UVW: 0.850 V UVF: 0.750 V

Iout - Output Current, Amps

OC Fault: 44.00 A OC Warn: 42.00 A

Temperature - Degrees Celsius

OTF: 120 °C OTW: 110 °C UTW: -30 °C UTF: -40 °C

Fusion Digital Power Designer v1.3.9 [2007-06-18] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

Figure 2 Monitoring Task, UCD9112

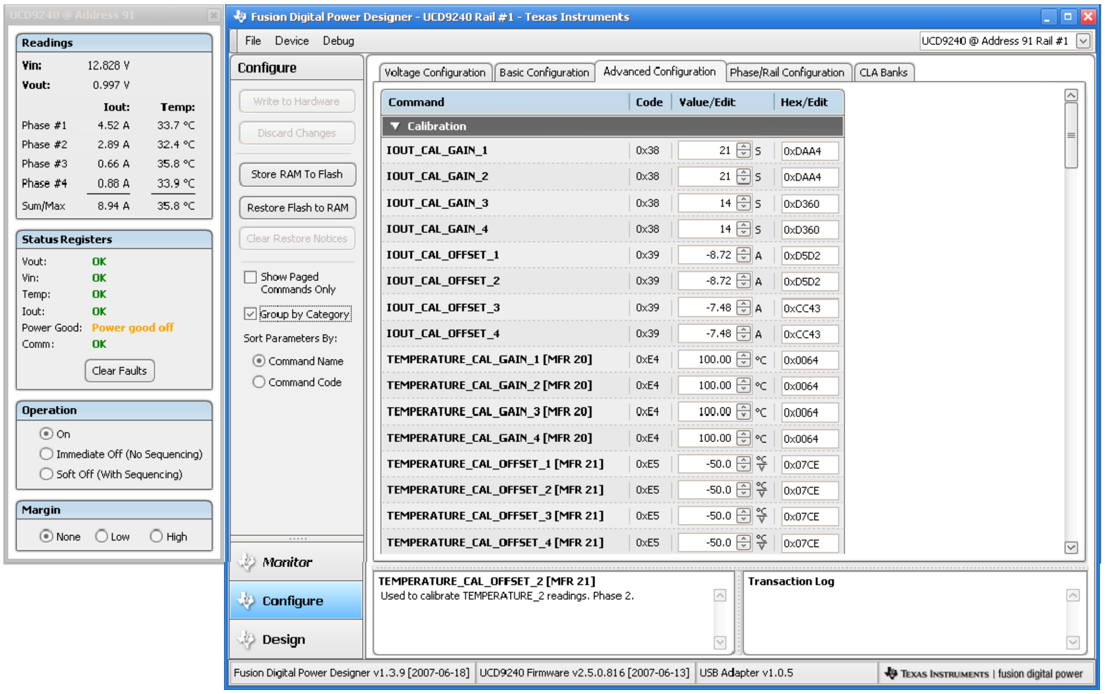
❶ **Monitor Control**. Use this area to configure monitoring:

- Click the *Vin*, *Vout*, etc. checkboxes to show or hide plots. Or click the ☒ symbol next to a plot to hide it.
- By default, all selected plots will be scaled to fit on the screen. You can click the *Scale Plots to Screen Width* button to make the plots a constant width and adjustable height.
- You can control whether the over/under warning and fault limit editors ❼ are shown on the form. They are shown in the screen shot above. See ❼ for a description of each limit.
- On plots, the latest reading is normally shown. For example, in the temperature plot 38ºC is the last value read and plotted. Uncheck this to hide the reading label on the plot.

- The *Stop Polling* button will turn off all background polling. This includes readings and status registers. Click to stop polling, and click again to restart polling. This can also be managed in the Device menu.

- The items in ❷ through ❻ are collectively referred to as the **dashboard**. You can view these in a stand-alone form by clicking the *Launch Dashboard* button. This is especially useful when you are in the Configure task and want to keep your eye on device readings. You can also launch the dashboard through the Device menu.

  Here is an example of the dashboard on a UCD9240 configured for four phases on output rail #1 and two phases on output rail #2:



Readings

	Iout:	Temp:
Vin:	12.828 V	
Vout:	0.997 V	
Phase #1	4.52 A	33.7 °C
Phase #2	2.89 A	32.4 °C
Phase #3	0.66 A	35.8 °C
Phase #4	0.88 A	33.9 °C
Sum/Max	8.94 A	35.8 °C

Status Registers

Vout:	OK
Vin:	OK
Temp:	OK
Iout:	OK
Power Good:	Power good off
Comm:	OK

Operation

● On
○ Immediate Off (No Sequencing)
○ Soft Off (With Sequencing)

Margin

● None ○ Low ○ High

□ Show Paged Commands Only
☑ Group by Category

Sort Parameters By:
● Command Name
○ Command Code

Command	Code	Value/Edit	Hex/Edit
▼ Calibration			
IOUT_CAL_GAIN_1	0x38	21 S	0xDAA4
IOUT_CAL_GAIN_2	0x38	21 S	0xDAA4
IOUT_CAL_GAIN_3	0x38	14 S	0xD360
IOUT_CAL_GAIN_4	0x38	14 S	0xD360
IOUT_CAL_OFFSET_1	0x39	-8.72 A	0xD5D2
IOUT_CAL_OFFSET_2	0x39	-8.72 A	0xD5D2
IOUT_CAL_OFFSET_3	0x39	-7.48 A	0xCC43
IOUT_CAL_OFFSET_4	0x39	-7.48 A	0xCC43
TEMPERATURE_CAL_GAIN_1 [MFR 20]	0xE4	100.00 °C	0x0064
TEMPERATURE_CAL_GAIN_2 [MFR 20]	0xE4	100.00 °C	0x0064
TEMPERATURE_CAL_GAIN_3 [MFR 20]	0xE4	100.00 °C	0x0064
TEMPERATURE_CAL_GAIN_4 [MFR 20]	0xE4	100.00 °C	0x0064
TEMPERATURE_CAL_OFFSET_1 [MFR 21]	0xE5	-50.0 °C/V	0x07CE
TEMPERATURE_CAL_OFFSET_2 [MFR 21]	0xE5	-50.0 °C/V	0x07CE
TEMPERATURE_CAL_OFFSET_3 [MFR 21]	0xE5	-50.0 °C/V	0x07CE
TEMPERATURE_CAL_OFFSET_4 [MFR 21]	0xE5	-50.0 °C/V	0x07CE

TEMPERATURE_CAL_OFFSET_2 [MFR 21]
Used to calibrate TEMPERATURE_2 readings. Phase 2.

Transaction Log

Fusion Digital Power Designer v1.3.9 [2007-06-18] | UCD9240 Firmware v2.5.0.816 [2007-06-13] | USB Adapter v1.0.5

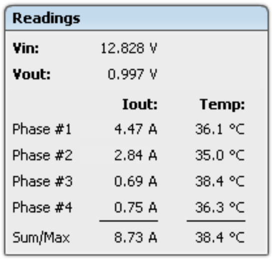
Figure 3 Dashboard, UCD9240

❷ **Readings**. The information displayed in this area will vary based on device. All readings are normally updated once every ½ second.

The PMBus PHASE command is used to acquire readings for different phases from the device. READ_IOUT will return different values depending on what value was last written to the PHASE command. A special case is the "all phase" value. Readings such as *Iout – All* in the UCD9112 sample and *Iout (Sum)* in the the UCD9240 sample are examples of this "all phase" reading. Because of delay between each read from the device, the total Iout reading may not add up to the summation of the individual Iout phase readings.

Reported and plotted temperature is always the temperature as reported by the external temperature sensors, not the die temperature of the device.

Device-specific reading notes:



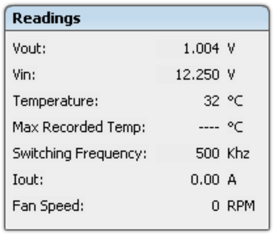
Readings

Vin: 12.828 V
Vout: 0.997 V

	Iout:	Temp:
Phase #1	4.47 A	36.1 °C
Phase #2	2.84 A	35.0 °C
Phase #3	0.69 A	38.4 °C
Phase #4	0.75 A	36.3 °C
Sum/Max	8.73 A	38.4 °C

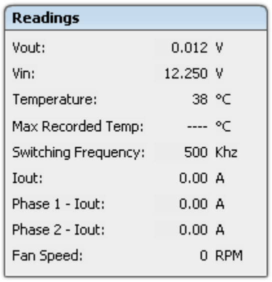
UCD9240:

- Temperature for each phase on the DPWM is reported, in addition to the maximum temperature for all phases.
- What phases are shown is determined by the settings of the PHASE_INFO command. DPWM phase/rail mapping is defined in the *Configure* task under the *Phase/Rail Configuration* tab.



Readings

Vout:	1.004 V
Vin:	12.250 V
Temperature:	32 °C
Max Recorded Temp:	---- °C
Switching Frequency:	500 Khz
Iout:	0.00 A
Fan Speed:	0 RPM



Readings

Vout:	0.012 V
Vin:	12.250 V
Temperature:	38 °C
Max Recorded Temp:	---- °C
Switching Frequency:	500 Khz
Iout:	0.00 A
Phase 1 - Iout:	0.00 A
Phase 2 - Iout:	0.00 A
Fan Speed:	0 RPM

UCD9111 / UCD9112:

- Max Recorded Temp corresponds to the LOGGED_MAX_TEMPERATURE manufacturer parameter, which is always stored to flash memory. When the external temperature reaches or exceeds OT_WARN_LIMIT, LOGGED_MAX_TEMPERATURE will be updated. "---" means the temperature was always less than OT_WARN_LIMIT. You can clear the maximum recorded temperature by selecting *Clear Max Recorded Temperature* in the Device menu.
- Fan speed will only give a reading if a fan is installed and configured through the Advanced Configuration screen. See FAN_CONFIG_1_2.

❸ **Status Registers.** This area displays a summary of status bits set in the various PMBus status registers. Warning conditions are colored **orange**, while fault conditions are colored **red**.

Vout	STATUS_VOUT
Vin	STATUS_VIN
Temp	STATUS_TEMPERATURE
Iout	STATUS_IOUT
Power Good	STATUS_WORD, hi byte
Comm	STATUS_CML
Fans	STATUS_FANS_1_2
Logged Faults	LOGGED_FAULT [MFR 26]

As is the case with most aspects of the GUI, status registers shown can vary with the device. For example, an in-development part may not show logged faults.

Logged faults are stored to non-volatile memory and will not be changed by a system reset. You clear these faults by clicking the *Clear Logged Faults* button, which writes to LOGGED_FAULT behind the scenes. All other faults are standard PMBus faults and are only stored in RAM. These are cleared by a reset or when you click the *Clear Faults* button. Clearing faults issues the PMBus CLEAR_FAULTS command.

❹ **Control**. The PC acts as a PMBus master via the USB serial adapter. You can command the CONTROL signal from the master to be on or off using this radio button. Whether this will have any affect depends on the setting of the ON_OFF_CONFIG parameter. For example, the default settings of the UCD9112 EVM require OPERATION to be ON and CONTROL ON for the device to output power.

Because the PC is a master, this radio button will never be set based on any device reading. If a fault occurs and power conversion stops, you will normally need to clear the fault, set CONTROL to OFF, and then back to ON to restart conversion.

❺ **Operation**. This widget provides quick access to bits 7:6 of the OPERATION command. Depending on ON_OFF_CONFIG settings, it can be used to control the output. OPERATION is not polled: the value shown is the last value you wrote to the device. An exception is if the device is reset: the GUI will refresh the value of OPERATION since it may have reverted to a different default state.

❻ **Margin**. This widget provides quick access to bits 5:4 of the OPERATION command. This command allows the user to set the output voltage to one of VOUT_MARGIN_HIGH, VOUT_MARGIN_LOW, or VOUT_COMMAND. The same rules regarding polling/reset that apply to Operation apply here.

❼ **Limit Editors**. You can modify warning and fault limits for a particular variable through these widgets. Just type in or use the ⬍ buttons to change a value. Click the Write button to commit your change to hardware. Once you have written your new limit value(s) to the device, the plot should be updated.

The following table summarizes limits specified in the PMBus v1.1 standard. Not all limits are supported on all devices.

Vin:

OVF	VIN_OV_FAULT_LIMIT	Vin Over Voltage Fault Limit
OVW	VIN_OV_WARN_LIMIT	Vin Over Voltage Warning Limit
UVW	VIN_UV_WARN_LIMIT	Vin Under Voltage Warning Limit
UVF	VIN_UV_FAULT_LIMIT	Vin Under Voltage Fault Limit

Vout:

OVF	VOUT_OV_FAULT_LIMIT	Vout Over Voltage Fault Limit
OVW	VOUT_OV_WARN_LIMIT	Vout Over Voltage Warning Limit
UVW	VOUT_UV_WARN_LIMIT	Vout Under Voltage Warning Limit
UVF	VOUT_UV_FAULT_LIMIT	Vout Under Voltage Fault Limit

Iout:

OCF	IOUT_OC_FAULT_LIMIT	Iout Over Current Fault Limit
OCW	IOUT_OC_WARN_LIMIT	Iout Over Current Warning Limit
UCF	IOUT_UC_FAULT_LIMIT	Iout Under Current Fault Limit

Temperature:

OTF	OT_FAULT_LIMIT	Over Temperature Fault Limit
OTW	OT_WARN_LIMIT	Over Temperature Warning Limit
UTW	UT_WARN_LIMIT	Under Temperature Warning Limit
UTF	UT_FAULT_LIMIT	Under Temperature Fault Limit …

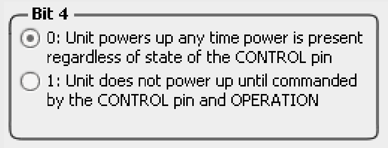
❽ **Plot**. A reading and its associated limits are plotted on the graph every 500 milliseconds. If communication is lost with the device for any reason, plotting will stop. Plotting will also stop if you turn off background polling using the *Stop Polling* button on the left side of the form. Fault limits are plotted in **red** while warning limits are plotted in **orange**. The device value is plotted in **green**.

You can chose whether to show or hide the fault limit editors and the value labels on using checkboxes on the left side of the form, directly above the *Stop Polling* button.

5.2 Control, Operation, and Margin

Note that clicking Control, Operation, or Margin will cause an immediate write to hardware. Any one of these may be "grayed out" – disabled from user input – depending on the current setting of ON_OFF_CONFIG and, in the case of Margin, the on/off setting of OPERATION. ON_OFF_CONFIG can be set under in Configure or by selecting *On/Off Configuration* in the Device menu.

For example, if ON_OFF_CONFIG is set as follows:

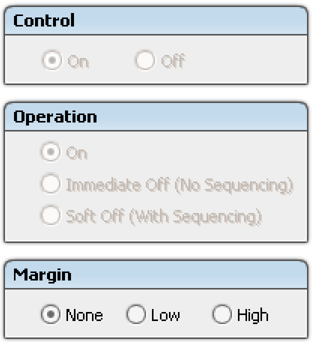


Bit 4

● 0: Unit powers up any time power is present regardless of state of the CONTROL pin

○ 1: Unit does not power up until commanded by the CONTROL pin and OPERATION

Then Control and Operation will be disabled, since their values are "don't cares" to the hardware and setting them will not have any effect. Margin can still be set, however:



Control

● On ○ Off

Operation

● On

○ Immediate Off (No Sequencing)

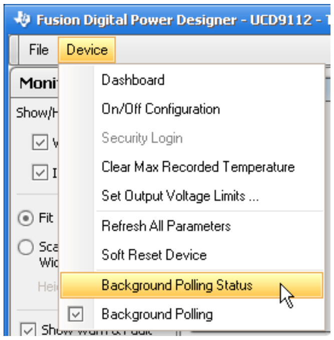
○ Soft Off (With Sequencing)

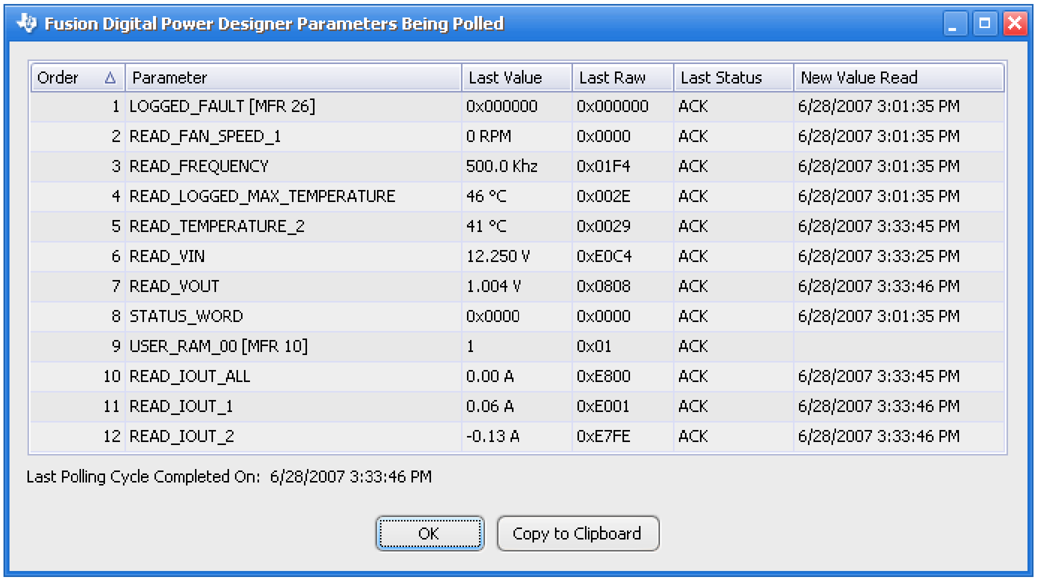
Margin

● None ○ Low ○ High

5.3 Polling Status

If you are curious to learn more about what is being polled in the background, you can bring up a stand-alone polling status form using by selecting *Background Polling Status* from the Device menu:





Order △	Parameter	Last Value	Last Raw	Last Status	New Value Read
1	LOGGED_FAULT [MFR 26]	0x000000	0x000000	ACK	6/28/2007 3:01:35 PM
2	READ_FAN_SPEED_1	0 RPM	0x0000	ACK	6/28/2007 3:01:35 PM
3	READ_FREQUENCY	500.0 Khz	0x01F4	ACK	6/28/2007 3:01:35 PM
4	READ_LOGGED_MAX_TEMPERATURE	46 °C	0x002E	ACK	6/28/2007 3:01:35 PM
5	READ_TEMPERATURE_2	41 °C	0x0029	ACK	6/28/2007 3:33:45 PM
6	READ_VIN	12.250 V	0xE0C4	ACK	6/28/2007 3:33:25 PM
7	READ_VOUT	1.004 V	0x0808	ACK	6/28/2007 3:33:46 PM
8	STATUS_WORD	0x0000	0x0000	ACK	6/28/2007 3:01:35 PM
9	USER_RAM_00 [MFR 10]	1	0x01	ACK	
10	READ_IOUT_ALL	0.00 A	0xE800	ACK	6/28/2007 3:33:45 PM
11	READ_IOUT_1	0.06 A	0xE001	ACK	6/28/2007 3:33:46 PM
12	READ_IOUT_2	-0.13 A	0xE7FE	ACK	6/28/2007 3:33:46 PM

Last Polling Cycle Completed On: 6/28/2007 3:33:46 PM

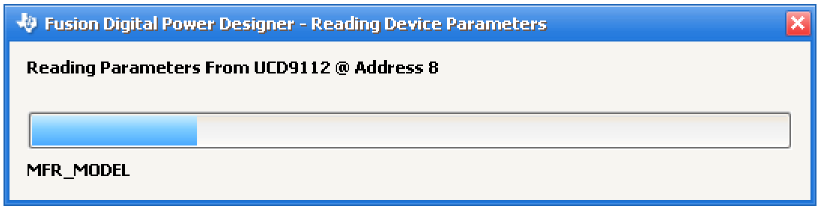
Figure 4 Background Polling Status Form, UCD9112, Monitor Task Active

This form is updated after every polling cycle, approximately once every ½ second. You can keep this form open while you work elsewhere in the GUI. When you are on the advanced configuration form, you'll see that a much larger number of parameters are polled, because the GUI polls all variables (dynamic parameters) while this form is visible.

You can click a column header to change the row sort order. By default the grid is sorted by the order in which the parameters are read from the device (the "Order" column).

6 Configuration

The Configure task is used to interactively configure the device through PMBus commands. When you first click the Configure button, the GUI will cache all parameters on the device by fetching those parameters that have not been previously read. A dialog box will show you the progress:



Fusion Digital Power Designer - Reading Device Parameters

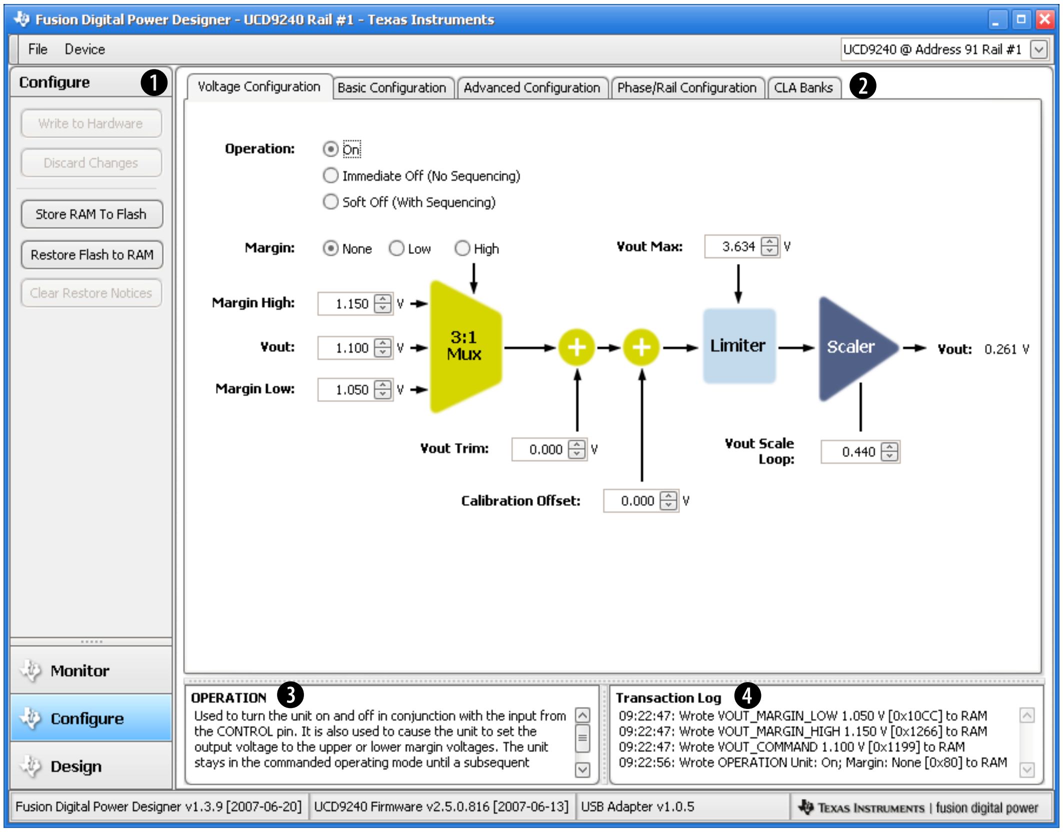
Reading Parameters From UCD9112 @ Address 8

MFR_MODEL

You can not cancel this step.

6.1 Configuration Overview

Once all parameters have been read from the device, the GUI should look something like the following:



Fusion Digital Power Designer - UCD9240 Rail #1 - Texas Instruments

UCD9240 @ Address 91 Rail #1

Operation: ● On ○ Immediate Off (No Sequencing) ○ Soft Off (With Sequencing)

Margin: ● None ○ Low ○ High

Vout Max: 3.634 V

Margin High: 1.150 V

Vout: 1.100 V

Margin Low: 1.050 V

Vout Trim: 0.000 V

Calibration Offset: 0.000 V

Vout Scale Loop: 0.440

Vout: 0.261 V

OPERATION

Used to turn the unit on and off in conjunction with the input from the CONTROL pin. It is also used to cause the unit to set the output voltage to the upper or lower margin voltages. The unit stays in the commanded operating mode until a subsequent

Transaction Log

```
09:22:47: Wrote VOUT_MARGIN_LOW 1.050 V [0x10CC] to RAM
09:22:47: Wrote VOUT_MARGIN_HIGH 1.150 V [0x1266] to RAM
09:22:47: Wrote VOUT_COMMAND 1.100 V [0x1199] to RAM
09:22:56: Wrote OPERATION Unit: On; Margin: None [0x80] to RAM
```

Fusion Digital Power Designer v1.3.9 [2007-06-20] | UCD9240 Firmware v2.5.0.816 [2007-06-13] | USB Adapter v1.0.5

Figure 5 Configure Task, UCD9240

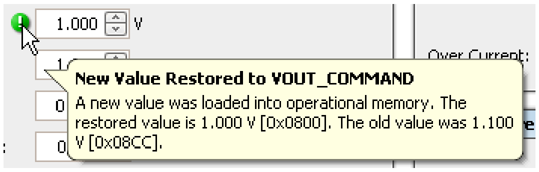
❶ **Configure Control**. This area controls writes to the device. In most cases, changes you make will not be written to hardware until you click the *Write to Hardware* button. As shown above, the button is disabled because there have been no changes to any parameters. Once a change is made, the *Write to Hardware* and *Discard Changes* buttons will be enabled.

This area manages writes to the device for all parameter editors on **all** tabs in the top of the form (❷). So if you make an edit in the *Basic Configuration* tab and then change to the *Advanced Configuration* tab, clicking *Write to Hardware* button will write changes made in both tabs.

Discard Changes will undo all pending changes you have made to your device's configuration since you last wrote to hardware. Warning: there is no confirmation for this button. This only affects the GUI: it does not affect hardware values.

Most PMBus parameters have an operational value that is stored in RAM and a power-on default that is stored in non-volatile flash memory. When you change one of these parameters and write out the change to the device, you are only changing the operational RAM copy. When the device is reset, this value will be overwritten with the value from flash memory. You can copy all RAM values to flash by clicking the *Store RAM to Flash* button. This executes the STORE_DEFAULT_ALL command on the device.

You can use the *Restore Flash to RAM* button to overwrite operational RAM values with the values stored in flash memory. This executes the RESTORE_DEFAULT_ALL command on the device, and is similar to doing a device reset. If the RESTORE_DEFAULT_ALL command is executed successfully, any differences between previous RAM values and new RAM values loaded from flash will be noted in the GUI with a ❗ icon. Moving the cursor over this icon will give additional details:



New Value Restored to VOUT_COMMAND
A new value was loaded into operational memory. The restored value is 1.000 V [0x0800]. The old value was 1.100 V [0x08CC].

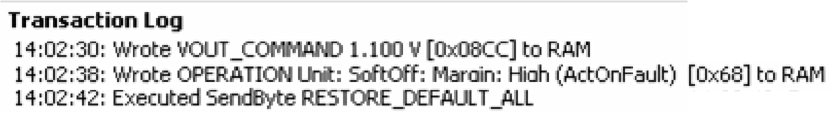
You can clear these notices clicking the *Clear Restore Notices* button.

Note: The *Restore Flash to* RAM button will only execute the RESTORE_DEFAULT_ALL command if the GUI determines that the corresponding output is off. The GUI looks at your ON_OFF_CONFIGURATION, the current setting of the CONTROL pin, and OPERATION to determine if the unit is converting power. You will receive an error message if it is, and can use the dashboard to stop power conversion (select Dashboard from the Device menu).

❷ **Configure Forms**. Configuration is broken down into several sub-tasks and accessed by clicking on the tabs at the top of the form. What tasks are available will vary based on the device. For example, each device family will have it's own unique CLA coefficient editor. Configure modes are described in more detail in Section 6.4.

❸ **Command Help**. When you move your cursor over an editor, this area of the form will give a short description of the parameter. You can make this area larger by dragging the horizontal dividers above help area.

❹ **Transaction Log**. When you click the *Write to Hardware*, *Store RAM to Flash*, or *Restore Flash to RAM* buttons, a log of the PMBus actions the GUI performs will be appended here. A sample is shown below:



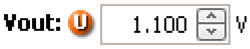
```
14:02:30: Wrote VOUT_COMMAND 1.100 V [0x08CC] to RAM
14:02:38: Wrote OPERATION Unit: SoftOff: Margin: High (ActOnFault)  [0x68] to RAM
14:02:42: Executed SendByte RESTORE_DEFAULT_ALL
```

The value in brackets is the raw, hexadecimal encoded value that was written to hardware. The timestamp is your local time in 24 hour format.

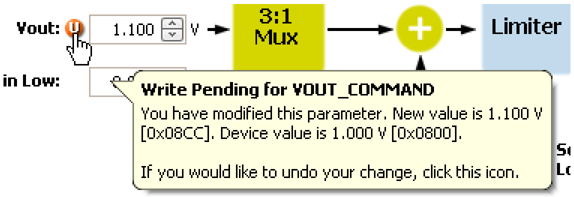
6.2 General Editing Concepts

Some important points about editing PMBus parameters in the GUI:

- When you modify a parameter, an icon will appear near to it to indicate that you have made a change. For example, changing Vout above from 1.0V to 1.1V:

  
  Vout: U 1.100 V

  You can move your mouse over icons like these to get more information:

  Write Pending for VOUT_COMMAND
  You have modified this parameter. New value is 1.100 V [0x08CC]. Device value is 1.000 V [0x0800].

  If you would like to undo your change, click this icon.

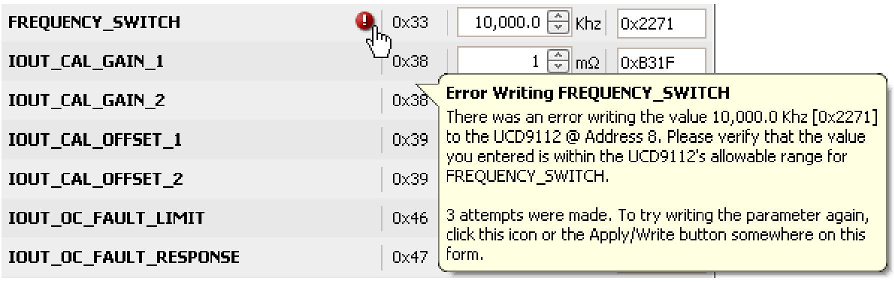
  This balloon shows both the current device value as well as the new, unwritten value. The U icon stands for "updated" and indicates that you have modified a parameter in the GUI but have not written your change to hardware.

- Editors in all Configure sub-task forms are **synchronized**. For example, if you edit VOUT_COMMAND in the voltage configuration form, your edit will be reflected in the basic and advanced configuration editors. This holds for uncommitted edits as well: even if you have not written the change to hardware, you will see the U icon in the other editors with your most recent edit.

- **Editors in different tasks are only synchronized when a new value is actually written to or read from the device**. Why? Because different tasks have their own write to hardware buttons that only manage writes to parameters in that task. For example, the design task described in Section 8 has a Write to Hardware button. It manages writes of FREQUENCY_SWITCH, VOUT_COMMAND, and the PID coefficients generated there. If you edit VOUT_COMMAND there without writing out your change and switch to the Configure task, you will notice that your change has not been reflected there. But once you click Write to Hardware in the design task, the Configure forms will be updated to reflect the new device value for VOUT_COMMAND.

- When you write your changes to hardware, the GUI will keep track of what writes succeeded and what failed. Normally the GUI looks to see if the device NACKed a write to determine if it failed. For some in-development devices, however, the GUI will take the extra step of reading back the parameter after write to verify that the write was successful. In either case, the GUI will log failure in the transaction log and change the U icon to a !. You can move your cursor over the icon to learn more.

  For example, if we tried to change the switching frequency on a UCD9112 to 10 MHz, the device would NACK the write because this is out of range:



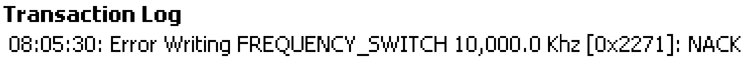
FREQUENCY_SWITCH	0x33	10,000.0	Khz	0x2271
IOUT_CAL_GAIN_1	0x38	1	mΩ	0xB31F
IOUT_CAL_GAIN_2	0x38			
IOUT_CAL_OFFSET_1	0x39			
IOUT_CAL_OFFSET_2	0x39			
IOUT_OC_FAULT_LIMIT	0x46			
IOUT_OC_FAULT_RESPONSE	0x47			

Error Writing FREQUENCY_SWITCH

There was an error writing the value 10,000.0 Khz [0x2271] to the UCD9112 @ Address 8. Please verify that the value you entered is within the UCD9112's allowable range for FREQUENCY_SWITCH.

3 attempts were made. To try writing the parameter again, click this icon or the Apply/Write button somewhere on this form.

And in the transaction log would have an entry like the following:



Transaction Log

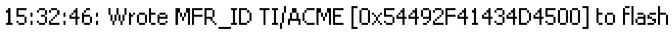
```
08:05:30: Error Writing FREQUENCY_SWITCH 10,000.0 Khz [0x2271]: NACK
```

The GUI attempts to write each parameter up to three times before giving up. This ensures that if a write is NACKed, it is likely because the value is either out of range or the device is currently rejecting writes due to some other factor.

Not all parameters are written to RAM. Some write directly to flash memory. The *Store RAM to Flash* and *Restore Flash to RAM* buttons will have no effect on these parameters. Commands that write directly to flash are listed below. Please refer to your device's data sheet for additional information.

UCD9111/UCD9112:	LOGGED_FAULT [MFR 26] LOGGED_MAX_TEMPERATURE [MFR 25] MFR_DATE MFR_LOCATION MFR_MODEL MFR_REVISION MFR_SERIAL USER_DATA_00 VOUT_SCALE_LOOP VOUT_SENSE_UPPER_RESISTR [MFR 02]
UCD9240:	None

The transaction log will indicate when a parameter is written directly to flash. For example, on the UCD9112 when MFR_ID is written:



```
15:32:46: Wrote MFR_ID TI/ACME [0x54492F41434D4500] to flash
```

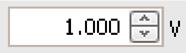
If a parameter is written directly to flash, the GUI will pause 200 ms after each write in order to give the flash write time to complete in firmware before executing the next PMBus command.

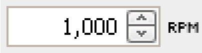
6.3 Editors

The GUI hides the complexity of the underlying encoding used for each parameter: a custom widget is always available for editing a particular parameter. Even though the GUI is ultimately reading and writing byte-encoded data to the device, you normally do not need to be concerned with encoding details. If you would like to debug or review encoding, the GUI provides several methods to review the low-level encoded value of a parameter.

6.3.1 Numeric Editors:

Most of the configurable items on the device represent numeric values. A widget called a spin edit and is used to edit numerical values, both floating point numbers such as for VOUT_COMMAND and integers such as for FAN_SPEED_FAULT_LIMIT. For example:

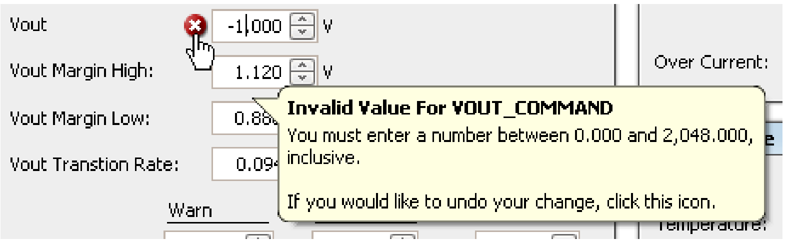
VOUT_COMMAND: 
1.000 V

FAN_SPEED_FAULT_LIMIT: 
1,000 RPM

You can either type an entry directly or use the up and down buttons to increment or decrement the value at the last decimal place. For example, clicking up for the 1.000 value shown would change it to 1.001.

Depending on the PMBus parameter, the spin edit may enforce a minimum and/or maximum value. If you try to use the up/down buttons to go beyond one of these limits, you will hear beep. If you type an invalid entry using the keyboard, you will hear a beep and see a special icon, ⊗. If you have typed in a bad value, you will only be informed of the error once you move away from the editor in question: pressing the TAB key or clicking elsewhere on the form will trigger the GUI's validation of your input.

For example, VOUT_COMMAND must be greater than or equal to zero. If you typed in -1 and then tried to write your new value to the device, the GUI would beep at you and show a ⊗ icon next to the offending input. You can move your cursor over the icon to learn more:



Invalid Value For VOUT_COMMAND
You must enter a number between 0.000 and 2,048.000, inclusive.

If you would like to undo your change, click this icon.

You must fix your error before you can perform any other actions in the GUI. The simplest way is to click the ⊗ icon. This will discard your change and revert back the value last read or written to the device. Alternatively, you can press the ESC key to discard your edit.

The device will handle most range checking for numerical values. The GUI is fairly "dumb" in this regard, except for obvious examples like VOUT_COMMAND and where the underlying encoding enforces a limited range of values. An example of the later is the LOUT [MFR 22]. It is encoding as an unsigned byte representing the output inductor for current ripple calculations in µH divided by 10. Of course the GUI hides this encoding, and lets the user enter a floating point number. The GUI therefore sets a minimum of 0 and a maximum of 25.5 for LOUT, translating to a byte encoded range from 0 to 255.

6.3.2 String Editors

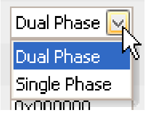
Several PMBus parameters allow entry of ASCII strings. These include MFR_LOCATION, MFR_REVISION, and USER_DATA_00. Just type in your string:

Hello World

The editor will enforce a maximum string length and beep if you try to enter too many characters. Refer to the data sheet for your device for maximum string lengths.

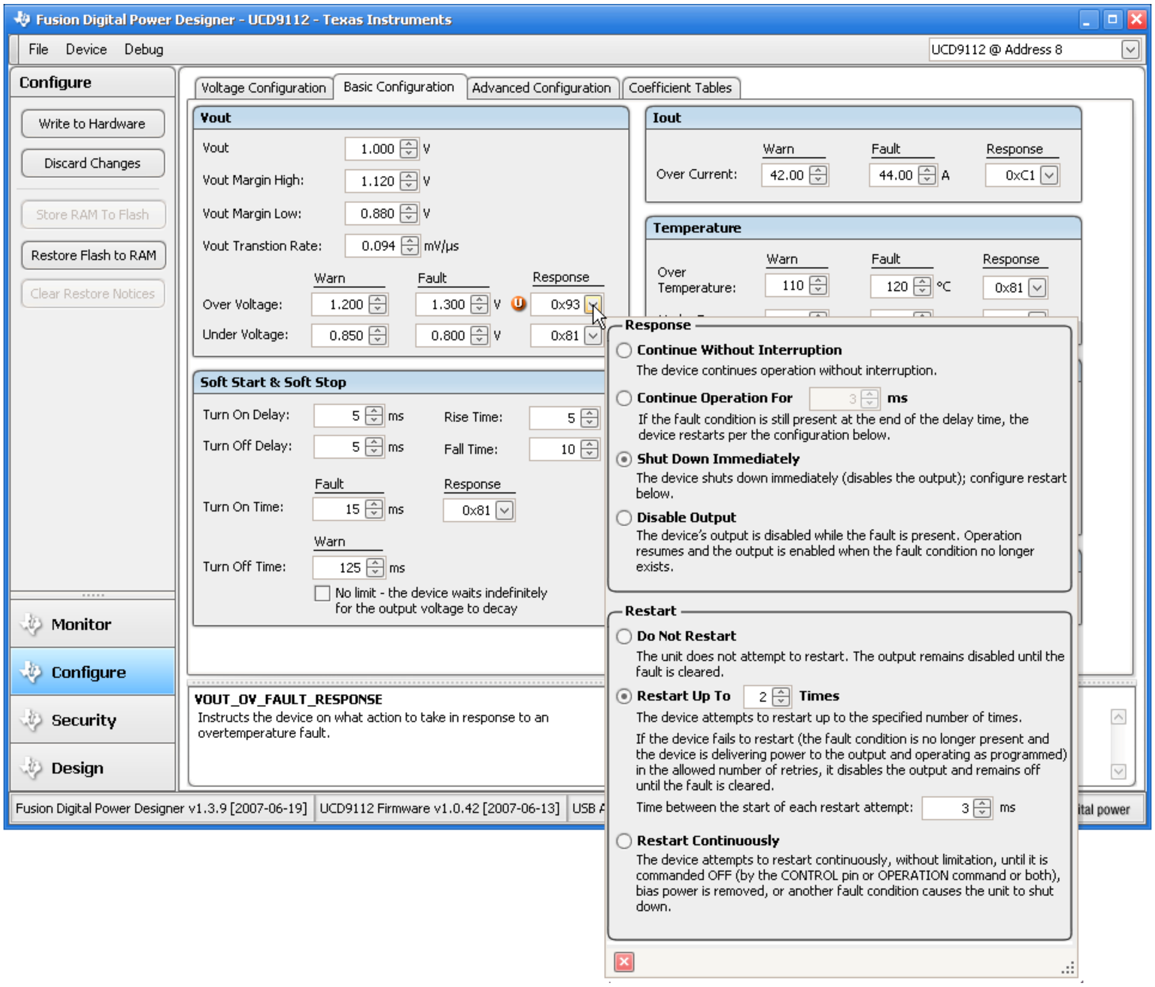
6.3.3 Enumeration Editors

Some parameters have a limited set of allowed values. For these parameters, you will select a value from a drop down. For example, for LIGHT_LOAD_ENABLE [MFR 29]:



6.3.4 Custom Editors

Some parameters require a stand-alone, custom editor because of complexity or to make editing the parameter easy for the user. A good example of this is the fault response parameters such as VOUT_OV_FAULT_RESPONSE. As shown below, clicking the ⌄ button will show the custom editor in a popup window:



Vout: 1.000 V
Vout Margin High: 1.120 V
Vout Margin Low: 0.880 V
Vout Transtion Rate: 0.094 mV/µs

	Warn	Fault	Response
Over Voltage:	1.200	1.300 V	0x93
Under Voltage:	0.850	0.800 V	0x81

	Warn	Fault	Response
Over Current:	42.00	44.00 A	0xC1
Over Temperature:	110	120 °C	0x81

Turn On Delay: 5 ms
Turn Off Delay: 5 ms
Rise Time: 5
Fall Time: 10

Turn On Time: Fault 15 ms, Response 0x81

Turn Off Time: Warn 125 ms

☐ No limit - the device waits indefinitely for the output voltage to decay

VOUT_OV_FAULT_RESPONSE
Instructs the device on what action to take in response to an overtemperature fault.

Response

○ Continue Without Interruption
The device continues operation without interruption.

○ Continue Operation For 3 ms
If the fault condition is still present at the end of the delay time, the device restarts per the configuration below.

● Shut Down Immediately
The device shuts down immediately (disables the output); configure restart below.

○ Disable Output
The device’s output is disabled while the fault is present. Operation resumes and the output is enabled when the fault condition no longer exists.

Restart

○ Do Not Restart
The unit does not attempt to restart. The output remains disabled until the fault is cleared.

● Restart Up To 2 Times
The device attempts to restart up to the specified number of times.
If the device fails to restart (the fault condition is no longer present and the device is delivering power to the output and operating as programmed) in the allowed number of retries, it disables the output and remains off until the fault is cleared.
Time between the start of each restart attempt: 3 ms

○ Restart Continuously
The device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

Figure 6 Over Voltage Fault Response Editor, UCD9112

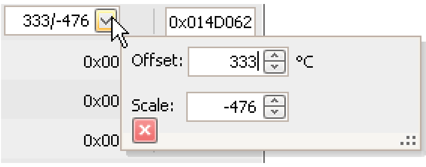
Click anywhere on the form to hide the editor or click the close button, ☒. Many editors “grey out” – disable input – certain combinations of input that are illegal or are “don’t cares.” For example, in the VOUT_OV_FAULT_RESPONSE example above, the continue operation time is disabled because it is not used when shut down immediately is selected.

The editor's pull down widget will show a representation of the value in the editor. This varies depending on the parameter. Some examples:

VOUT_OV_FAULT_RESPONSE, etc.
The hex encoded value is displayed.

0x81

REMOTE_TEMP_CAL [MFR 18]
This command sets temperature offset and scale in a single parameter. The pulldown summarizes the current setting.



333/-476

0x014D062

0x00

0x00

0x00

Offset: 333 °C

Scale: -476

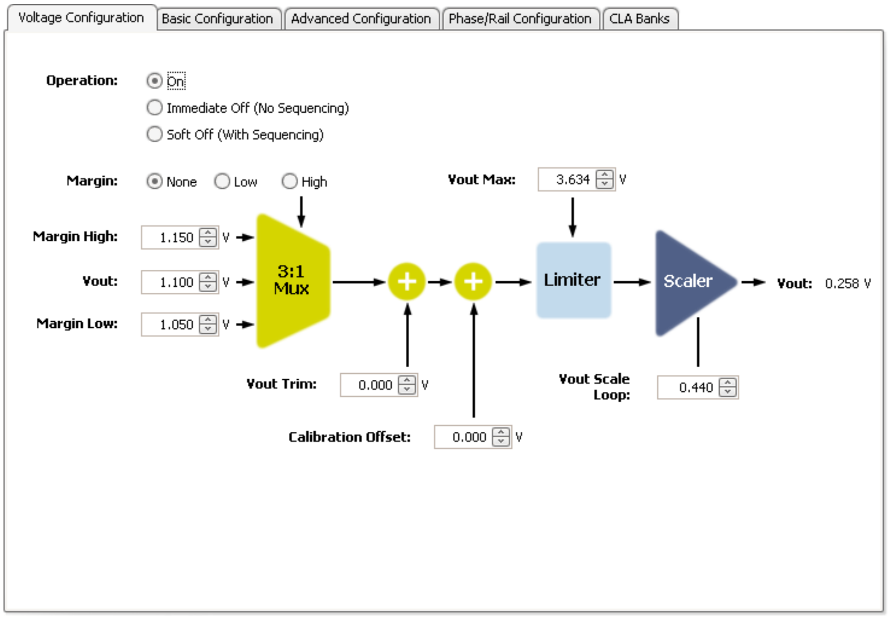
6.4 Configure Forms

While configure forms vary by device, certain forms or variations of forms are always present:

- Voltage configuration: edit output voltage related parameters
- Basic configuration: edit parameters most likely to need tweaking for your application
- Advanced configuration: view and optionally edit most parameters supported by the device
- PID coefficient editor: varies by device family, but allows direct editing of CLA coefficients

6.4.1 Voltage Configuration

This form graphically represents how output voltage related parameters are applied to determine the output voltage. Move your cursor over an editor to view it's official PMBus command name. This form may vary slightly depending on the device. Pre-production UCD9240 is shown below:



Operation: ● On ○ Immediate Off (No Sequencing) ○ Soft Off (With Sequencing)

Margin: ● None ○ Low ○ High

Vout Max: 3.634 V

Margin High: 1.150 V

Vout: 1.100 V

Margin Low: 1.050 V

Vout: 0.258 V

Vout Trim: 0.000 V

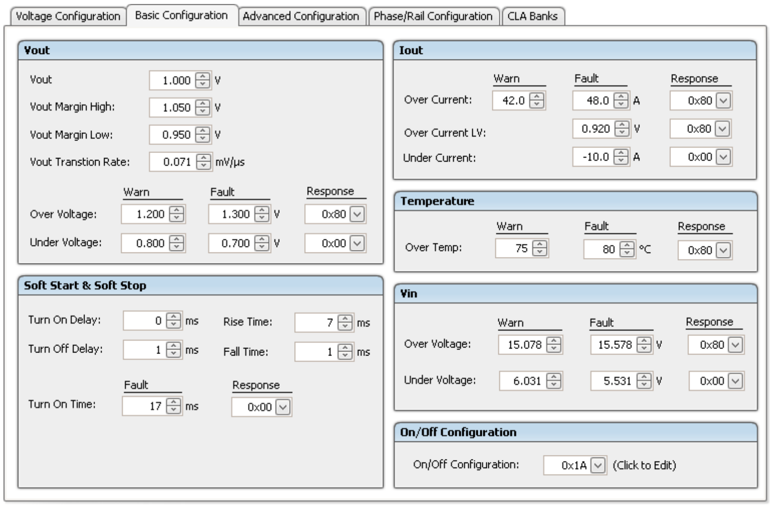
Vout Scale Loop: 0.440

Calibration Offset: 0.000 V

Figure 7 Voltage Configuration, UCD9240

6.4.2 Basic Configuration

The basic configuration tab collects the most critical configuration parameters in one form. The UCD91XX form is shown below. Other device versions may vary slightly.



Vout

Vout	1.000	V
Vout Margin High:	1.050	V
Vout Margin Low:	0.950	V
Vout Transtion Rate:	0.071	mV/µs

	Warn	Fault	Response
Over Voltage:	1.200	1.300 V	0x80
Under Voltage:	0.800	0.700 V	0x00

Soft Start & Soft Stop

Turn On Delay:	0 ms	Rise Time:	7 ms
Turn Off Delay:	1 ms	Fall Time:	1 ms

	Fault	Response
Turn On Time:	17 ms	0x00

Iout

	Warn	Fault	Response
Over Current:	42.0	48.0 A	0x80
Over Current LV:		0.920 V	0x80
Under Current:		-10.0 A	0x00

Temperature

	Warn	Fault	Response
Over Temp:	75	80 °C	0x80

Vin

	Warn	Fault	Response
Over Voltage:	15.078	15.578 V	0x80
Under Voltage:	6.031	5.531 V	0x00

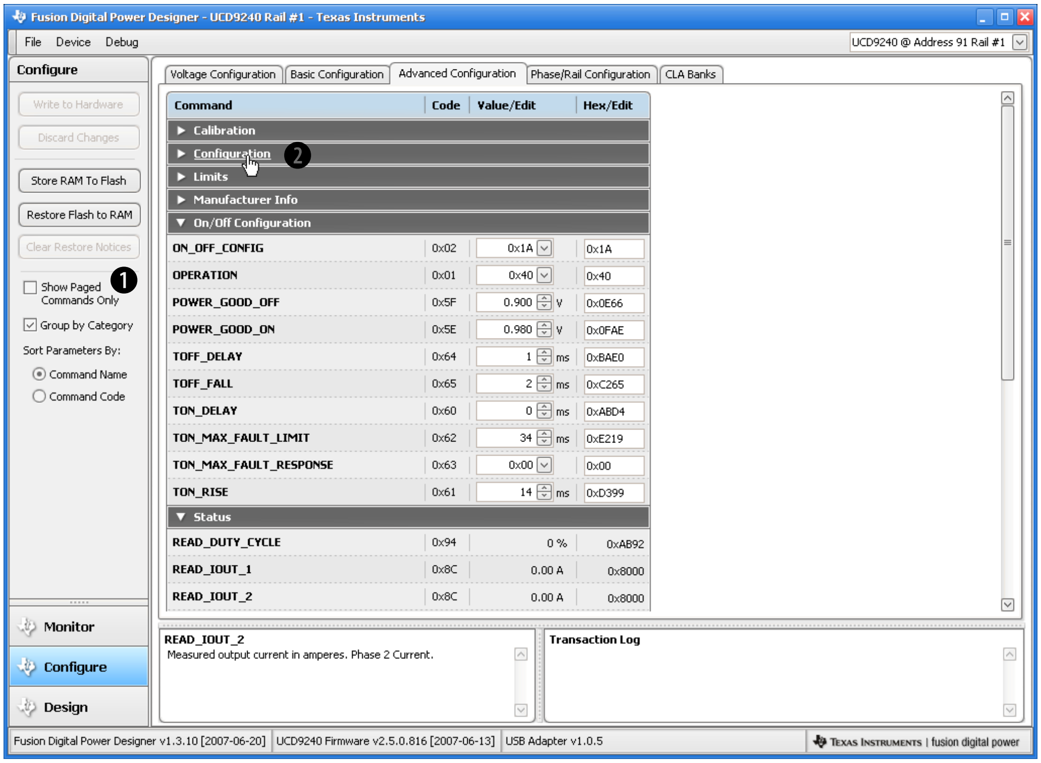
On/Off Configuration

On/Off Configuration: 0x1A (Click to Edit)

Figure 8 Basic Configuration, UCD91XX

6.4.3 Advanced Configuration

A sample advanced configuration form for a UCD9240 is shown below:



☐ Show Paged Commands Only
☑ Group by Category
Sort Parameters By:
● Command Name
○ Command Code

Command	Code	Value/Edit	Hex/Edit
▶ Calibration			
▶ Configuration			
▶ Limits			
▶ Manufacturer Info			
▼ On/Off Configuration			
ON_OFF_CONFIG	0x02	0x1A	0x1A
OPERATION	0x01	0x40	0x40
POWER_GOOD_OFF	0x5F	0.900 V	0x0E66
POWER_GOOD_ON	0x5E	0.980 V	0x0FAE
TOFF_DELAY	0x64	1 ms	0xBAE0
TOFF_FALL	0x65	2 ms	0xC265
TON_DELAY	0x60	0 ms	0xABD4
TON_MAX_FAULT_LIMIT	0x62	34 ms	0xE219
TON_MAX_FAULT_RESPONSE	0x63	0x00	0x00
TON_RISE	0x61	14 ms	0xD399
▼ Status			
READ_DUTY_CYCLE	0x94	0 %	0xAB92
READ_IOUT_1	0x8C	0.00 A	0x8000
READ_IOUT_2	0x8C	0.00 A	0x8000

READ_IOUT_2
Measured output current in amperes. Phase 2 Current.

Transaction Log

Fusion Digital Power Designer v1.3.10 [2007-06-20] | UCD9240 Firmware v2.5.0.816 [2007-06-13] | USB Adapter v1.0.5

Figure 9 Advanced Configuration, Group by Category, UCD9240

By default, the advanced configuration form organizes parameters into several categories. Categories can be collapsed by clicking it’s header (❷). The available categories are:

- Calibration
- Configuration
- Limits
- Manufacturer Info
- On/Off Configuration
- Status

Within a category, parameters are sorted by command name.

Alternatively, you can turn off category grouping using the checkbox shown in ❶. This is especially useful when you want to modify a few parameters and know their names or command codes. If you are reviewing parameters against the official PMBus specification or a Texas Instruments PMBus command reference, you may find it useful to sort the grid by command code using the sort radio button.

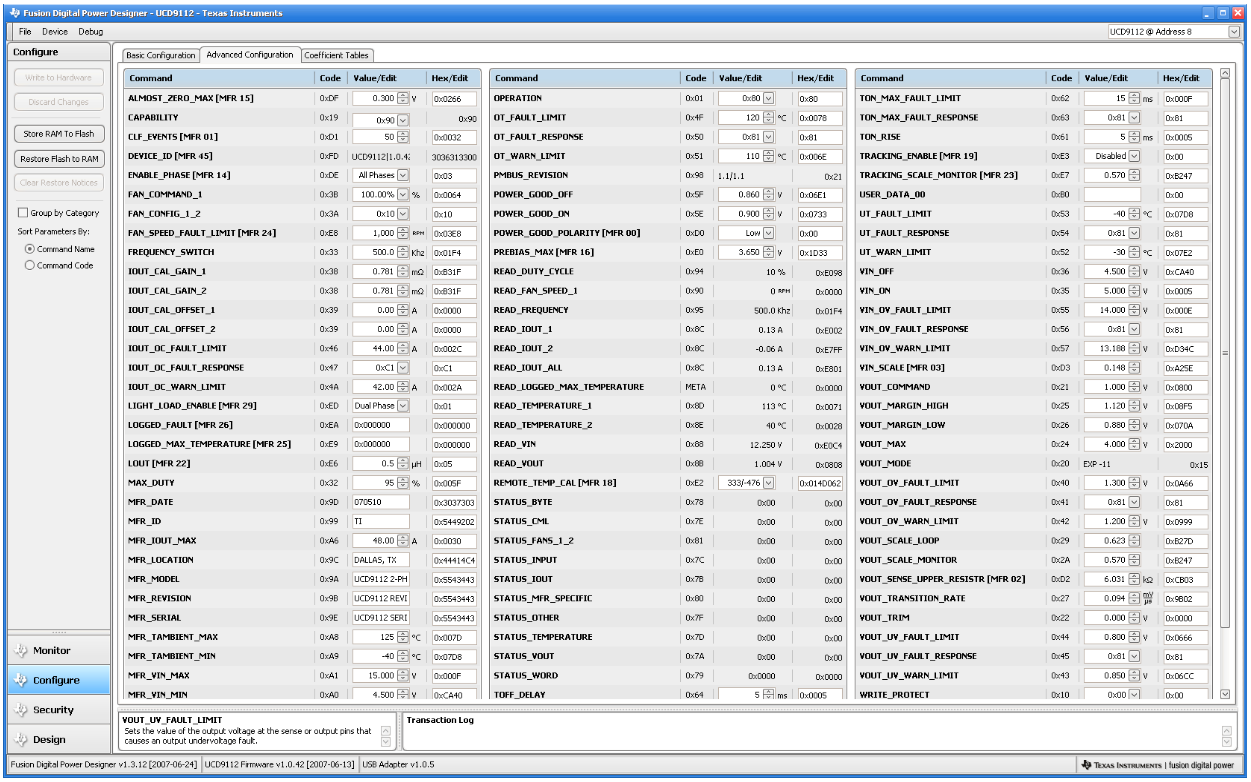
Certain devices may have additional options shown in the left hard control area (❶). Devices like the UCD92XX that support multiple output rails will have the checkbox “Show Paged Commands Only.” This will filter the grid and only show those parameters that have unique values for each output rail (via the PMBus PAGE command, described briefly in Section 2.3).

The advanced configuration form gives you access to every parameter the device supports, with the following exceptions:

- PID coefficient related parameters are not displayed. There is a stand-alone coefficient editor in a separate tab.
- Security related parameters are not displayed. There is a custom Security management task when a device supports TI configuration security.
- The UCD92XX PHASE_INFO parameter is not displayed. This is edited through a custom phase/rail configuration tab.
- PHASE and PAGE are not displayed. These parameters are set internally by the GUI to manage access to parameters which have different values depending on current phase (PHASE) and output rail (PAGE).
- USER_RAM_00 is also managed internally by the GUI. The GUI uses this to detect if you have power cycled or reset the device.

If an item is dynamic on the device, such as READ_TEMPERATURE_2, it will be polled while the form is displayed. For example, READ_DUTY_CYCLE is normally not displayed anywhere within the GUI and will not be polled from the device. But when you are on the advanced configuration form, it will be polled in the background and update approximately every ½ second.

If you have a large PC display, the grid will expand to fill in the space available. In the UCD9112 example shown below, almost every parameter is visible on a widescreen notebook. The grid is sorted by command name in this example:



☐ Group by Category

Sort Parameters By:
● Command Name
○ Command Code

Command	Code	Value/Edit	Hex/Edit
ALMOST_ZERO_MAX [MFR 15]	0xDF	0.300 V	0x0266
CAPABILITY	0x19	0x90	0x90
CLF_EVENTS [MFR 01]	0xD1	50	0x0032
DEVICE_ID [MFR 45]	0xFD	UCD9112|1.0.4	3036313300
ENABLE_PHASE [MFR 14]	0xDE	All Phases	0x03
FAN_COMMAND_1	0x3B	100.00% %	0x0064
FAN_CONFIG_1_2	0x3A	0x10	0x10
FAN_SPEED_FAULT_LIMIT [MFR 24]	0xE8	1,000 RPM	0x03E8
FREQUENCY_SWITCH	0x33	500.0 Khz	0x01F4
IOUT_CAL_GAIN_1	0x38	0.781 mΩ	0xB31F
IOUT_CAL_GAIN_2	0x38	0.781 mΩ	0xB31F
IOUT_CAL_OFFSET_1	0x39	0.00 A	0x0000
IOUT_CAL_OFFSET_2	0x39	0.00 A	0x0000
IOUT_OC_FAULT_LIMIT	0x46	44.00 A	0x002C
IOUT_OC_FAULT_RESPONSE	0x47	0xC1	0xC1
IOUT_OC_WARN_LIMIT	0x4A	42.00 A	0x002A
LIGHT_LOAD_ENABLE [MFR 29]	0xED	Dual Phase	0x01
LOGGED_FAULT [MFR 26]	0xEA	0x000000	0x000000
LOGGED_MAX_TEMPERATURE [MFR 25]	0xE9	0x000000	0x000000
LOUT [MFR 22]	0xE6	0.5 µH	0x05
MAX_DUTY	0x32	95 %	0x005F
MFR_DATE	0x9D	070510	0x3037303
MFR_ID	0x99	TI	0x5449202
MFR_IOUT_MAX	0xA6	48.00 A	0x0030
MFR_LOCATION	0x9C	DALLAS, TX	0x44414C4
MFR_MODEL	0x9A	UCD9112 2-PH	0x5543443
MFR_REVISION	0x9B	UCD9112 REVI	0x5543443
MFR_SERIAL	0x9E	UCD9112 SERI	0x5543443
MFR_TAMBIENT_MAX	0xA8	125 °C	0x007D
MFR_TAMBIENT_MIN	0xA9	-40 °C	0x07D8
MFR_VIN_MAX	0xA1	15.000 V	0x000F
MFR_VIN_MIN	0xA0	4.500 V	0xCA40

Command	Code	Value/Edit	Hex/Edit
OPERATION	0x01	0x80	0x80
OT_FAULT_LIMIT	0x4F	120 °C	0x0078
OT_FAULT_RESPONSE	0x50	0x81	0x81
OT_WARN_LIMIT	0x51	110 °C	0x006E
PMBUS_REVISION	0x98	1.1/1.1	0x21
POWER_GOOD_OFF	0x5F	0.860 V	0x06E1
POWER_GOOD_ON	0x5E	0.900 V	0x0733
POWER_GOOD_POLARITY [MFR 00]	0xD0	Low	0x00
PREBIAS_MAX [MFR 16]	0xE0	3.650 V	0x1D33
READ_DUTY_CYCLE	0x94	10 %	0xE098
READ_FAN_SPEED_1	0x90	0 RPM	0x0000
READ_FREQUENCY	0x95	500.0 Khz	0x01F4
READ_IOUT_1	0x8C	0.13 A	0xE002
READ_IOUT_2	0x8C	-0.06 A	0xE7FF
READ_IOUT_ALL	0x8C	0.13 A	0xE801
READ_LOGGED_MAX_TEMPERATURE	META	0 °C	0x0000
READ_TEMPERATURE_1	0x8D	113 °C	0x0071
READ_TEMPERATURE_2	0x8E	40 °C	0x0028
READ_VIN	0x88	12.250 V	0xE0C4
READ_VOUT	0x8B	1.004 V	0x0808
REMOTE_TEMP_CAL [MFR 18]	0xE2	333/-476	0x014D062
STATUS_BYTE	0x78	0x00	0x00
STATUS_CML	0x7E	0x00	0x00
STATUS_FANS_1_2	0x81	0x00	0x00
STATUS_INPUT	0x7C	0x00	0x00
STATUS_IOUT	0x7B	0x00	0x00
STATUS_MFR_SPECIFIC	0x80	0x00	0x00
STATUS_OTHER	0x7F	0x00	0x00
STATUS_TEMPERATURE	0x7D	0x00	0x00
STATUS_VOUT	0x7A	0x00	0x00
STATUS_WORD	0x79	0x0000	0x0000
TOFF_DELAY	0x64	5 ms	0x0005

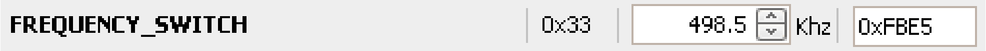
Command	Code	Value/Edit	Hex/Edit
TON_MAX_FAULT_LIMIT	0x62	15 ms	0x000F
TON_MAX_FAULT_RESPONSE	0x63	0x81	0x81
TON_RISE	0x61	5 ms	0x0005
TRACKING_ENABLE [MFR 19]	0xE3	Disabled	0x00
TRACKING_SCALE_MONITOR [MFR 23]	0xE7	0.570	0xB247
USER_DATA_00	0xB0		0x00
UT_FAULT_LIMIT	0x53	-40 °C	0x07D8
UT_FAULT_RESPONSE	0x54	0x81	0x81
UT_WARN_LIMIT	0x52	-30 °C	0x07E2
VIN_OFF	0x36	4.500 V	0xCA40
VIN_ON	0x35	5.000 V	0x0005
VIN_OV_FAULT_LIMIT	0x55	14.000 V	0x000E
VIN_OV_FAULT_RESPONSE	0x56	0x81	0x81
VIN_OV_WARN_LIMIT	0x57	13.188 V	0xD34C
VIN_SCALE [MFR 03]	0xD3	0.148	0xA25E
VOUT_COMMAND	0x21	1.000 V	0x0800
VOUT_MARGIN_HIGH	0x25	1.120 V	0x08F5
VOUT_MARGIN_LOW	0x26	0.880 V	0x070A
VOUT_MAX	0x24	4.000 V	0x2000
VOUT_MODE	0x20	EXP -11	0x15
VOUT_OV_FAULT_LIMIT	0x40	1.300 V	0x0A66
VOUT_OV_FAULT_RESPONSE	0x41	0x81	0x81
VOUT_OV_WARN_LIMIT	0x42	1.200 V	0x0999
VOUT_SCALE_LOOP	0x29	0.623	0xB27D
VOUT_SCALE_MONITOR	0x2A	0.570	0xB247
VOUT_SENSE_UPPER_RESISTR [MFR 02]	0xD2	6.031 kΩ	0xCB03
VOUT_TRANSITION_RATE	0x27	0.094 mV/µs	0x9B02
VOUT_TRIM	0x22	0.000 V	0x0000
VOUT_UV_FAULT_LIMIT	0x44	0.800 V	0x0666
VOUT_UV_FAULT_RESPONSE	0x45	0x81	0x81
VOUT_UV_WARN_LIMIT	0x43	0.850 V	0x06CC
WRITE_PROTECT	0x10	0x00	0x00

VOUT_UV_FAULT_LIMIT
Sets the value of the output voltage at the sense or output pins that causes an output undervoltage fault.

Fusion Digital Power Designer v1.3.12 [2007-06-24] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

Figure 10 Advanced Configuration, Do Not Group by Category on a Wide Display

In addition to providing one of the editors described in Section 6.3 for each parameter, each row of the grid displays the hex encoding of the parameter. When a parameter is writable, you can edit the hex directly. In the switching frequency example shown below, 0xFBE5 is the LINEAR11 encoding of 498.5:



FREQUENCY_SWITCH	0x33	498.5 Khz	0xFBE5

7 CONFIGURATION SECURITY

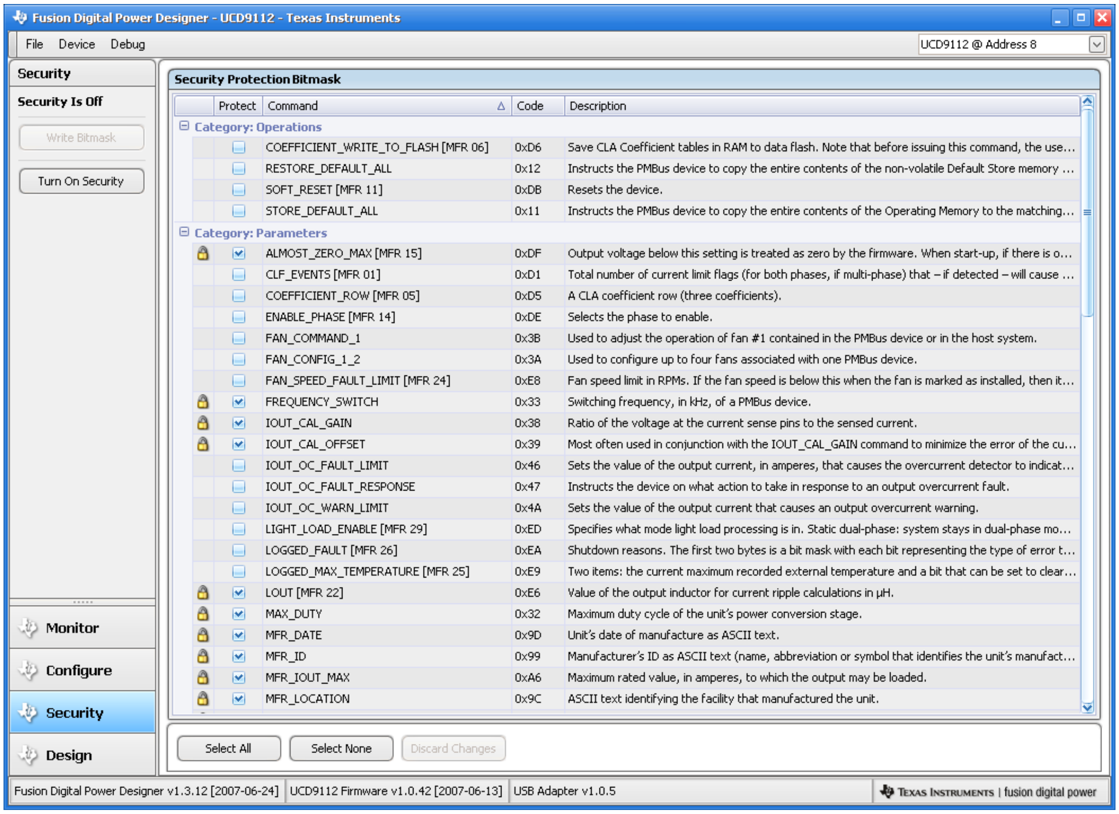
7.1 Configuration Security Overview

The PMBus standard only allows very basic write protection through the WRITE_PROTECT parameter. With it you can lockout writes to the entire device, or optionally select a pre-defined list of commands to exclude from write protection. Version 1.1 of the PMBus specification only allows the following combinations:

Data Byte Value	Meaning
1000 0000	Disable all writes except to the WRITE_PROTECT command.
0100 0000	Disable all writes except to the WRITE_PROTECT, OPERATION and PAGE commands.
0010 0000	Disable all writes except to the WRITE_PROTECT, OPERATION, PAGE, ON_OFF_CONFIG and VOUT_COMMAND commands.
0000 0000	Enable writes to all commands.

Texas Instruments’ enhanced configuration security lets you pick and chose which commands to write protect on a command-by-command basis though a security bitmask. Selecting which commands to protect is as simple as clicking a checkbox.

When a device supports security, a Security task is shown in the GUI. For example, on the UCD9112:



Security Is Off

Security Protection Bitmask

	Protect	Command	Code	Description
Category: Operations				
	☐	COEFFICIENT_WRITE_TO_FLASH [MFR 06]	0xD6	Save CLA Coefficient tables in RAM to data flash. Note that before issuing this command, the use…
	☐	RESTORE_DEFAULT_ALL	0x12	Instructs the PMBus device to copy the entire contents of the non-volatile Default Store memory …
	☐	SOFT_RESET [MFR 11]	0xDB	Resets the device.
	☐	STORE_DEFAULT_ALL	0x11	Instructs the PMBus device to copy the entire contents of the Operating Memory to the matching…
Category: Parameters				
🔒	☑	ALMOST_ZERO_MAX [MFR 15]	0xDF	Output voltage below this setting is treated as zero by the firmware. When start-up, if there is o…
	☐	CLF_EVENTS [MFR 01]	0xD1	Total number of current limit flags (for both phases, if multi-phase) that – if detected – will cause …
	☐	COEFFICIENT_ROW [MFR 05]	0xD5	A CLA coefficient row (three coefficients).
	☐	ENABLE_PHASE [MFR 14]	0xDE	Selects the phase to enable.
	☐	FAN_COMMAND_1	0x3B	Used to adjust the operation of fan #1 contained in the PMBus device or in the host system.
	☐	FAN_CONFIG_1_2	0x3A	Used to configure up to four fans associated with one PMBus device.
	☐	FAN_SPEED_FAULT_LIMIT [MFR 24]	0xE8	Fan speed limit in RPMs. If the fan speed is below this when the fan is marked as installed, then it…
🔒	☑	FREQUENCY_SWITCH	0x33	Switching frequency, in kHz, of a PMBus device.
🔒	☑	IOUT_CAL_GAIN	0x38	Ratio of the voltage at the current sense pins to the sensed current.
🔒	☑	IOUT_CAL_OFFSET	0x39	Most often used in conjunction with the IOUT_CAL_GAIN command to minimize the error of the cu…
	☐	IOUT_OC_FAULT_LIMIT	0x46	Sets the value of the output current, in amperes, that causes the overcurrent detector to indicat…
	☐	IOUT_OC_FAULT_RESPONSE	0x47	Instructs the device on what action to take in response to an output overcurrent fault.
	☐	IOUT_OC_WARN_LIMIT	0x4A	Sets the value of the output current that causes an output overcurrent warning.
	☐	LIGHT_LOAD_ENABLE [MFR 29]	0xED	Specifies what mode light load processing is in. Static dual-phase: system stays in dual-phase mo…
	☐	LOGGED_FAULT [MFR 26]	0xEA	Shutdown reasons. The first two bytes is a bit mask with each bit representing the type of error t…
	☐	LOGGED_MAX_TEMPERATURE [MFR 25]	0xE9	Two items: the current maximum recorded external temperature and a bit that can be set to clear…
🔒	☑	LOUT [MFR 22]	0xE6	Value of the output inductor for current ripple calculations in µH.
🔒	☑	MAX_DUTY	0x32	Maximum duty cycle of the unit’s power conversion stage.
🔒	☑	MFR_DATE	0x9D	Unit’s date of manufacture as ASCII text.
🔒	☑	MFR_ID	0x99	Manufacturer’s ID as ASCII text (name, abbreviation or symbol that identifies the unit’s manufact…
🔒	☑	MFR_IOUT_MAX	0xA6	Maximum rated value, in amperes, to which the output may be loaded.
🔒	☑	MFR_LOCATION	0x9C	ASCII text identifying the facility that manufactured the unit.

Fusion Digital Power Designer v1.3.12 [2007-06-24] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

Figure 11 UCD9112 Security – Security Off State

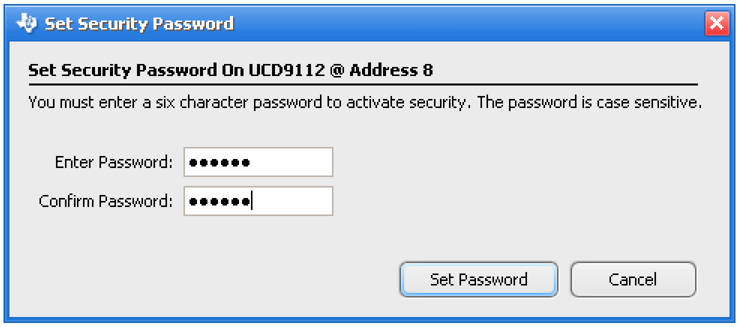
Note that both writeable PMBus parameters (VOUT_COMMAND, IOUT_OC_FAULT_LIMIT, etc) and send byte operations (STORE_DEFAULT_ALL, SOFT_RESET, etc.) can be protected. Certain commands are not shown in the bitmask editor because they should not be write protected. For example, the PAGE and PHASE parameters must be writable in order to take readings from the device through commands such as READ_VOUT and READ_IOUT.

The device has four security states it can be in:

1. **Off**: Security is deactivated. Writes to all commands are allowed. The security bitmask can be written to.
2. **On**: Security is active. The configured security bit mask defines what commands are protected. Any writes to those commands will be NACKed. The security bitmask can not be written to.
3. **Temporarily Disabled**: Security is temporarily disabled. Any command can be written to and the security bitmask can be modified. When the device is reset, security will be returned to the On state.
4. **Password Lockout**: When changing the password or disabling security, the user must enter the current password. If they enter it incorrectly, the system will lockout additional password entry until the device is reset.

7.2 Turning on Security

EVMs provided directly from Texas Instruments normally have security turned off by default. To turn on security, you set a security password. Click the *Turn On Security* button shown in Figure 11. You will be prompted for a password:



Set Security Password

Set Security Password On UCD9112 @ Address 8

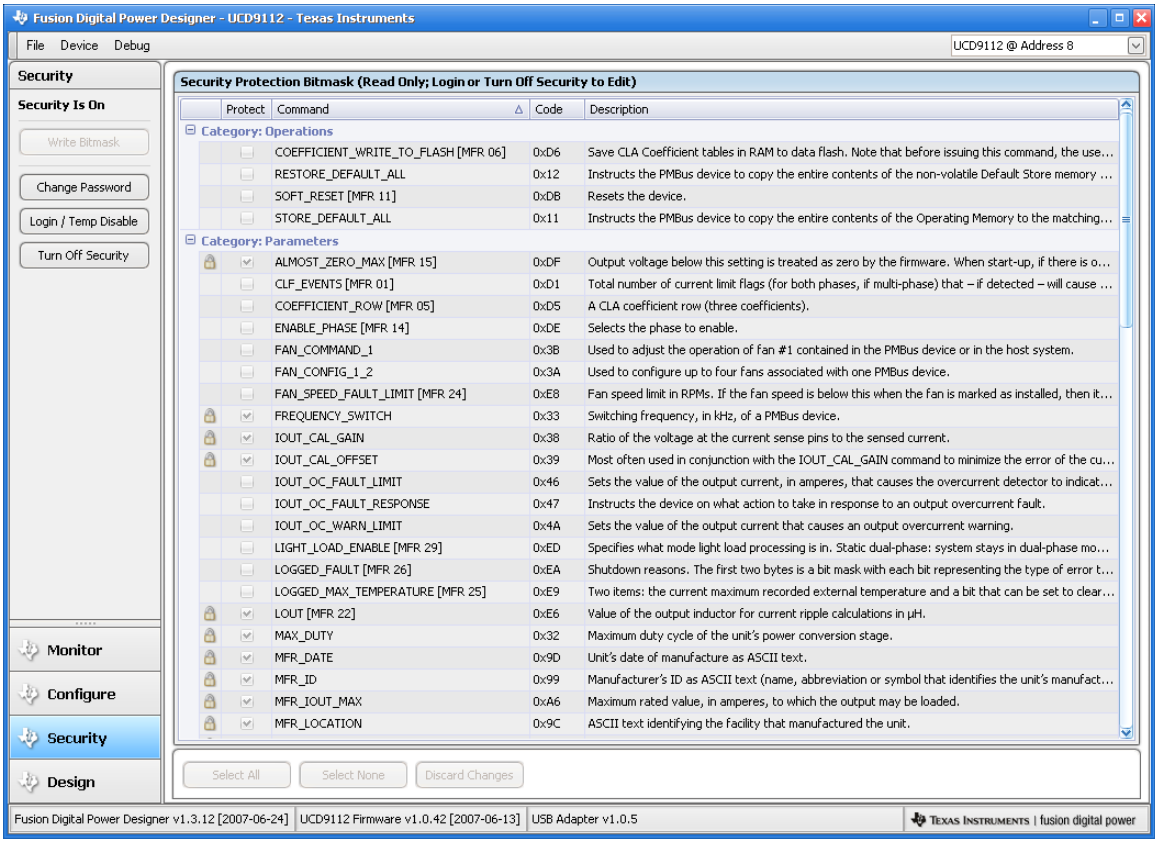
You must enter a six character password to activate security. The password is case sensitive.

Enter Password: ●●●●●●

Confirm Password: ●●●●●●

Figure 12 Security Activation Form

Passwords must be exactly six characters long. Once you click Set Password, you will get a confirmation on success and the security task form will change to reflect the new state, Security On:



Fusion Digital Power Designer - UCD9112 - Texas Instruments

File Device Debug — UCD9112 @ Address 8

Security

Security Is On

Write Bitmask | Change Password | Login / Temp Disable | Turn Off Security

Security Protection Bitmask (Read Only; Login or Turn Off Security to Edit)

	Protect	Command	Code	Description
Category: Operations				
	☐	COEFFICIENT_WRITE_TO_FLASH [MFR 06]	0xD6	Save CLA Coefficient tables in RAM to data flash. Note that before issuing this command, the use…
	☐	RESTORE_DEFAULT_ALL	0x12	Instructs the PMBus device to copy the entire contents of the non-volatile Default Store memory …
	☐	SOFT_RESET [MFR 11]	0xDB	Resets the device.
	☐	STORE_DEFAULT_ALL	0x11	Instructs the PMBus device to copy the entire contents of the Operating Memory to the matching…
Category: Parameters				
🔒	☑	ALMOST_ZERO_MAX [MFR 15]	0xDF	Output voltage below this setting is treated as zero by the firmware. When start-up, if there is o…
	☐	CLF_EVENTS [MFR 01]	0xD1	Total number of current limit flags (for both phases, if multi-phase) that – if detected – will cause …
	☐	COEFFICIENT_ROW [MFR 05]	0xD5	A CLA coefficient row (three coefficients).
	☐	ENABLE_PHASE [MFR 14]	0xDE	Selects the phase to enable.
	☐	FAN_COMMAND_1	0x3B	Used to adjust the operation of fan #1 contained in the PMBus device or in the host system.
	☐	FAN_CONFIG_1_2	0x3A	Used to configure up to four fans associated with one PMBus device.
	☐	FAN_SPEED_FAULT_LIMIT [MFR 24]	0xE8	Fan speed limit in RPMs. If the fan speed is below this when the fan is marked as installed, then it…
🔒	☑	FREQUENCY_SWITCH	0x33	Switching frequency, in kHz, of a PMBus device.
🔒	☑	IOUT_CAL_GAIN	0x38	Ratio of the voltage at the current sense pins to the sensed current.
🔒	☑	IOUT_CAL_OFFSET	0x39	Most often used in conjunction with the IOUT_CAL_GAIN command to minimize the error of the cu…
	☐	IOUT_OC_FAULT_LIMIT	0x46	Sets the value of the output current, in amperes, that causes the overcurrent detector to indicat…
	☐	IOUT_OC_FAULT_RESPONSE	0x47	Instructs the device on what action to take in response to an output overcurrent fault.
	☐	IOUT_OC_WARN_LIMIT	0x4A	Sets the value of the output current that causes an output overcurrent warning.
	☐	LIGHT_LOAD_ENABLE [MFR 29]	0xED	Specifies what mode light load processing is in. Static dual-phase: system stays in dual-phase mo…
	☐	LOGGED_FAULT [MFR 26]	0xEA	Shutdown reasons. The first two bytes is a bit mask with each bit representing the type of error t…
	☐	LOGGED_MAX_TEMPERATURE [MFR 25]	0xE9	Two items: the current maximum recorded external temperature and a bit that can be set to clear…
🔒	☑	LOUT [MFR 22]	0xE6	Value of the output inductor for current ripple calculations in µH.
🔒	☑	MAX_DUTY	0x32	Maximum duty cycle of the unit’s power conversion stage.
🔒	☑	MFR_DATE	0x9D	Unit’s date of manufacture as ASCII text.
🔒	☑	MFR_ID	0x99	Manufacturer’s ID as ASCII text (name, abbreviation or symbol that identifies the unit’s manufact…
🔒	☑	MFR_IOUT_MAX	0xA6	Maximum rated value, in amperes, to which the output may be loaded.
🔒	☑	MFR_LOCATION	0x9C	ASCII text identifying the facility that manufactured the unit.

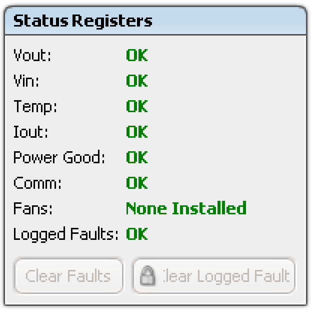
Select All | Select None | Discard Changes

Monitor | Configure | Security | Design

Fusion Digital Power Designer v1.3.12 [2007-06-24] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5 | Texas Instruments | fusion digital power

Figure 13 UCD9112 Security – Security On State

Note how the security bitmask can not be edited anymore, as shown by the grayed out rows in the bitmask editor. In other parts of the GUI, if an operation would be affected because a command is write protected and security is on, this will be shown by a lock icon and grayed out state. For example, if LOGGED_FAULT and LOGGED_MAX_TEMPERATURE are write protected and security activated on a UCD9112, you would see these changes in the GUI:

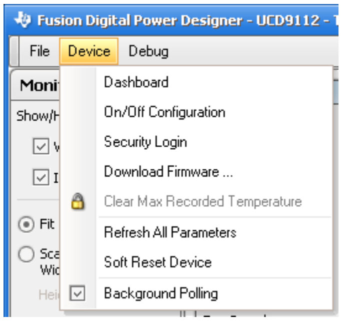


Status Registers

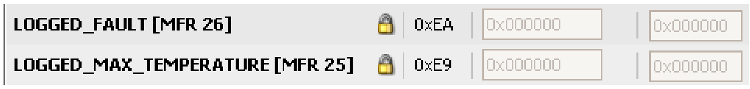
Vout:	OK
Vin:	OK
Temp:	OK
Iout:	OK
Power Good:	OK
Comm:	OK
Fans:	None Installed
Logged Faults:	OK

Clear Faults | 🔒 lear Logged Fault

Clear Logged Faults button locked



Clear Max Recorded Temperature function in the Device menu locked



LOGGED_FAULT [MFR 26]	🔒	0xEA	0x000000	0x000000
LOGGED_MAX_TEMPERATURE [MFR 25]	🔒	0xE9	0x000000	0x000000

Low-level editors for LOGGED_FAULT and LOGGED_MAX_TEMPERATURE in the Advanced Configuration tab locked.

Of course the GUI is not the only part of the system that is enforcing security. The device will write protect commands specified in the security bitmask when security is on, and will NACK attempts to write to the parameter or, in the case of a send byte, execute the command.

7.3 Turning Off or Disabling Security

When security has been activated and you would like to edit a locked parameter or edit the security bitmask, you have two choices:

- Temporarily disable security. This unlocks the device until it is reset or power cycled. This is useful if you are concerned about remembering to reactivate security.
- Turn off security. This unlocks the device until you re-active security per the procedure described in Section 7.2.

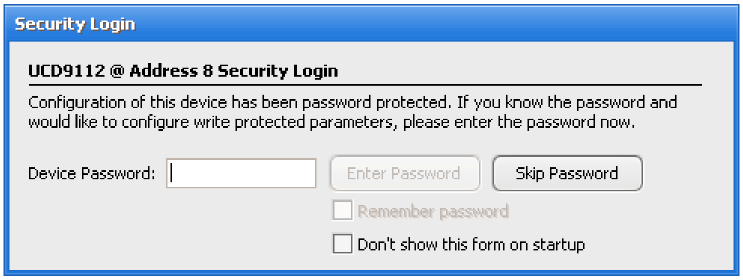
In either case you must know the password for the device. There is no backdoor password for device: be sure to write it down somewhere secure. Texas Instruments can not recover your password or unlock your device if you forget your password.

If you enter the wrong password for either of the above, the device will enter the password locked out state. You will not be able to make another attempt at temporarily disabling security or turning security off until you reset the device. There is no restriction on the number of times you can attempt to enter a password outside of the reset requirement between each attempt. So you need not worry about permanently locking your device due to some "bad attempt" count.

7.4 Automatic Login / Disable Form

If security is activated on your device, when you start the GUI it will prompt you for the password to temporarily disable security. Why does this form appear? It is assumed you are working on an EVM that you make frequent edits to write protected parameters, and then hand off the EVM to other individuals or groups who should not have the same access.

If you do not have the password to the device or care not to enter it, you can simply click the *Skip Password* button to hide the form:


Security Login

UCD9112 @ Address 8 Security Login

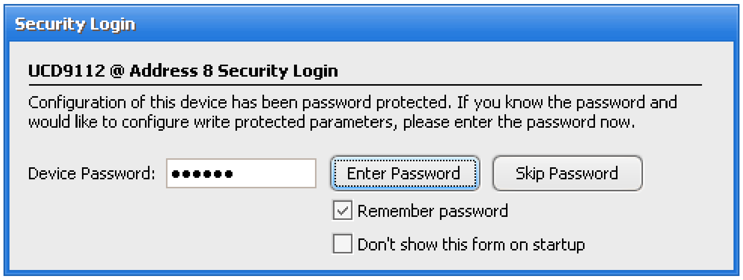
Configuration of this device has been password protected. If you know the password and would like to configure write protected parameters, please enter the password now.

Device Password:

Figure 14 Security Login / Disable Form

If you would prefer not to see the security login on GUI startup, click the *Don't show this form on startup checkbox*.

If you know the password and would like to automatically enter it when necessary at GUI startup, check the *Remember password* checkbox before clicking the *Enter Password* button:



Security Login

UCD9112 @ Address 8 Security Login

Configuration of this device has been password protected. If you know the password and would like to configure write protected parameters, please enter the password now.

Device Password: ●●●●●● [Enter Password] [Skip Password]

☑ Remember password

□ Don't show this form on startup

Figure 15 GUI Startup Security Automatic Login / Disable Form

If you use the remember password feature, your password will be stored in the clear on your PC's hard drive inside the GUI's preferences file.

7.5 Security Commands

The GUI uses three TI manufacturer commands to manage security: SECURITY_BIT_MASK, SETUP_PASSWORD, and DISABLE_SECURITY. The GUI hides implementation details of these commands through its security forms. For more information about these commands, refer to the appropriate application note for your device:

- UCD91XX: *Configuration Security for the UCD91XX Digital Controllers*[2]
- UCD9240: this device is in-development; security to be available in a future pre-production release

You can only edit the security bitmask and configure the security password through the security task. The advanced configuration editor does not provide direct access to these commands.

7.6 Security is Flash Based

When you set/update the device password, update the security bitmask, or turn off security, the change is written directly to flash memory on the device. There is no need to execute STORE_DEFAULT_ALL for security commands.

7.7 Security in Offline Mode

When you open a project file in offline mode for a device that has security activated, the security bitmask will be retained and enforced: you will see the 🔒 icon next to any write protected commands.

You can emulate activating and deactivating security in offline mode through the *Turn On Security* and *Turn Off Security* buttons. Clicking these buttons will not request a password, and will only simulate turning security on and off. You can edit the security bitmask when security is virtually disabled. If you later import the file in online mode, your new security bitmask will be written to the device. Of course, if you don't actually have the device password, this part of the import will fail.

Real security activation and deactivation can only be performed while connected to the EVM. Turning security on and off in offline mode does not bypass the EVM security in any way nor allow any "backdoor" writes to protected parameters.

8 Design

8.1 Design & Hardware Overview

The Design task is used to create a set of Control Law Accelerator (CLA) coefficients for your target device's digital Pulse Width Modulation (PWM) controller(s). The general workflow of the design task is:

- Define your power stage transfer function (the "plant model").
- Define the loop compensation by specifying the gain and zeros of the CLA. On select hardware you will also specify poles. Alternatively, you can specify the PID gains of the compensator.
- Adjust your design parameters until your desired crossover, phase margin and gain margin are reached on the control loop gain Bode plot.

Each output rail of a device has a set of coefficients, stored in a series of tables (UCD91XX) or banks (UCD92XX). The device dynamically selects which coefficient tables or banks to use based on its current operational mode. The following summarizes the coefficients on each device supported by the GUI:

UCD91XX The UCD91XX has two programmable coefficient lookup tables. Tables are first stored to the device's RAM similar to other PMBus parameters. You can review the impact of a design change on power supply operation this way. When you want to make your changes non-volatile, you must save the device's configuration to flash.

CLA table 1 is used during normal regulation mode. CLA table 2 is used during soft start and soft stop voltage ramp. See TI application report *Designing the Digital Compensator For UCD91xx based Digital Power Supply*[3] for more information about the UCD91XX CLA and the design of its coefficient set.

Section 8.11 covers features specific to the UCD91XX device family.

UCD92XX UCD92XX devices have three programmable coefficient banks for each output voltage rail (power supply output). **These banks are flash based**. Bank 0x0 is used during soft start and stop, bank 0x1 during normal regulation mode, and bank 0x2 during light load operation.

In operation the UCD92XX copies the coefficient values stored in flash to one of two sets of registers dynamically based on what operation mode the device is in (normal, soft start/stop, or light load). You can also manually activate a flash bank through the design tool, allowing easy review of design change impact on hardware operation. See *UCD9240 Digital Point of Load System Controller Device and EVM Description*[4] for more information about the UCD92XX CLA and design theory.

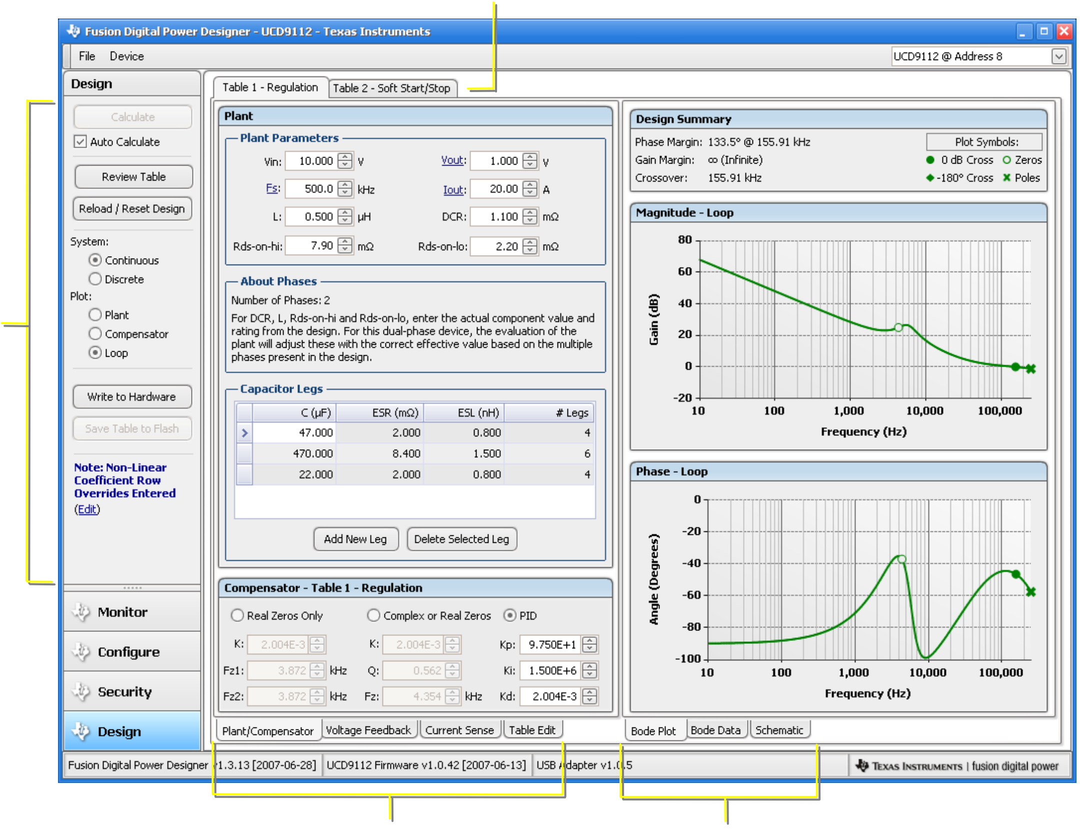
Section 8.12 covers features specific to the UCD92XX device family.

You do not have to be connected to your target device to develop its CLA designs. Please review Section 10, Offline Mode, if you would like to work on your design "offline."

8.2 Design User Interface Overview

The majority of the design user interface remains the same regardless of the device you are designing for. The figure on the next page summarizes generic design features.

Select CLA Table/Bank
Change the set of coefficients you are designing for.



Design Control
Critical functions such as writing your coefficients to hardware are controlled here.

☑ Auto Calculate

System: ● Continuous ○ Discrete

Plot: ○ Plant ○ Compensator ● Loop

Note: Non-Linear Coefficient Row Overrides Entered (Edit)

Plant Parameters

Vin:	10.000 V	Vout:	1.000 V		
Fs:	500.0 kHz	Iout:	20.00 A		
L:	0.500 µH	DCR:	1.100 mΩ		
Rds-on-hi:	7.90 mΩ	Rds-on-lo:	2.20 mΩ		

About Phases

Number of Phases: 2

For DCR, L, Rds-on-hi and Rds-on-lo, enter the actual component value and rating from the design. For this dual-phase device, the evaluation of the plant will adjust these with the correct effective value based on the multiple phases present in the design.

Capacitor Legs

C (µF)	ESR (mΩ)	ESL (nH)	# Legs
47.000	2.000	0.800	4
470.000	8.400	1.500	6
22.000	2.000	0.800	4

Compensator - Table 1 - Regulation

○ Real Zeros Only ○ Complex or Real Zeros ● PID

K: 2.004E-3	K: 2.004E-3	Kp: 9.750E+1
Fz1: 3.872 kHz	Q: 0.562	Ki: 1.500E+6
Fz2: 3.872 kHz	Fz: 4.354 kHz	Kd: 2.004E-3

Design Summary

Phase Margin: 133.5° @ 155.91 kHz
Gain Margin: ∞ (Infinite)
Crossover: 155.91 kHz

Plot Symbols: ● 0 dB Cross ○ Zeros ◆ -180° Cross ✖ Poles

Fusion Digital Power Designer v1.3.13 [2007-06-28] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5

Left Tab Group
Used to switch between design input entry forms and perform other device-specific functions (UCD91XX advanced table editing shown here).

Right Tab Group
Used to switch between bode plots, bode data, and a schematic of the EVM.

8.3 Design Defaults

The first time you launch the GUI, it will load a default set of design inputs. These inputs come from three places:

- Most plant parameters use a set of defaults based on the factory EVM for the device. The design parameters loaded in this fashion are:

Plant/Compensator Tab

- Vin
- Iout
- Filter Inductor L
- Inductor DCR
- RDS-on-hi
- RDS-on-lo
- Output capacitor legs

Voltage Feedback Tab

- R1
- R2
- Cp
- Cz

- Select plant parameters are synchronized to PMBus device parameters. When you start the GUI, the following inputs will be set from the device's configuration:
    - Vout – synchronized to VOUT_COMMAND
    - Fs - synchronized to FREQUENCY_SWITCH

  Please refer to Section 8.5.2 for more information on how these parameters are synchronized.

- The compensator design parameter inputs are derived from the CLA table/bank they are associated with. For example, on a UCD9240 the compensator defaults for CLA bank 0x0 on rail #2 are derived from the current set of coefficients in flash memory on the attached device. The digital coefficients are mapped from the discrete domain to the continuous domain, from which the continuous design parameters are derived. When running in offline mode, the project file's snapshot of the coefficient bank is used.

- All the plant parameters must be entered in the units specified to the right of the entry box.

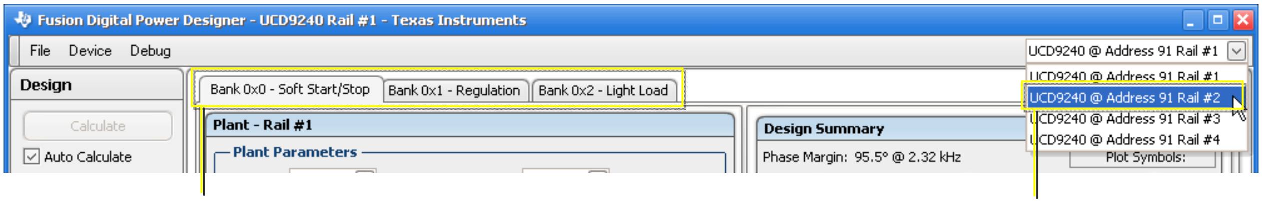
You can reset the plant and/or compensator inputs at any time using the *Reload/Reset Design* button on the left side of the design form. This is covered in more detail in Section 8.9.

8.4 How Designs Are Saved

When you start the GUI in online mode, it will load – if available – the last design you worked on for the attached device. How? The GUI stores the last design for each device it supports in its preferences file (see Section 3.5). Designs are keyed off of the device's part number: UCD9111, UCD9112, etc. If you have two different systems for the same part but configured for different PMBus addresses, only a single design will be stored in the preference file.

If you need to switch between designs or would like to save the state of a particular design, you can save your design to a project file. You can then later import this design into the GUI or even work offline on your design away from the EVM. See Section 9 Project Files and Section 10 Offline Mode.

The GUI maintains separate compensator design for each CLA table/bank. As you click the table/bank tab at the top of the design form, the compensator inputs you are editing may therefore change. On a multi-rail device such as the UCD92XX, you can define different plant designs for each rail. Each rail in turn has unique compensator designs for each CLA bank on the rail.


Fusion Digital Power Designer - UCD9240 Rail #1 - Texas Instruments
File
Device
Debug
UCD9240 @ Address 91 Rail #1
UCD9240 @ Address 91 Rail #1
UCD9240 @ Address 91 Rail #2
UCD9240 @ Address 91 Rail #3
UCD9240 @ Address 91 Rail #4
Design
Calculate
☑ Auto Calculate
Bank 0x0 - Soft Start/Stop
Bank 0x1 - Regulation
Bank 0x2 - Light Load
Plant - Rail #1
Plant Parameters
Design Summary
Plot Symbols:

Phase Margin: 95.5° @ 2.32 kHz

Selecting a new **table/bank**:

- Switches compensator inputs.
- But does not affect plant parameters other than Iout; these are global to the output rail (or device in the case of a UCD91XX).
- Recalculates the design.
- Changes the coefficients affected by the hardware buttons on the left side of the form.

Selecting a new **output rail** (UCD92XX only):

- Switches plant inputs and sets Fs and Vout based on device values for the new rail.
- Switches compensator inputs to the bank for this rail.
- Recalculates the design.
- Changes the coefficients affected by the hardware buttons on the left side of the form.

The following diagram shows the hierarchical nature of saved designs, using the UCD9240 as an example:

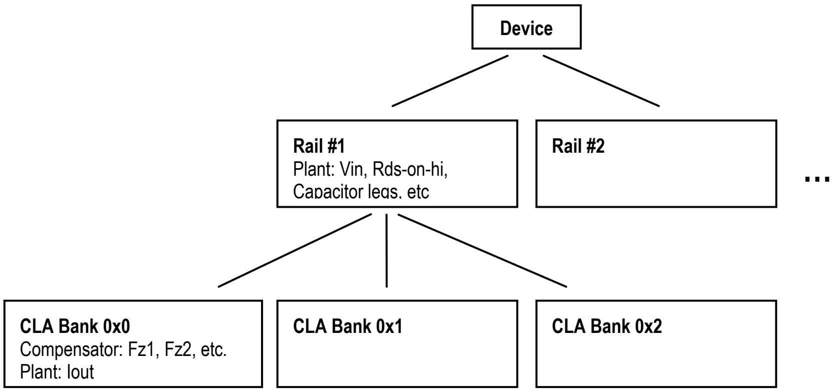
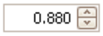


Figure 16 Design Preferences Hierarchy, UCD9240

Although Iout is a plant parameter, each CLA design can have a unique value for Iout. This simplifies design review by allowing the design to address various load ranges. And as was described in Section 8.3, plant switching frequency (Fs) and output voltage (Vout) are not stored in your design preferences at all. These are always derived from current hardware values.

8.5 Design Input

8.5.1 Auto Calculation of Design

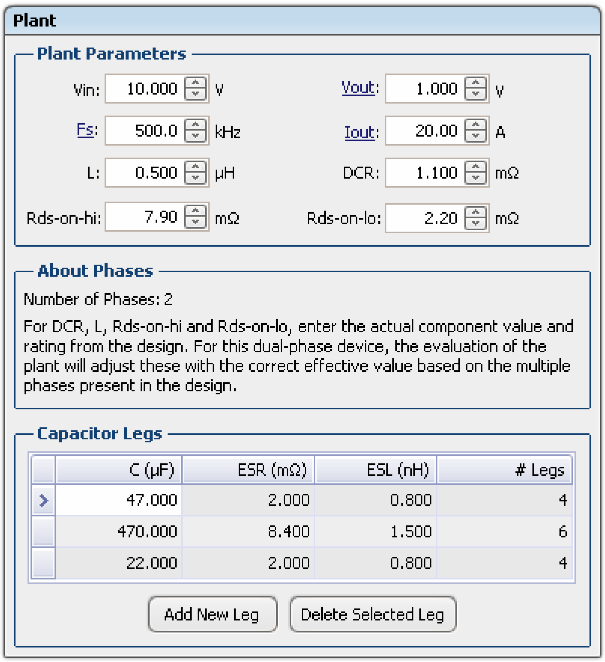
By default, the design is recalculated when you edit a design input. In the case of clicking on the up/down button in a spin edit (), the calculation is performed immediately. If you type in an entry, such as 1.5 into Vout, the calculation is performed approximately 2 seconds after you finish typing. The auto calculate feature can be disabled by unchecking the *Auto Calculate* checkbox below the *Calculate* button.

If you turn off auto calculate mode, you will need to click the *Calculate* button after you change your design. The button will be enabled – no longer grayed out – after you change an input.

8.5.2 Plant Inputs

Input of the plant is split between two tabs available at the bottom of the form. Plant parameters are the same regardless of the device attached (UCD91XX or UCD92XX).

Plant/Compensator Tab



Plant

Plant Parameters

Vin: 10.000 V
Vout: 1.000 V
Fs: 500.0 kHz
Iout: 20.00 A
L: 0.500 µH
DCR: 1.100 mΩ
Rds-on-hi: 7.90 mΩ
Rds-on-lo: 2.20 mΩ

About Phases

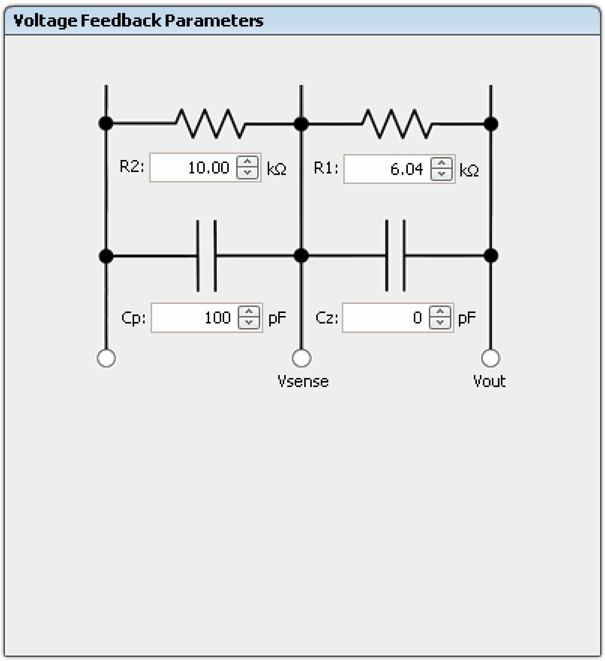
Number of Phases: 2

For DCR, L, Rds-on-hi and Rds-on-lo, enter the actual component value and rating from the design. For this dual-phase device, the evaluation of the plant will adjust these with the correct effective value based on the multiple phases present in the design.

Capacitor Legs

C (µF)	ESR (mΩ)	ESL (nH)	# Legs
47.000	2.000	0.800	4
470.000	8.400	1.500	6
22.000	2.000	0.800	4

Voltage Feedback Tab



Voltage Feedback Parameters

R2: 10.00 kΩ
R1: 6.04 kΩ
Cp: 100 pF
Cz: 0 pF

:

Figure 17 Plant Inputs, UCD9112 Defaults

The number of converter phases for each output rail will be factored into the plant response calculations. The series connected components in the plant – L, DCR, RDS-on-hi, and RDS-on-lo – are automatically adjusted based on the number of phases specified for that output voltage rail. The actual component values for a single phase should therefore be entered.

Because the capacitors are typically connected in parallel, it is not necessary to have a fixed number of capacitors per power stage. Therefore the tool does not automatically adjust the total capacitance based on the number of phases: you should enter the total number of each type of capacitor connected to the output voltage rail.

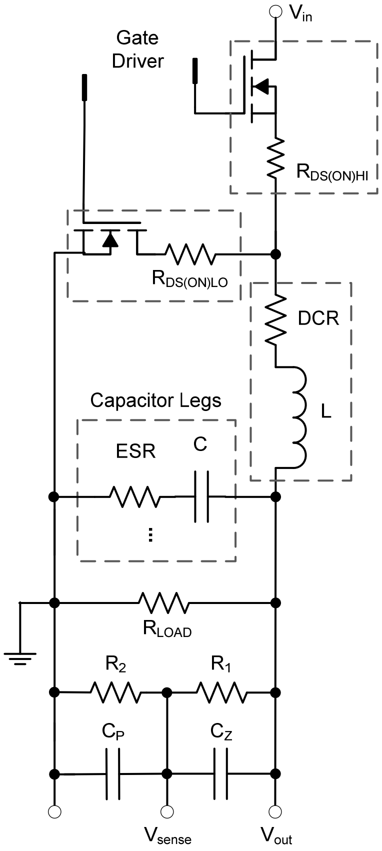
On a multi-rail device, as you change output rails the *Number of Phases* label shown in the Plant box will be updated to reflect the number of phases specified for the new rail on the Phase/Rail Configuration tab.

Vout and Fs are linked to the VOUT_COMMAND and FREQUENCY_SWITCH PMBus parameters for the output rail. You can modify them directly with the form, and the change will be reflected with the design when it recalculates. Your change will not be written to hardware, however, until you click the *Write to Hardware* button on the left side of the form. Remember that Vout and Fs are not stored in your design preferences or project file. The current rail/device value will be used the next time you work on this design.

Capacitors are entered using an Excel-like grid. Each type of capacitor defines a "capacitor leg". To edit a cell, click the cell and then type in your new value. The # Legs column allows you to quickly replicate a capacitor. For example, the UCD9112 example shown uses this to specify 14 total capacitors using only three entries in the grid: similar caps are paralleled and treated as one cap. In auto calculate mode, you must click another input box or hit the TAB key to indicate that you have completed your edit on the capacitor leg cell.

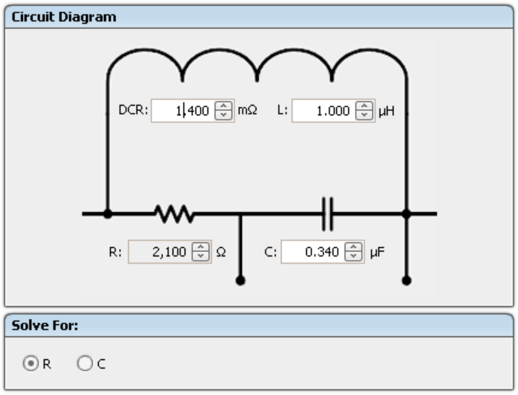
When you click *Add New Leg*, a single 1 µF capacitor leg will be added to the grid with 0 mΩ ESR and 0 nH ESL. The actual capacitor values can then be edited in the new row. To delete a leg, click on the leg's row and then click the *Delete Selected Leg* button.

Plant inputs are summarized below:



Input	Description	Units
Vin	Input voltage	V
Vout	Output voltage; synchronized to VOUT_COMMAND	V
Fs	Switching frequency; synchronized to FREQUENCY_SWITCH	kHz
Iout	Output current used to define the plant response	A
L	Output filter inductor	µH
DCR	DC series resistance of the inductor L	mΩ
Rds-on-hi	Upper MOSFET drain to source on resistance	mΩ
Rds-on-lo	Lower MOSFET drain to source on resistance	mΩ
R1	Vout sense filter top voltage divider resistor	kΩ
R2	Vout sense filter bottom voltage divider resistor	kΩ
Cp	Vout sense filter capacitor	pF
Cz	Vout sense filter capacitor	pF
Capacitor Legs:		
C	Output filter capacitance	µF
ESR	Equivalent series resistance of the capacitor C	mΩ
ESL	Equivalent series inductance of the capacitor C	nH

8.5.2.1 Current Sense Calculator



DCR: 1.400 mΩ L: 1.000 µH

R: 2,100 Ω C: 0.340 µF

Solve For: ● R ○ C

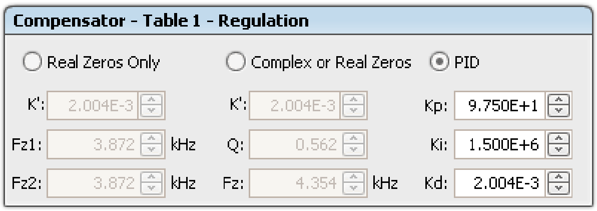
This tab, next to the voltage feedback tab at the bottom of the form, is used to input the parameters for the current sense circuit. The schematic represents the lossless current sense technique used by the UCD7230 gate driver. This form will calculate either values of R or C so that the time-constant of the R-C circuit matches that of the L-DCR circuit. At this value the voltage across C will match the voltage across DCR and the inductor current can be determined.

DCR and L are synchronized to their values on the Plant/Compensator tab: any change you make here will be reflected there, and vice versa.

You can select whether to solve for C or R by clicking the radio button.

8.5.3 Compensator Inputs

UCD91XX:



Compensator - Table 1 - Regulation

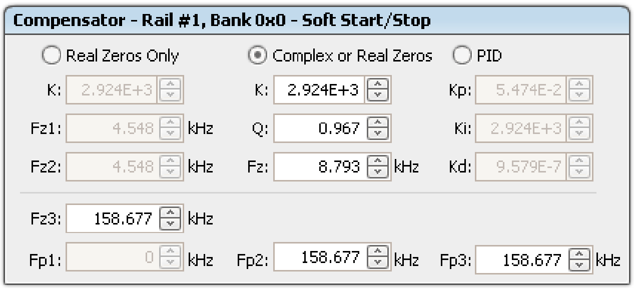
○ Real Zeros Only ○ Complex or Real Zeros ● PID

K': 2.004E-3 K': 2.004E-3 Kp: 9.750E+1

Fz1: 3.872 kHz Q: 0.562 Ki: 1.500E+6

Fz2: 3.872 kHz Fz: 4.354 kHz Kd: 2.004E-3

UCD92XX:



Compensator - Rail #1, Bank 0x0 - Soft Start/Stop

○ Real Zeros Only ● Complex or Real Zeros ○ PID

K: 2.924E+3 K: 2.924E+3 Kp: 5.474E-2

Fz1: 4.548 kHz Q: 0.967 Ki: 2.924E+3

Fz2: 4.548 kHz Fz: 8.793 kHz Kd: 9.579E-7

Fz3: 158.677 kHz

Fp1: 0 kHz Fp2: 158.677 kHz Fp3: 158.677 kHz

The compensator inputs are entered in the continuous s-domain. There are three modes of entering the second order filter. Click on the radio button to change modes:

Real Zeros Only In this mode you can only enter two real zeros Fz1 and Fz2 along with the filter gain, K.

Complex or Real Zeros Specify a quality factor (Q) and the compensator zero frequency (Fz) along with the compensator gain (K). If Q is greater than 0.5, the compensator will have a pair of complex zeros. If Q is less than or equal to 0.5, it will have two real zeros.

$$H(s)=K_{Gain}\underbrace{\frac{\frac{s^2}{\omega_Z^2}+\frac{s}{\omega_Z Q}+1}{s}}_{\text{UCD91XX}} \quad \text{or} \quad H(s)=K_{Gain}\underbrace{\frac{\frac{s^2}{\omega_Z^2}+\frac{s}{\omega_Z Q}+1}{\frac{s^2}{\omega_{P2}}+s}\cdot\frac{\frac{s}{\omega_{Z3}}+1}{\frac{s}{\omega_{P3}}+1}}_{\text{UCD92XX}}$$

PID Specify the Proportional-Integral-Derivative (PID) gains of the compensator in **continuous** terms, Kp, Ki, and Kd.

As you modify a design parameter in a particular input mode, the complimentary inputs are calculated and shown. The relationship between real and complex zeros is:

$$F_{zn}=\frac{F_z}{2Q}\left[1\mp\left(1-4Q^2\right)^{1/2}\right]$$

The one special case is going from complex zeros (Q > 0.5) to real zeros. In this case:

$$F_{z1}=F_{z2}=\frac{F_z}{2Q}$$

UCD91XX Notes: The gain entered in real zero or complex mode, K’, is not the same as the gain defined in the UCD91XX application note, *Designing the Digital Compensator For UCD91xx based Digital Power Supply*. The relationship between K’ and Kcr is:

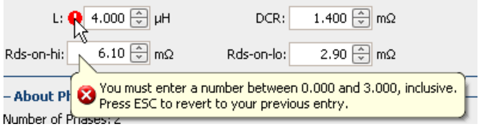
$$K'=\frac{K_{C_r}}{K_{eadc}\cdot K_{dpwm}\cdot K_{sense}}$$

UCD92XX Notes: The cascaded first order filter section is automatically disabled if the digital coefficients are zero. Zero digital coefficients correspond to continuous pole and zero frequencies of F_S/π.

The design tool assumes that the compensator includes an integrator and forces the first compensator pole F_{p1} to be zero Hz.

8.6 Input Errors

Most design inputs restrict entry to a pre-defined range. If you enter an illegal value, an icon will appear next to the input. Move your cursor over the icon to learn more. For example in the current synchronous buck topologies, L must be between 0 and 3 µH:



L: 4.000 µH DCR: 1.400 mΩ

Rds-on-hi: 6.10 mΩ Rds-on-lo: 2.90 mΩ

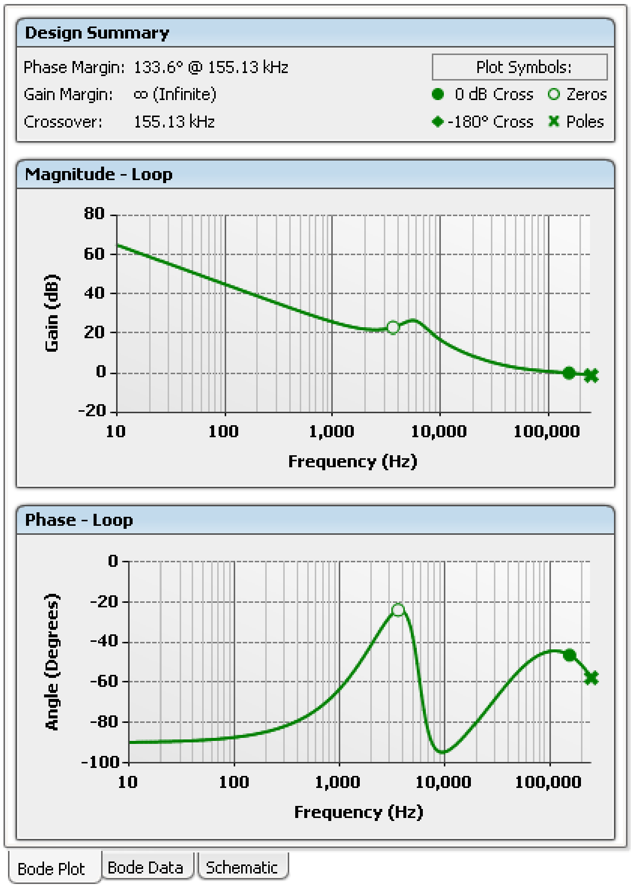
You must enter a number between 0.000 and 3.000, inclusive.
Press ESC to revert to your previous entry.

– About Ph

Number of Phases: 2

You must fix your error before you can edit another design parameter or calculate the design. Or press the ESC key to revert to the previous legal input.

8.7 Bode Plot



Design Summary

Phase Margin: 133.6° @ 155.13 kHz

Gain Margin: ∞ (Infinite)

Crossover: 155.13 kHz

Plot Symbols:
● 0 dB Cross ○ Zeros
◆ -180° Cross ✖ Poles

When the design is recalculated, the Bode Plot and Bode Data tabs will be updated.

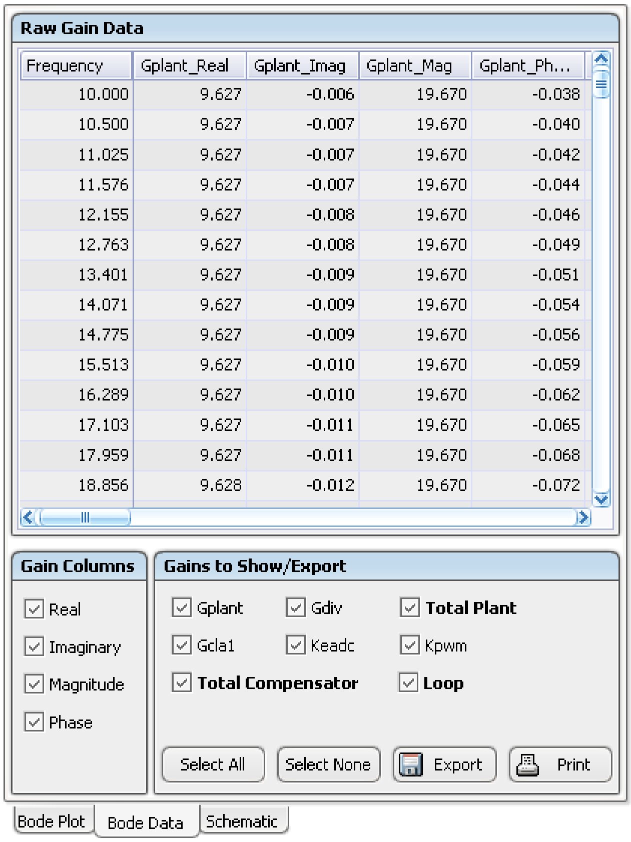
Phase Margin and Gain Margin are calculated based on the overall loop response of the system. If there is no crossover point (gain plot crossing 0 dB line), the Phase Margin will be listed as "unstable." If the phase plot does not cross the -180º line, the Gain Margin will be listed as Infinite.

You can choose to plot only the plant response, only the compensator response, or overall loop response by using the radio buttons on the left side of the design form.

0 dB and -180º crossovers are marked on the Bode plot. Poles and zeros of the compensator are shown when the loop or the compensator response is selected.

Section 8.11.1 reviews the components of the plant and compensator gains for the UCD91XX and Section 8.12.1 for the UCD92XX.

8.8 Bode Data Export



Raw Gain Data

Frequency	Gplant_Real	Gplant_Imag	Gplant_Mag	Gplant_Ph...
10.000	9.627	-0.006	19.670	-0.038
10.500	9.627	-0.007	19.670	-0.040
11.025	9.627	-0.007	19.670	-0.042
11.576	9.627	-0.007	19.670	-0.044
12.155	9.627	-0.008	19.670	-0.046
12.763	9.627	-0.008	19.670	-0.049
13.401	9.627	-0.009	19.670	-0.051
14.071	9.627	-0.009	19.670	-0.054
14.775	9.627	-0.009	19.670	-0.056
15.513	9.627	-0.010	19.670	-0.059
16.289	9.627	-0.010	19.670	-0.062
17.103	9.627	-0.011	19.670	-0.065
17.959	9.627	-0.011	19.670	-0.068
18.856	9.628	-0.012	19.670	-0.072

Gain Columns

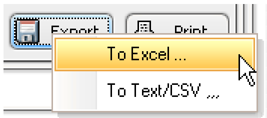
☑ Real
☑ Imaginary
☑ Magnitude
☑ Phase

Gains to Show/Export

☑ Gplant ☑ Gdiv ☑ **Total Plant**
☑ Gcla1 ☑ Keadc ☑ Kpwm
☑ **Total Compensator** ☑ **Loop**

You can export the raw data used to create the Bode plots by clicking on the Bode Data tab. By default every gain component of the overall loop response will be included in the export. You can narrow your export using the checkboxes at the bottom of the form.

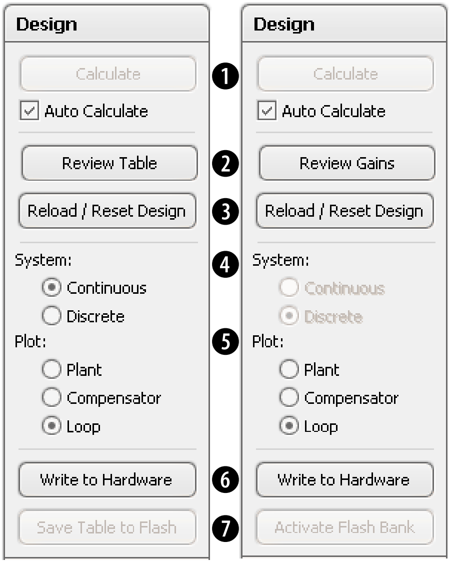
- *Gain Columns*. A gain is a complex number. You can select whether to export the real part of the gain, the imaginary part, the magnitude, or the phase angle in degrees.
- *Gains to Show/Export*. You can select whether to include individual gain components, such as the divider gain Gdiv, in the export or simply export what is plotted: total plant, total compensator, or overall loop.
- Once you have decided what to export, click the Export button:



- You can export to either an Excel spreadsheet or a simple text file in comma separated value (CSV) format..

8.9 Controlling the Design Task

UCD91XX: **UCD92XX:**



UCD91XX:

Design

Calculate
☑ Auto Calculate
Review Table
Reload / Reset Design
System:
● Continuous
○ Discrete
Plot:
○ Plant
○ Compensator
● Loop
Write to Hardware
Save Table to Flash

UCD92XX:

Design

Calculate
☑ Auto Calculate
Review Gains
Reload / Reset Design
System:
○ Continuous
● Discrete
Plot:
○ Plant
○ Compensator
● Loop
Write to Hardware
Activate Flash Bank

Design task options and actions vary only slightly between UCD91XX and UCD92XX devices.

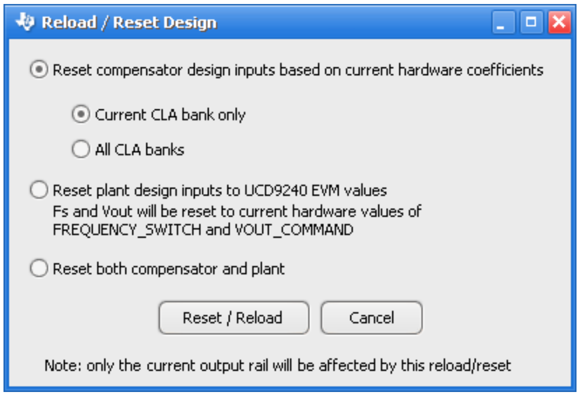
❶ When the *Auto Calculate* checkbox is checked, the *Calculate* button will always be disabled: the design will re-calculate when you change an input. If *Auto Calculate* is unchecked, the Calculate button will be enabled when the design is out-of-date and you need to recalculate. After you click the button, it will be grayed out again.

❷ You can review the CLA coefficients that have been generated by clicking the *Review Table* or *Review Gains* button. The coefficients are displayed in their own floating window. When the design is updated, the coefficients will be refreshed.

If the design is not stable, no coefficients will be generated and the *Review Table/Gains* button and the Write to Hardware button will be disabled.

❸ The *Reload/Reset Design* button is used to redefine the CLA inputs based on the current hardware coefficients and/or reset the plant inputs based on the EVM reference design. Fs and Vout will be reset to current hardware values of VOUT_COMMAND and FREQUENCY_SWITCH.

Clicking the button brings up a dialog box, in which you can select what to reload/reset:



Reload / Reset Design

● Reset compensator design inputs based on current hardware coefficients

● Current CLA bank only

○ All CLA banks

○ Reset plant design inputs to UCD9240 EVM values
Fs and Vout will be reset to current hardware values of
FREQUENCY_SWITCH and VOUT_COMMAND

○ Reset both compensator and plant

Reset / Reload | Cancel

Note: only the current output rail will be affected by this reload/reset

The default is to only redefine the compensator for the currently selected table/bank. Selecting the middle radio button will only reset the plant. Selecting the bottom radio button will reset both the plant and compensator inputs.

❹ The *System* radio buttons select whether to plot the continuous (s-domain) or discrete (z-domain) response. On the UCD92XX, only the discrete option is available. On the UCD91XX, the discrete option also adds in Gdelay to the compensator. See design errata starting in Section 8.11 for a summary of design equations and individual gain components for each device family.

❺ The *Plot* radio buttons controls whether the plant, compensator, or loop (plant*compensator) response is shown in the bode plot.

❻ The *Write to Hardware* button:

- Writes any changes to VOUT_COMMAND and FREQUENCY_SWITCH to hardware (RAM).
- On the UCD91XX, writes the coefficient table for the currently selected CLA tab (such as "Table 1 – Regulation") to RAM.
- On the UCD92XX, writes the CLA gains to the flash bank for the currently selected CLA tab (such as "Bank 0x0 – Soft Start/Stop").

A confirmation of the write – or list of errors – will be display when complete.

❼ The name and behavior of the final button varies depending on the target device. But in each case, the button is only enabled after the coefficients have been written to hardware.

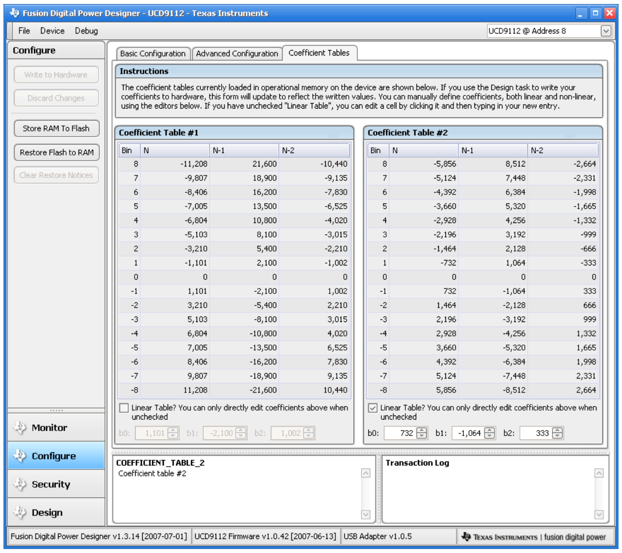
- UCD91XX: *Save Table to Flash*
  When you write the coefficients to hardware, they are loaded into operational memory on the device. You must save the parameters in the device's RAM to flash if you want this set of coefficients to survive a device reset. Clicking this button will execute the PMBus STORE_DEFAULT_ALL command. You will receive a confirmation.
- UCD92XX: *Activate Flash Bank*
  The UCD92XX normally selects the current, active flash bank automatically based on the current mode of the device: soft start/stop, light load, or normal operation. You can force the device to switch to a particular flash bank using this button.

8.10 CLA Editing vs. Design

The GUI supports editing individual CLA tables/banks on both UCD91XX and UCD92XX devices through the Configure task. Edits made in this way do not directly affect your design.

You could, for example, use your own design methodology and tools to define your coefficients. You would then manually type these into the CLA editor:

UCD91XX CLA Editor:



Instructions

The coefficient tables currently loaded in operational memory on the device are shown below. If you use the Design task to write your coefficients to hardware, this form will update to reflect the written values. You can manually define coefficients, both linear and non-linear, using the editors below. If you have unchecked "Linear Table", you can edit a cell by clicking it and then typing in your new entry.

Coefficient Table #1

Bin	N	N-1	N-2
8	-11,208	21,600	-10,440
7	-9,807	18,900	-9,135
6	-8,406	16,200	-7,830
5	-7,005	13,500	-6,525
4	-6,804	10,800	-4,020
3	-5,103	8,100	-3,015
2	-3,210	5,400	-2,210
1	-1,101	2,100	-1,002
0	0	0	0
-1	1,101	-2,100	1,002
-2	3,210	-5,400	2,210
-3	5,103	-8,100	3,015
-4	6,804	-10,800	4,020
-5	7,005	-13,500	6,525
-6	8,406	-16,200	7,830
-7	9,807	-18,900	9,135
-8	11,208	-21,600	10,440

☐ Linear Table? You can only directly edit coefficients above when unchecked

b0: 1,101 b1: -2,100 b2: 1,002

Coefficient Table #2

Bin	N	N-1	N-2
8	-5,856	8,512	-2,664
7	-5,124	7,448	-2,331
6	-4,392	6,384	-1,998
5	-3,660	5,320	-1,665
4	-2,928	4,256	-1,332
3	-2,196	3,192	-999
2	-1,464	2,128	-666
1	-732	1,064	-333
0	0	0	0
-1	732	-1,064	333
-2	1,464	-2,128	666
-3	2,196	-3,192	999
-4	2,928	-4,256	1,332
-5	3,660	-5,320	1,665
-6	4,392	-6,384	1,998
-7	5,124	-7,448	2,331
-8	5,856	-8,512	2,664

☑ Linear Table? You can only directly edit coefficients above when unchecked

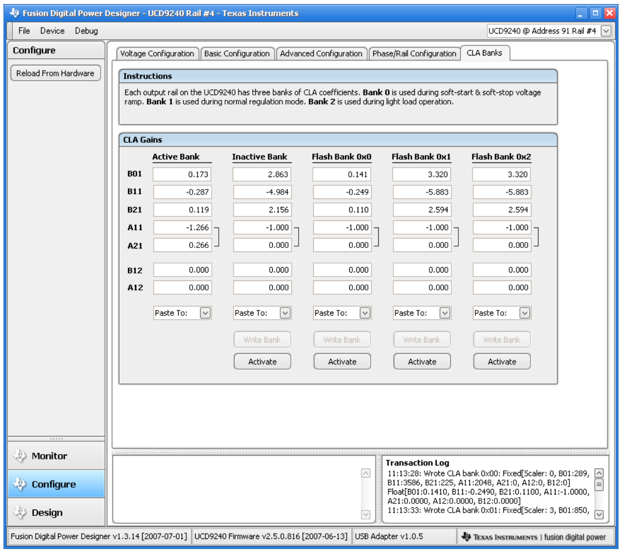
b0: 732 b1: -1,064 b2: 333

COEFFICIENT_TABLE_2
Coefficient table #2

Transaction Log

Fusion Digital Power Designer v1.3.14 [2007-07-01] | UCD9112 Firmware v1.0.42 [2007-06-13] | USB Adapter v1.0.5 | Texas Instruments | fusion digital power

UCD92XX CLA Editor:



Instructions

Each output rail on the UCD9240 has three banks of CLA coefficients. **Bank 0** is used during soft-start & soft-stop voltage ramp. **Bank 1** is used during normal regulation mode. **Bank 2** is used during light load operation.

CLA Gains

	Active Bank	Inactive Bank	Flash Bank 0x0	Flash Bank 0x1	Flash Bank 0x2
B01	0.173	2.863	0.141	3.320	3.320
B11	-0.287	-4.984	-0.249	-5.883	-5.883
B21	0.119	2.156	0.110	2.594	2.594
A11	-1.266	-1.000	-1.000	-1.000	-1.000
A21	0.266	0.000	0.000	0.000	0.000
B12	0.000	0.000	0.000	0.000	0.000
A12	0.000	0.000	0.000	0.000	0.000

Transaction Log

```
11:13:28: Wrote CLA bank 0x00: Fixed[Scaler: 0, B01:289,
B11:3586, B21:225, A11:2048, A21:0, A12:0, B12:0]
Float[B01:0.1410, B11:-0.2490, B21:0.1100, A11:-1.0000,
A21:0.0000, A12:0.0000, B12:0.0000]
11:13:33: Wrote CLA bank 0x01: Fixed[Scaler: 3, B01:850,
```

Fusion Digital Power Designer v1.3.14 [2007-07-01] | UCD9240 Firmware v2.5.0.816 [2007-06-13] | USB Adapter v1.0.5 | Texas Instruments | fusion digital power

You could also use the Design task to write coefficients to hardware and later use the CLA Editor to "tweak" the coefficients.

Going the other way, from hardware to design, is also possible. You can "reload" your compensator inputs based on the hardware coefficients using the Reload/Reset Design button described in Section 8.9.

Thus, **calculated design coefficients and configuration are only loosely coupled**: you control when hardware coefficients are written to, you can set the compensator design from hardware on demand, and you can manually edit hardware coefficient values at any time.

8.11 UCD91XX Design Errata

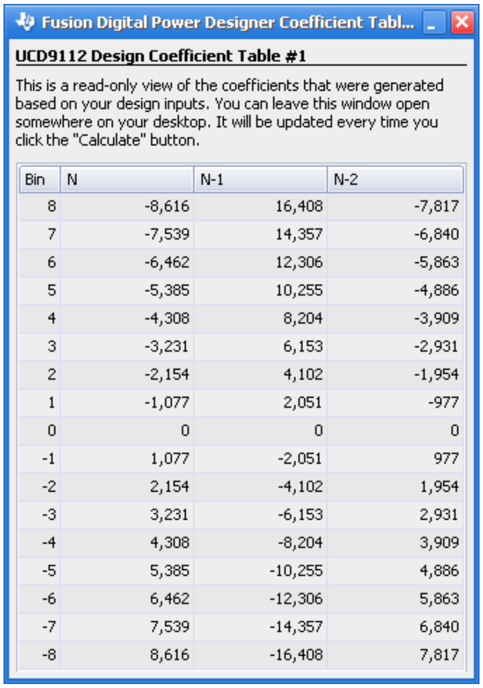
8.11.1 UCD91XX Loop Response Components

Power Stage	= Gstage
Controller	= Gcla1 * Gdelay1 * Gdelay2 * Gdiv * Keadc * Kpwm
Loop	= Power Stage * Controller

Power Stage	**Gplant**	Transfer function for the power stage circuit consisting of the FET switches, LC output filter and load. $G_{plant} = \dfrac{V_{in} \cdot Z_{eq}(s)}{R + Ls + Z_{eq}(s)}$ $Z_{eq}(s) = \dfrac{Z_c(s) \cdot R_1}{Z_c(s) + R_1}, \quad z_C(s) = \dfrac{Z_{C1} \cdot Z_{C2} \cdots}{Z_{C1} + Z_{C2} + \cdots}$ $Z_{Cn} = ESR_{Cn} + s \cdot ESL_{Cn} + \dfrac{1}{s \cdot C_n}$
	Gdiv	Transfer function for the VOUT sense divider and it's capacitive filter network. $G_{div} = \dfrac{v_{sense}}{v_{out}} = \dfrac{R_1 R_2 C_Z s + R_2}{R_1 R_2 (C_Z + C_P) s + R_1 + R_2}$
Compensator	**Gcla1(s)**	Transfer function of the CLA stage in the continuous s-domain. Refer to the TI application report *Designing the Digital Compensator For UCD91xx based Digital Power Supply* for details.
	Gcla1(z)	Transfer function of the CLA stage in the discrete z-domain. $G_{cla1}(z) = \dfrac{b_0 z^2 + b_1 z + b_2}{z(z-1)}$
	Gdelay1(s)	Phase shift due to the delay due to the error ADC and the CLA. $\mathrm{G_{delay1}(s) = e^{-s \cdot Tdelay1}}$ $\mathrm{T_{delay1} = 0.242 \cdot T_s}$

Gdelay2(s)	Phase shift due to on-time pulse width and the phase shift between multiple phases. $G_{delay2}(s) = e^{-s(T_{duty} + T_{phase})}, T_{duty} = \frac{Vo}{Vin}T_s, T_{phase} = \frac{N_{phases} - 1}{2 \cdot N_{phases}}T_s$
Gdiv	Transfer function for the VOUT sense divider and its capacitive filter network. $G_{div} = \frac{v_{sense}}{v_{out}} = \frac{R_1R_2C_Zs + R_2}{R_1R_2(C_Z + C_P)s + R_1 + R_2}$
Keadc	Gain of the 4-bit Error ADC in units of LSBs/V. $K_{eadc} = 200$ LSBs/V
Kpwm	DPWM modulator gain. This accounts for the bit resolution of the DPWM output. $K_{pwm} = 2^{-15}\ K_{pwm} = \frac{1}{2^{Npwm} - 1}$ $N_{pwm} = Log\left(\frac{1}{F_s \cdot T_{\mathrm{Re}\,sHrPwm}}\right)$ $T_{\mathrm{Re}\,sHrPwm} = 175\mathrm{E-12}$ seconds/LSB

8.11.2 Coefficient Table Review Form Example



UCD9112 Design Coefficient Table #1

This is a read-only view of the coefficients that were generated based on your design inputs. You can leave this window open somewhere on your desktop. It will be updated every time you click the "Calculate" button.

Bin	N	N-1	N-2
8	-8,616	16,408	-7,817
7	-7,539	14,357	-6,840
6	-6,462	12,306	-5,863
5	-5,385	10,255	-4,886
4	-4,308	8,204	-3,909
3	-3,231	6,153	-2,931
2	-2,154	4,102	-1,954
1	-1,077	2,051	-977
0	0	0	0
-1	1,077	-2,051	977
-2	2,154	-4,102	1,954
-3	3,231	-6,153	2,931
-4	4,308	-8,204	3,909
-5	5,385	-10,255	4,886
-6	6,462	-12,306	5,863
-7	7,539	-14,357	6,840
-8	8,616	-16,408	7,817

- The coefficients are read only in this view.
- The table updates when the design is recalculated.
- You can override specific rows of the CLA table and make them non-linear using the *Table Edit* feature described in the next section. Any non-linear overrides will be shown in this form.
- If the design is not stable or produces a calculation error, this form will show blank cells in all bins. You will not be able to write the table until you fix your design.

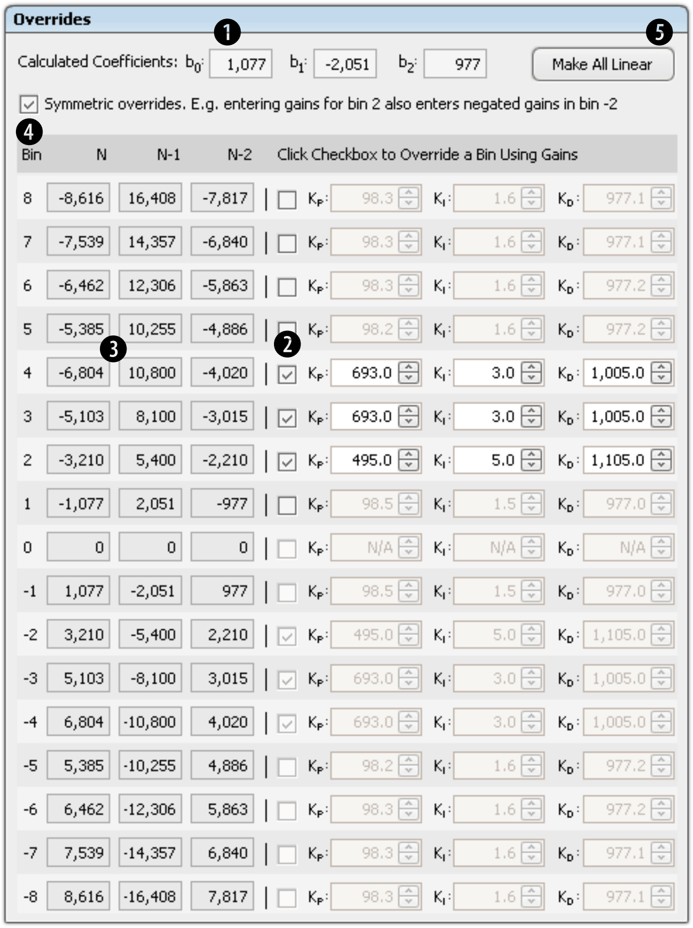
8.11.3 Table Edit Feature

The design calculates coefficients b0, b1, and b2. With a linear design, these map into bin -1 of the UCD91XX coefficient table, with all other table bins calculated based on these coefficients. The table shown in the preceding section is an example of a linear table. In this example:

Coefficients:	b0 = 1,077	b1 = -2,051	b2 = 977
Bin -1:	N = 1,077	N-1 = -2,051	N-2 = 977
Bin 8:	N = -8*b0	N-1 = -8*b1	N-2 = -8*b2
	N = -8,616	N-1 = 16,408	N-2 = -7,817

The *Table Edit* tab provides a way to make one or more rows in the generated coefficient table non-linear. You do this by entering a set of PID gains for a particular row, overriding the calculated linear bin. Note that while the PID gains are entered in continuous terms in the compensator tab, they are entered in **discrete** form here.

In the following example, bins 2 through 4 and -2 through -4 have been made non-linear:



Overrides

Calculated Coefficients: b_0: 1,077 b_1: -2,051 b_2: 977

☑ Symmetric overrides. E.g. entering gains for bin 2 also enters negated gains in bin -2

Bin	N	N-1	N-2	Click Checkbox to Override a Bin Using Gains			
8	-8,616	16,408	-7,817	☐	K_P: 98.3	K_I: 1.6	K_D: 977.1
7	-7,539	14,357	-6,840	☐	K_P: 98.3	K_I: 1.6	K_D: 977.1
6	-6,462	12,306	-5,863	☐	K_P: 98.3	K_I: 1.6	K_D: 977.2
5	-5,385	10,255	-4,886	☐	K_P: 98.2	K_I: 1.6	K_D: 977.2
4	-6,804	10,800	-4,020	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
3	-5,103	8,100	-3,015	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
2	-3,210	5,400	-2,210	☑	K_P: 495.0	K_I: 5.0	K_D: 1,105.0
1	-1,077	2,051	-977	☐	K_P: 98.5	K_I: 1.5	K_D: 977.0
0	0	0	0	☐	K_P: N/A	K_I: N/A	K_D: N/A
-1	1,077	-2,051	977	☐	K_P: 98.5	K_I: 1.5	K_D: 977.0
-2	3,210	-5,400	2,210	☑	K_P: 495.0	K_I: 5.0	K_D: 1,105.0
-3	5,103	-8,100	3,015	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
-4	6,804	-10,800	4,020	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
-5	5,385	-10,255	4,886	☐	K_P: 98.2	K_I: 1.6	K_D: 977.2
-6	6,462	-12,306	5,863	☐	K_P: 98.3	K_I: 1.6	K_D: 977.2
-7	7,539	-14,357	6,840	☐	K_P: 98.3	K_I: 1.6	K_D: 977.1
-8	8,616	-16,408	7,817	☐	K_P: 98.3	K_I: 1.6	K_D: 977.1

❶ The calculated b0, b1, and b2 are shown here. These can no be edited. They will be updated whenever the design is recalculated.

❷ To override a bin, click it's checkbox and enter a new discrete Kp, Ki, and/or Kd. Any non-linear overrides you define will be "sticky" and will be maintained even after the design is recalculated. Overrides are also saved to design preferences and project files.

❸ As you edit the PID gains, the new values for the row will be updated. The N, N-1, and N-2 columns always represent the value that will be written to the device when you click the *Write to Hardware* button.

❹ By default, overrides are symmetrical. If you override bin 4, bin -4 will also be overridden, as shown in this example. If you would like to enter different overrides for a negative bin, uncheck this checkbox.

❺ Clicking this button is equivalent to unchecking every override checkbox: it will discard any overrides present and make the entire table linear.

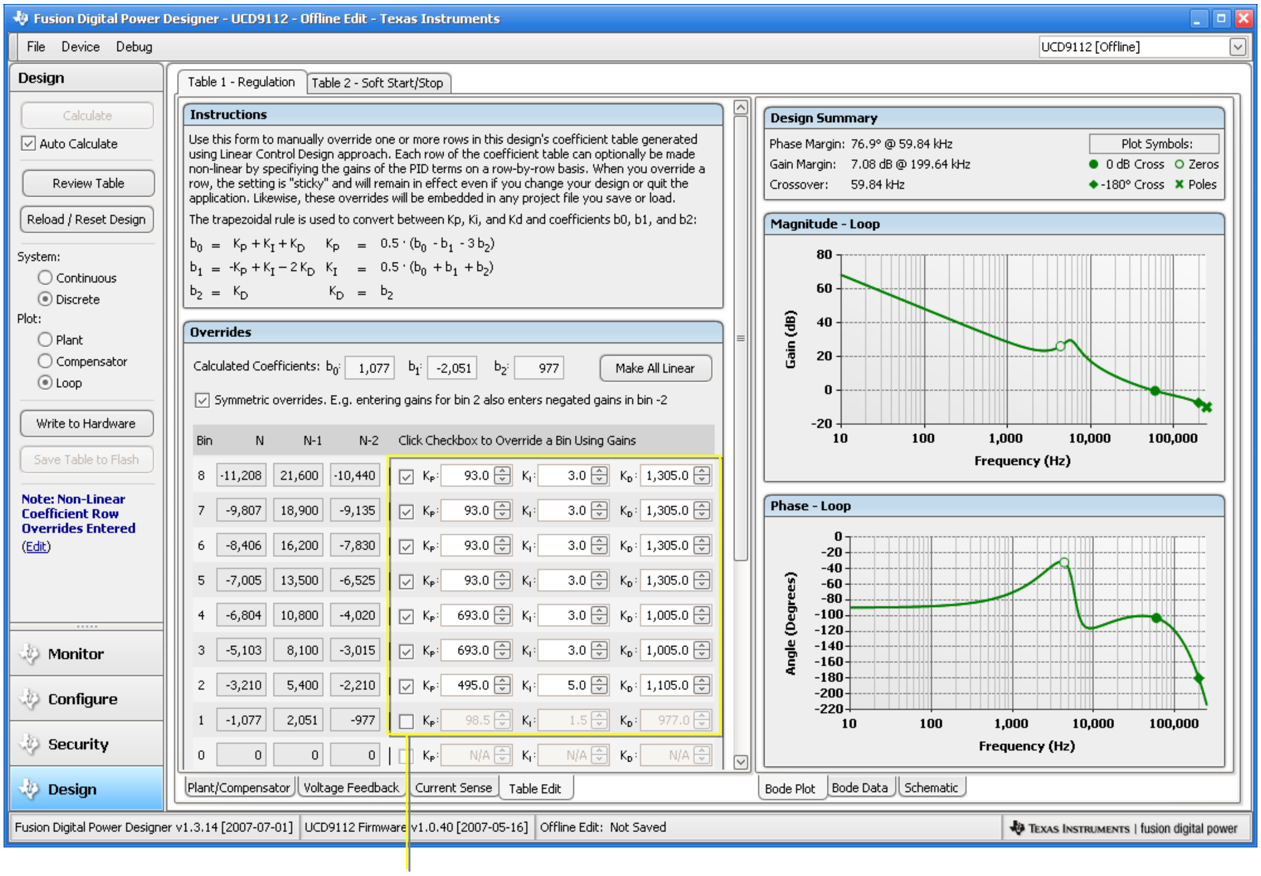
The trapezoidal rule for integration is used to derive the relationship between Kp, Ki, and Kd and b0, b1, and b2:

$$b_0 = K_P + K_I + K_D \qquad K_P = \frac{b_0 - b_1 - 3b_2}{2}$$

$$b_1 = -K_P + K_I - 2K_D \qquad K_I = \frac{b_0 + b_1 + b_2}{2}$$

$$b_2 = K_D \qquad K_D = b_2$$

When the GUI loads a compensator design from a hardware coefficient table – such as when you click *Reload/Reset Design* or when the GUI is first run – a set of bin overrides is created based on a comparison between bin -1 and every other bin. For example, on the factory UCD9112 EVM, table 1 is symmetrically non-linear while table 2 is linear. The default compensator design for table 1 will automatically show a set of table overrides to reflect this:



Note: Non-Linear Coefficient Row Overrides Entered (Edit)

Instructions

Use this form to manually override one or more rows in this design's coefficient table generated using Linear Control Design approach. Each row of the coefficient table can optionally be made non-linear by specifiying the gains of the PID terms on a row-by-row basis. When you override a row, the setting is "sticky" and will remain in effect even if you change your design or quit the application. Likewise, these overrides will be embedded in any project file you save or load.

The trapezoidal rule is used to convert between Kp, Ki, and Kd and coefficients b0, b1, and b2:

$$b_0 = K_P + K_I + K_D \qquad K_P = 0.5 \cdot (b_0 - b_1 - 3\,b_2)$$

$$b_1 = -K_P + K_I - 2\,K_D \qquad K_I = 0.5 \cdot (b_0 + b_1 + b_2)$$

$$b_2 = K_D \qquad K_D = b_2$$

Overrides

Calculated Coefficients: b_0: 1,077 b_1: -2,051 b_2: 977

☑ Symmetric overrides. E.g. entering gains for bin 2 also enters negated gains in bin -2

Bin	N	N-1	N-2	Click Checkbox to Override a Bin Using Gains			
8	-11,208	21,600	-10,440	☑	K_P: 93.0	K_I: 3.0	K_D: 1,305.0
7	-9,807	18,900	-9,135	☑	K_P: 93.0	K_I: 3.0	K_D: 1,305.0
6	-8,406	16,200	-7,830	☑	K_P: 93.0	K_I: 3.0	K_D: 1,305.0
5	-7,005	13,500	-6,525	☑	K_P: 93.0	K_I: 3.0	K_D: 1,305.0
4	-6,804	10,800	-4,020	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
3	-5,103	8,100	-3,015	☑	K_P: 693.0	K_I: 3.0	K_D: 1,005.0
2	-3,210	5,400	-2,210	☑	K_P: 495.0	K_I: 5.0	K_D: 1,105.0
1	-1,077	2,051	-977	□	K_P: 98.5	K_I: 1.5	K_D: 977.0
0	0	0	0	□	K_P: N/A	K_I: N/A	K_D: N/A

Design Summary

Phase Margin: 76.9° @ 59.84 kHz
Gain Margin: 7.08 dB @ 199.64 kHz
Crossover: 59.84 kHz

Plot Symbols:
● 0 dB Cross ○ Zeros
◆ -180° Cross ✖ Poles

Fusion Digital Power Designer v1.3.14 [2007-07-01] | UCD9112 Firmware v1.0.40 [2007-05-16] | Offline Edit: Not Saved

Non-Linear Symmetrical Overrides

As the design is recalculated, these overrides will stay in effect. Note that bin 1/-1 is not overridden: this will be updated as you change your design. This allows the steady state behavior of the CLA and the power supply output to be controlled by the designed coefficients in +1/-1 bins. The entries in the other bins (2~8) are modified to control the transient behavior of the CLA and, hence, that of the power supply output.

Thus the GUI allows you to tune the compensator for both the steady state and transient operation by generating a non-linear controller and then maintain these settings in your design preferences or project file.

8.12 UCD92XX Design Errata

8.12.1 UCD92XX Loop Response Components

Power Stage = Gstage

Controller = Gcla1 * Gcla2 * Gdelay1 * Gdelay2 * Gdiv * Keadc * Kpwm * Kafe * Knonlinear

Loop = Power Stage * Controller

Power Stage

Gstage

Transfer function for the power stage circuit consisting of the FET switches, LC output filter and load.

$$G_{plant} = \frac{V_{in} \cdot Z_{eq}(s)}{R + Ls + Z_{eq}(s)}$$

$$Z_{eq}(s) = \frac{Z_c(s) \cdot R_1}{Z_c(s) + R_1}, \quad z_C(s) = \frac{Z_{C1} \cdot Z_{C2} \cdots}{Z_{C1} + Z_{C2} + \cdots}$$

$$Z_{Cn} = ESR_{Cn} + s \cdot ESL_{Cn} + \frac{1}{s \cdot C_n}$$

Compensator

Gcla1(z)

Transfer function of the first order CLA stage.

$$G_{cla1}(z) = 32 \cdot \frac{B_{01}z^2 + B_{11}z + B_{21}}{z^2 + A_{11}z + A_{21}}$$

Gcla2(z)

Transfer function of the second order CLA stage.

$$G_{cla2}(z) = \frac{z + B_{12}}{z + A_{12}}$$

Gdelay1(s)

Phase shift due to the delay due to the error ADC and the CLA.

$$G_{delay1}(s) = e^{-s(TsampTrig - Thold)}$$

$$T_{sample\_trig} = EADC\_SAMPLE\_TRIGGER, \quad T_{hold} = 80ns$$

Gdelay2(s)

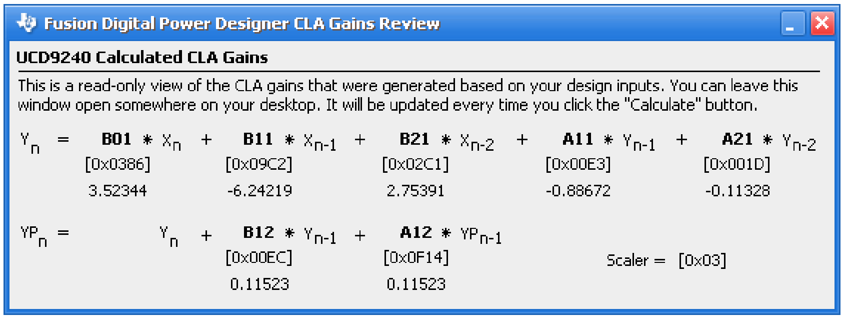
Phase shift due to on-time pulse width and the phase shift between multiple power stages.

$$G_{delay2}(s) = e^{-s(T_{duty} + T_{phase})}, T_{duty} = \frac{Vo}{Vin} T_s, T_{phase} = \frac{N_{phases} - 1}{2 \cdot N_{phases}} T_s$$

Gdiv	Transfer function for the VOUT sense divider and its capacitive filter network. $G_{div} = \frac{v_{sense}}{v_{out}} = \frac{R_1 R_2 C_Z s + R_2}{R_1 R_2 (C_Z + C_P) s + R_1 + R_2}$
Keadc	Gain of the 6-bit Error ADC. It has a value of 125 LSBs/V. The next effect is that during regulation mode the resolution of the error ADC is 1.0 mV.
Kpwm	DPWM modulator gain. This accounts for the bit resolution of the DPWM output. $K_{pwm} = 2^{-15}$ seconds/LSB
Kafe	Analog front-end amplifier gain. This is user adjustable in the design tool and stored on a per-rail, per-bank basis.

Knonlinear	Gain for a near zero error signal through the nonlinear gain block between the EADC and control law accelerator (CLA). To ensure stability for the system, the gain that is used when calculating loop response is the gain that would be selected when the error voltage value is greater than or equal to zero. For example:
	gain[4] = 6
	limit[3] = 12
	gain[3] = 5.5
	limit[2] = 8
	gain[2] = 4.25
	limit[1] = 3
	gain[1] = 4.0 ← **nominal gain is 4.0**
	limit[0] = -5
	gain[0] = 4.5

8.12.2 CLA Gains Review Form Example



UCD9240 Calculated CLA Gains

This is a read-only view of the CLA gains that were generated based on your design inputs. You can leave this window open somewhere on your desktop. It will be updated every time you click the "Calculate" button.

```
Yn  =    B01 * Xn   +   B11 * Xn-1   +   B21 * Xn-2   +   A11 * Yn-1   +   A21 * Yn-2
        [0x0386]       [0x09C2]         [0x02C1]         [0x00E3]         [0x001D]
        3.52344        -6.24219         2.75391          -0.88672         -0.11328

YPn =           Yn  +   B12 * Yn-1   +   A12 * YPn-1
                       [0x00EC]         [0x0F14]                  Scaler =  [0x03]
                       0.11523          0.11523
```

- The coefficients are read only in this view.
- The form updates when the design is recalculated.
- If the design is not stable or produces a calculation error, this form will show blank cells in all bins. You will not be able to write the gains to hardware until you remedy your design.
- The calculated floating point coefficient term is shown below the fixed point version. The fixed point terms use hex notation.

- The scaler used to convert the floating point gains into fixed point is also shown.

8.12.3 Floating Point CLA Gains Used for Loop Response

The floating point coefficients displayed in the CLA review form shown above are based on the fixed point values that are written to the device’s flash memory if you click the *Write to Hardware* button. Thus the CLA gains take into account rounding errors due to the conversion from floating point to fixed point using the scalar shown in the form. These “rounded” coefficients are also used to calculate the loop response of the system. The loop response therefore more accurately simulates the power supply performance.

9 PROJECT FILES

9.1 Project File Overview

A Fusion Digital Power Designer project file holds a snapshot of a device's PMBus parameters and the current design input parameters from the Design task. Both read-only and read-write PMBus parameters are saved in the project file.

Some of the uses of project files include:

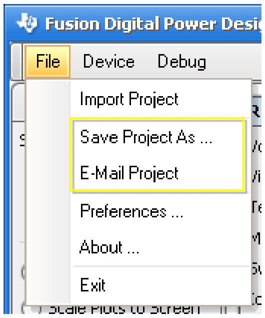
- You can experiment with different device configurations, and easily revert back to an older configuration by importing all or part of the project file's configuration.
- You can exchange a device configuration and/or design with a co-worker, partner, or Texas Instruments support personnel.
- You can review your device configuration or work on it's design offline, without the need for the EVM to be connected to your PC, through the GUI's offline mode. See Section 10 for more information.
- You can create scripts to extract important parameters from a project file to automate testing or other activities. The project file uses the Extensible Markup Language[5] (XML) format, a richly structured text-based data exchange language.

There is an important distinction between CLA hardware coefficients and design inputs. As described in Section 8, the designs you are working on in the Design task do not necessarily match the coefficients in hardware. While there may be a correlation if you have written the design-generated coefficients to hardware, this is a loose association. You can edit coefficients directly in the Configure task, bypassing the design process entirely. Or you can edit your design and chose not to write out the generated coefficients to hardware.

Thus, the project file contains separate entries for design inputs – for every output rail and every CLA table/bank on an output rail – and separate entries for a device's actual CLA tables/banks on each output rail.

9.2 Saving Project Files

The File menu is used to save a project file to your hard drive, using the *Save Project As …* item:

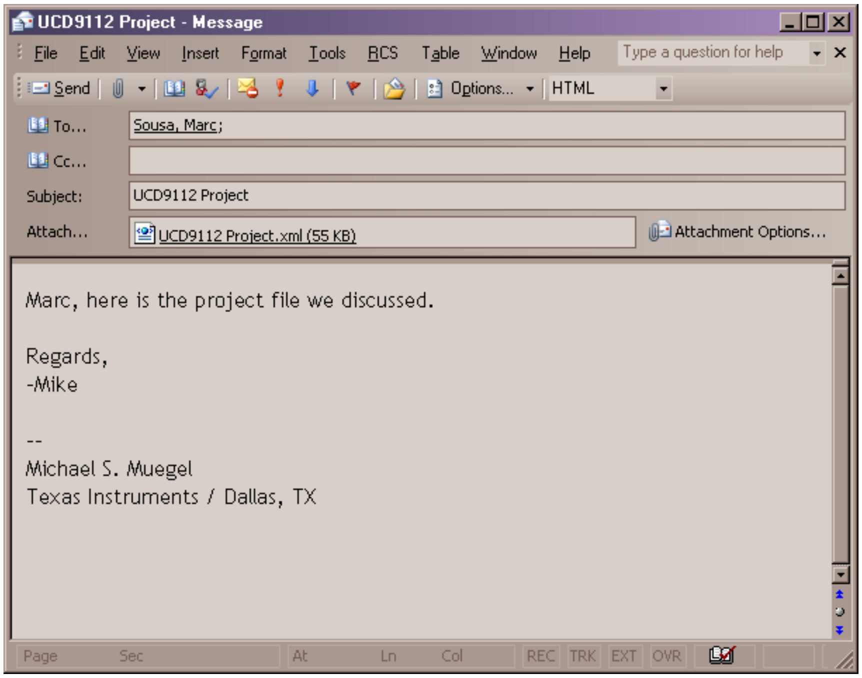


This will bring up a standard Windows save dialog box. By default, the device's part number will be part of the filename, with the extension xml. For example, "UCD9112 Project.xml".

When saving, everything is saved: all PMBus configurable parameters and your current design input parameters from the Design task. If you have never visited the Configure task in this session, the GUI will first need to read all of the device's parameters.

Remember that saving a project file only takes a snapshot in time. If you change your configuration through the GUI later on, any project file you previously saved is not updated.

The *E-Mail Project* feature is a time saver if you intend to e-mail the project file and don't really need a copy of the file on your PC (other than your e-mail outbox). It will create a new message in your e-mail client, insert a default subject, and create/attach the project file to the message.


UCD9112 Project - Message
File Edit View Insert Format Tools RCS Table Window Help
Type a question for help
Send
Options...
HTML
Attachment Options...
Page Sec At Ln Col REC TRK EXT OVR

To...: Sousa, Marc;
Cc...:
Subject: UCD9112 Project
Attach...: UCD9112 Project.xml (55 KB)

Marc, here is the project file we discussed.

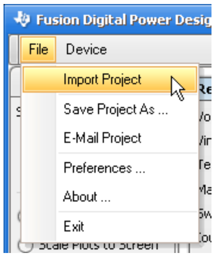
Regards,
-Mike

--
Michael S. Muegel
Texas Instruments / Dallas, TX

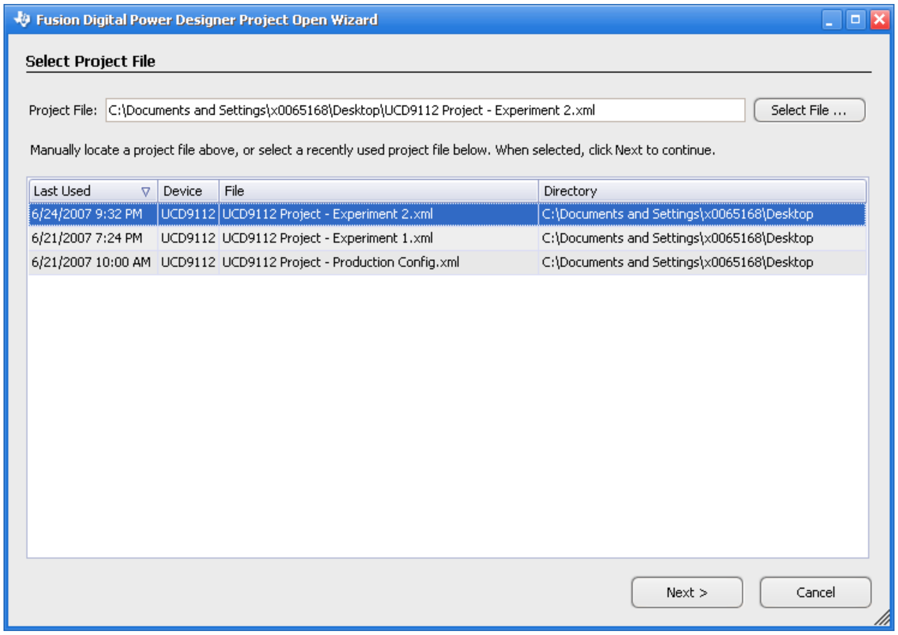
Figure 18 E-Mail Project Sample, Microsoft Outlook

9.3 Importing Project Files

In online mode, project files are not really opened so much as a section of the project file is imported. Select *Import Project* from the File menu:



This will launch the Import Project Wizard form in a new window:



Select Project File

Project File: C:\Documents and Settings\x0065168\Desktop\UCD9112 Project - Experiment 2.xml

Manually locate a project file above, or select a recently used project file below. When selected, click Next to continue.

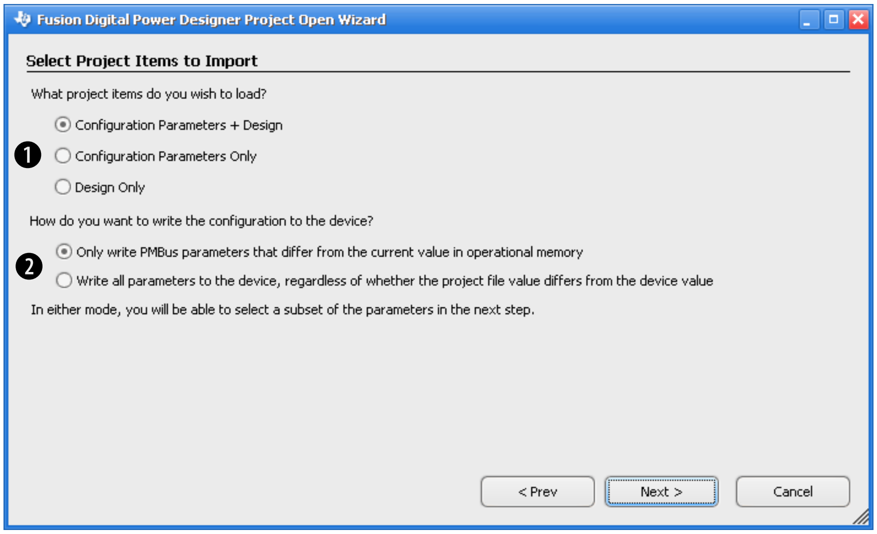
Last Used ▽	Device	File	Directory
6/24/2007 9:32 PM	UCD9112	UCD9112 Project - Experiment 2.xml	C:\Documents and Settings\x0065168\Desktop
6/21/2007 7:24 PM	UCD9112	UCD9112 Project - Experiment 1.xml	C:\Documents and Settings\x0065168\Desktop
6/21/2007 10:00 AM	UCD9112	UCD9112 Project - Production Config.xml	C:\Documents and Settings\x0065168\Desktop

Figure 19 Import Project Wizard, Select File on UCD9112

The GUI keeps track of your 25 most recent projects you either opened or saved. In online mode, the GUI will only show projects for a device that matches the current device you have connected. For example, in the example shown in Figure 19, only recent UCD9112 projects are shown because a UCD9112 device is attached. Files are also only shown if they can be accessed. If you opened a project on a file server previously and are now disconnected from the file server, the project file will not appear in this list. But if you later reconnect to the file server and run the import wizard, the file will be listed.

If one of the recent projects is what you want to import, click the file's entry in the grid. Or, click the *Select File …* button to bring up a file open dialog box and find the file on your PC or server.

Once you have selected the project file you want to import, click the *Next* button to bring up project item selection page of the wizard:



Select Project Items to Import

What project items do you wish to load?

● Configuration Parameters + Design

○ Configuration Parameters Only

○ Design Only

How do you want to write the configuration to the device?

● Only write PMBus parameters that differ from the current value in operational memory

○ Write all parameters to the device, regardless of whether the project file value differs from the device value

In either mode, you will be able to select a subset of the parameters in the next step.

Figure 20 Import Project Wizard, Item Selection

This form is used to broadly define what items to import from the selected project file (❶):

- PMBus configuration and design parameters
- PMBus configuration only
- Design parameters only

PMBus configuration means all PMBus-configurable and writable parameters on the device with the exception of the device's security password. While the device's security bitmask can be imported, the security password can not be imported and must be set via the Security task.

Design input parameters can also be imported. This means plant design parameters for each output rail and compensator parameters for each CLA bank/table on each output rail.

The second section of the form selects how to manage PMBus configuration import (❷). Please keep the following important points in mind when importing a PMBus configuration:

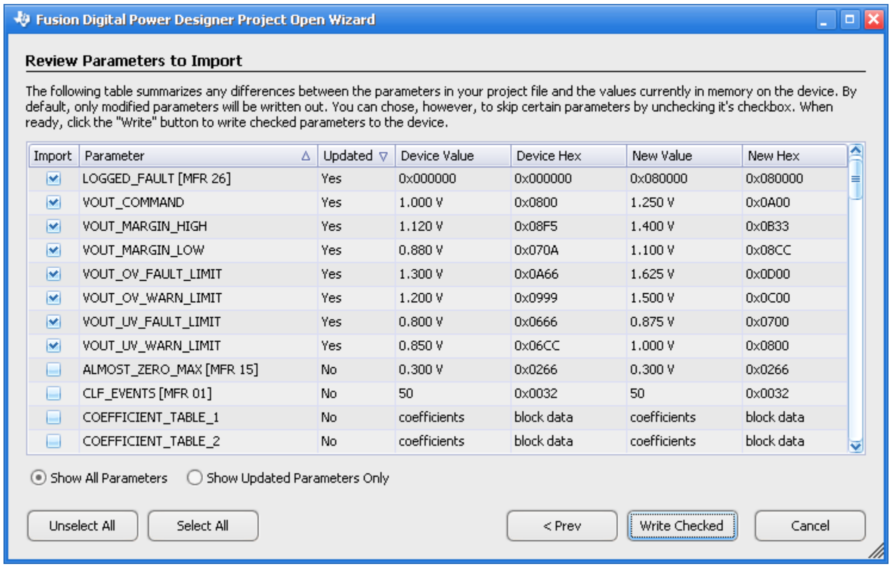
1. On the page after this one, you will have the opportunity to review what parameters will be imported, and can cancel the import or select a sub-set of parameters to import.
2. When a configuration parameter is imported, the GUI writes the imported value directly to the device. For most parameters this means only the device's RAM is updated. But some parameters, as outlined in section 6.2, write directly to flash memory. The wizard log will inform you whether a parameter was written to RAM or flash.
3. If you want to commit your device's new operational memory (RAM) configuration to flash, you will need to click the *Store RAM to Flash* button in the Configure task.

You have two options when importing PMBus configuration:

1. Only write PMBus parameters that differ from the current value in operational memory. This is the default. This mode basically does a "diff" on the project and device configuration. It selects only those parameters that differ to be written. This mode may start a little slower but will write much more quickly. If the GUI has never read all parameters on the device – for example, you have not clicked the Configure task during this GUI session – it will first need to cache all parameters on the device.
2. Write all parameters to the device, regardless of whether the project file value differs from the device value. The GUI does not need to read the current values from the device in this case. This mode starts quickly but takes longer to run because every single parameter is written, even if the imported parameter does not differ from the target device parameter.

There is normally no need to use mode (2).

In both modes, on the next page you can review the parameters which will be written to the device. In the following example, option 2 was selected above:



Fusion Digital Power Designer Project Open Wizard

Review Parameters to Import

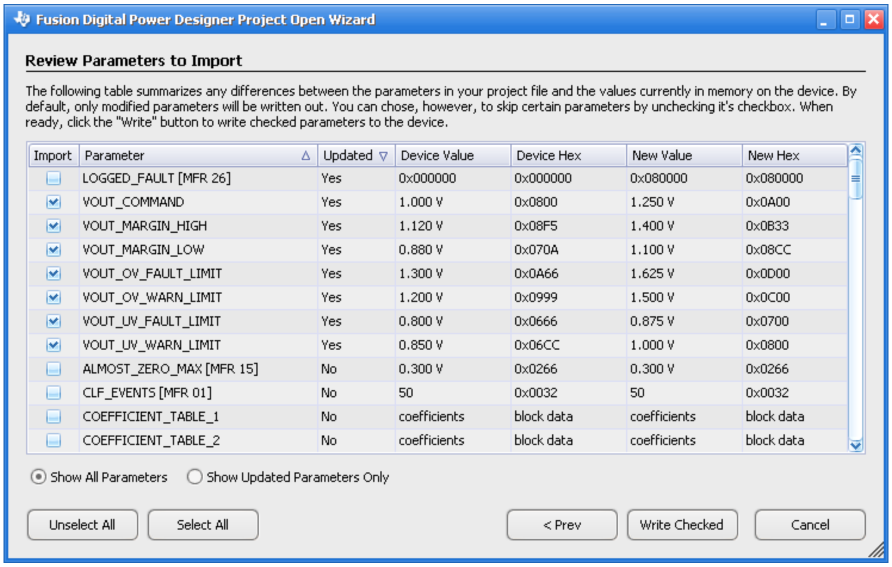
The following table summarizes any differences between the parameters in your project file and the values currently in memory on the device. By default, only modified parameters will be written out. You can chose, however, to skip certain parameters by unchecking it's checkbox. When ready, click the "Write" button to write checked parameters to the device.

Import	Parameter	Updated	Device Value	Device Hex	New Value	New Hex
☑	LOGGED_FAULT [MFR 26]	Yes	0x000000	0x000000	0x080000	0x080000
☑	VOUT_COMMAND	Yes	1.000 V	0x0800	1.250 V	0x0A00
☑	VOUT_MARGIN_HIGH	Yes	1.120 V	0x08F5	1.400 V	0x0B33
☑	VOUT_MARGIN_LOW	Yes	0.880 V	0x070A	1.100 V	0x08CC
☑	VOUT_OV_FAULT_LIMIT	Yes	1.300 V	0x0A66	1.625 V	0x0D00
☑	VOUT_OV_WARN_LIMIT	Yes	1.200 V	0x0999	1.500 V	0x0C00
☑	VOUT_UV_FAULT_LIMIT	Yes	0.800 V	0x0666	0.875 V	0x0700
☑	VOUT_UV_WARN_LIMIT	Yes	0.850 V	0x06CC	1.000 V	0x0800
□	ALMOST_ZERO_MAX [MFR 15]	No	0.300 V	0x0266	0.300 V	0x0266
□	CLF_EVENTS [MFR 01]	No	50	0x0032	50	0x0032
□	COEFFICIENT_TABLE_1	No	coefficients	block data	coefficients	block data
□	COEFFICIENT_TABLE_2	No	coefficients	block data	coefficients	block data

● Show All Parameters ○ Show Updated Parameters Only

Figure 21 Project Import, Review Parameters Form on UCD9112

In this example the device has a Vout set point of 1.0V. Vout margins and limits are set accordingly. The project file that is being imported has a set point of 1.25V, again with margins and limits are set accordingly. The GUI detected these differences and selected the project values to be written. Another parameter, LOGGED_FAULT, is checked because there was a logged fault present at the time the project file was saved. We will uncheck this box and skip over LOGGED_FAULT:



Fusion Digital Power Designer Project Open Wizard

Review Parameters to Import

The following table summarizes any differences between the parameters in your project file and the values currently in memory on the device. By default, only modified parameters will be written out. You can chose, however, to skip certain parameters by unchecking it's checkbox. When ready, click the "Write" button to write checked parameters to the device.

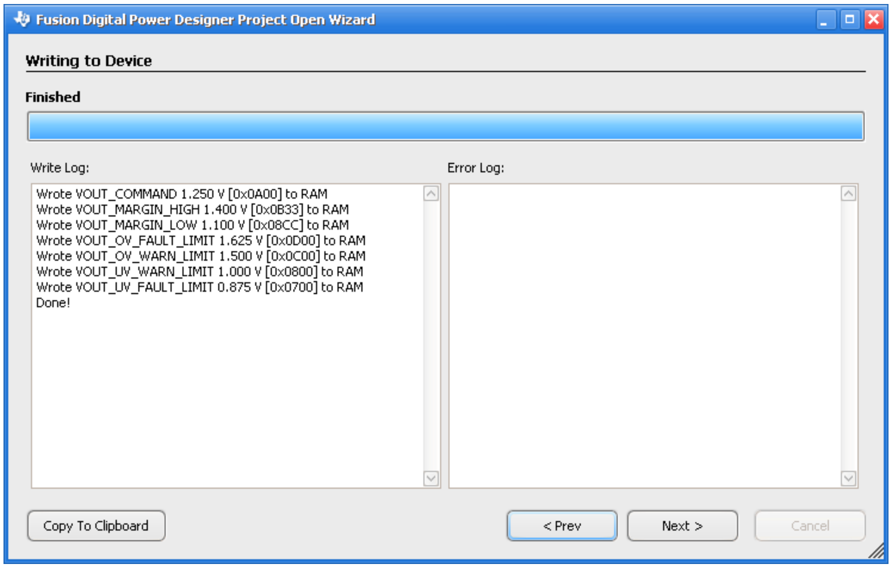
Import	Parameter	Updated	Device Value	Device Hex	New Value	New Hex
□	LOGGED_FAULT [MFR 26]	Yes	0x000000	0x000000	0x080000	0x080000
☑	VOUT_COMMAND	Yes	1.000 V	0x0800	1.250 V	0x0A00
☑	VOUT_MARGIN_HIGH	Yes	1.120 V	0x08F5	1.400 V	0x0B33
☑	VOUT_MARGIN_LOW	Yes	0.880 V	0x070A	1.100 V	0x08CC
☑	VOUT_OV_FAULT_LIMIT	Yes	1.300 V	0x0A66	1.625 V	0x0D00
☑	VOUT_OV_WARN_LIMIT	Yes	1.200 V	0x0999	1.500 V	0x0C00
☑	VOUT_UV_FAULT_LIMIT	Yes	0.800 V	0x0666	0.875 V	0x0700
☑	VOUT_UV_WARN_LIMIT	Yes	0.850 V	0x06CC	1.000 V	0x0800
□	ALMOST_ZERO_MAX [MFR 15]	No	0.300 V	0x0266	0.300 V	0x0266
□	CLF_EVENTS [MFR 01]	No	50	0x0032	50	0x0032
□	COEFFICIENT_TABLE_1	No	coefficients	block data	coefficients	block data
□	COEFFICIENT_TABLE_2	No	coefficients	block data	coefficients	block data

● Show All Parameters ○ Show Updated Parameters Only

Figure 22 Project Import, Review Parameters Form, LOGGED_FAULT Unchecked

Note the Unselect All and Select All buttons. These quickly change the checked status of all parameters. And you can always use the *Prev* button to go back and repeat a step.

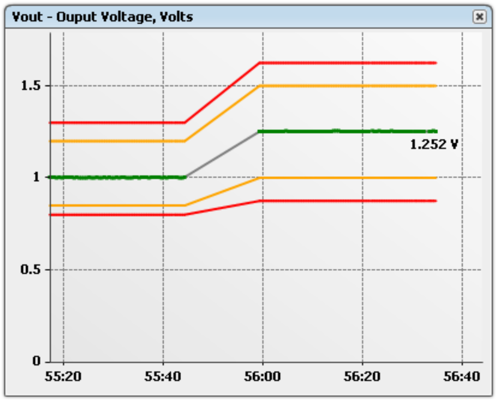
Once you are ready to write the checked parameters to hardware, click the *Write Checked* button. The status of each write will be shown in real-time as they occur:



```
Wrote VOUT_COMMAND 1.250 V [0x0A00] to RAM
Wrote VOUT_MARGIN_HIGH 1.400 V [0x0B33] to RAM
Wrote VOUT_MARGIN_LOW 1.100 V [0x08CC] to RAM
Wrote VOUT_OV_FAULT_LIMIT 1.625 V [0x0D00] to RAM
Wrote VOUT_OV_WARN_LIMIT 1.500 V [0x0C00] to RAM
Wrote VOUT_UV_WARN_LIMIT 1.000 V [0x0800] to RAM
Wrote VOUT_UV_FAULT_LIMIT 0.875 V [0x0700] to RAM
Done!
```

Figure 23 Project Import, PMBus Configuration Write Log

On the Monitor task, we see our changes have taken affect in hardware:

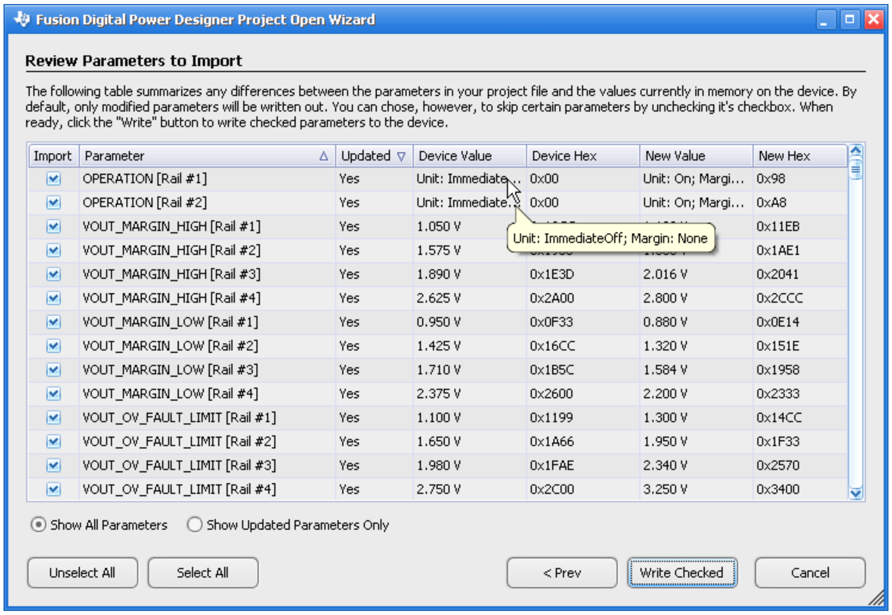


Device writes are ordered to ensure that any global configuration parameters are written first. Writes are ordered as follows:

1. PHASE_INFO is written 1st (92XX only)
2. VOUT_MAX 2nd
3. All other parameters are written
4. ON_OFF_CONFIG is written 2nd to last
5. OPERATION is written last

Within (2)-(5), writes are ordered by rail number (PAGE, 92XX only). Within (3), writes are ordered by PHASE and then alphabetically by parameter name. This order does not correspond to the order shown in the parameter review form. Parameters are sorted alphabetically there.

On a device with multiple output rails, paged parameters will have unique entries for each rail. The following screen shot shows an example where OPERATION differs for two output rails and Vout margins and limits are different for all four output rails on a UCD9240:



Review Parameters to Import

The following table summarizes any differences between the parameters in your project file and the values currently in memory on the device. By default, only modified parameters will be written out. You can chose, however, to skip certain parameters by unchecking it's checkbox. When ready, click the "Write" button to write checked parameters to the device.

Import	Parameter △	Updated ▽	Device Value	Device Hex	New Value	New Hex
☑	OPERATION [Rail #1]	Yes	Unit: Immediate...	0x00	Unit: On; Margi...	0x98
☑	OPERATION [Rail #2]	Yes	Unit: Immediate...	0x00	Unit: On; Margi...	0xA8
☑	VOUT_MARGIN_HIGH [Rail #1]	Yes	1.050 V	[illegible]	[illegible]	0x11EB
☑	VOUT_MARGIN_HIGH [Rail #2]	Yes	1.575 V	[illegible]	[illegible]	0x1AE1
☑	VOUT_MARGIN_HIGH [Rail #3]	Yes	1.890 V	0x1E3D	2.016 V	0x2041
☑	VOUT_MARGIN_HIGH [Rail #4]	Yes	2.625 V	0x2A00	2.800 V	0x2CCC
☑	VOUT_MARGIN_LOW [Rail #1]	Yes	0.950 V	0x0F33	0.880 V	0x0E14
☑	VOUT_MARGIN_LOW [Rail #2]	Yes	1.425 V	0x16CC	1.320 V	0x151E
☑	VOUT_MARGIN_LOW [Rail #3]	Yes	1.710 V	0x1B5C	1.584 V	0x1958
☑	VOUT_MARGIN_LOW [Rail #4]	Yes	2.375 V	0x2600	2.200 V	0x2333
☑	VOUT_OV_FAULT_LIMIT [Rail #1]	Yes	1.100 V	0x1199	1.300 V	0x14CC
☑	VOUT_OV_FAULT_LIMIT [Rail #2]	Yes	1.650 V	0x1A66	1.950 V	0x1F33
☑	VOUT_OV_FAULT_LIMIT [Rail #3]	Yes	1.980 V	0x1FAE	2.340 V	0x2570
☑	VOUT_OV_FAULT_LIMIT [Rail #4]	Yes	2.750 V	0x2C00	3.250 V	0x3400

Unit: ImmediateOff; Margin: None

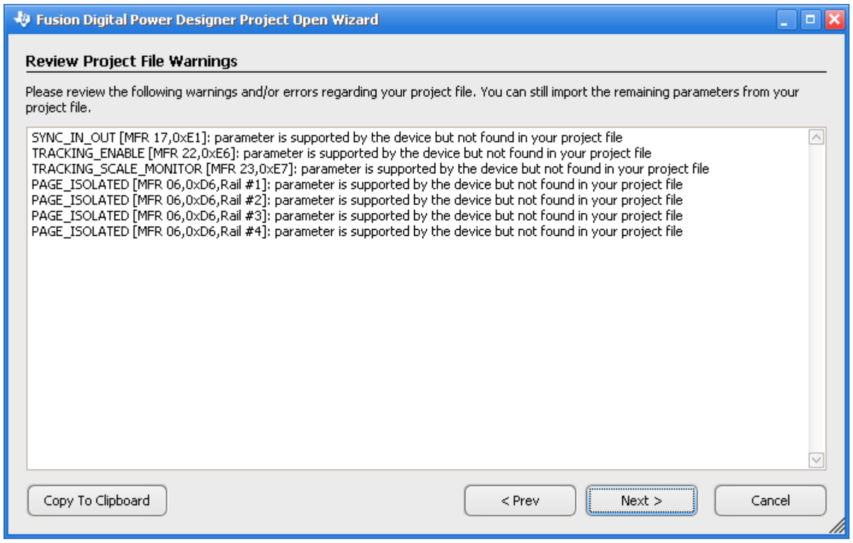
● Show All Parameters ○ Show Updated Parameters Only

Figure 24 Project Import, Review Parameters Form, UCD9240

This example also shows how you can move your cursor over a cell to view the contents of a clipped cell. The wizard form can also be resized.

9.3.1 Configuration Import Warnings

The wizard reviews your project file for inconsistencies. The file is checked against the expected PMBus configuration for the device and firmware version you are connected to. If any inconsistencies are found, you will see a warning page similar to the following:



Review Project File Warnings

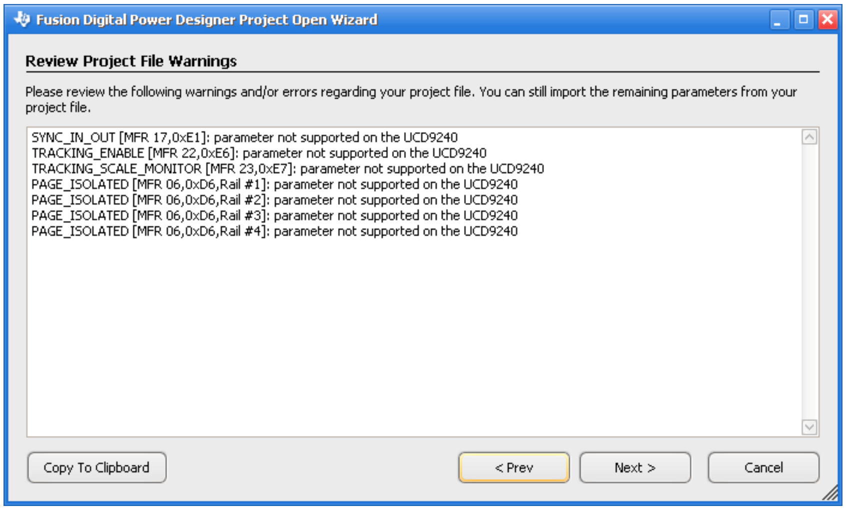
Please review the following warnings and/or errors regarding your project file. You can still import the remaining parameters from your project file.

```
SYNC_IN_OUT [MFR 17,0xE1]: parameter is supported by the device but not found in your project file
TRACKING_ENABLE [MFR 22,0xE6]: parameter is supported by the device but not found in your project file
TRACKING_SCALE_MONITOR [MFR 23,0xE7]: parameter is supported by the device but not found in your project file
PAGE_ISOLATED [MFR 06,0xD6,Rail #1]: parameter is supported by the device but not found in your project file
PAGE_ISOLATED [MFR 06,0xD6,Rail #2]: parameter is supported by the device but not found in your project file
PAGE_ISOLATED [MFR 06,0xD6,Rail #3]: parameter is supported by the device but not found in your project file
PAGE_ISOLATED [MFR 06,0xD6,Rail #4]: parameter is supported by the device but not found in your project file
```

Figure 25 Project Import, Configuration Warnings Example 1

This example, from a UCD9240, shows warnings that can result from reading a project file that was saved from an early, pre-production version of firmware and then later imported into the same device with newer firmware loaded. The GUI detected that four parameters – one paged – are supported by the attached device but not found in the project file being imported.

The opposite scenario is also checked for. If your project file contains parameters that are not supported by the firmware you have loaded in the device, you will also get warnings. For example:



Review Project File Warnings

Please review the following warnings and/or errors regarding your project file. You can still import the remaining parameters from your project file.

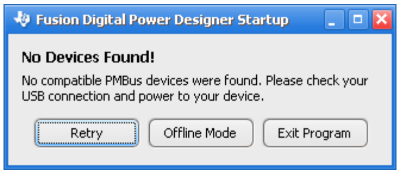
```
SYNC_IN_OUT [MFR 17,0xE1]: parameter not supported on the UCD9240
TRACKING_ENABLE [MFR 22,0xE6]: parameter not supported on the UCD9240
TRACKING_SCALE_MONITOR [MFR 23,0xE7]: parameter not supported on the UCD9240
PAGE_ISOLATED [MFR 06,0xD6,Rail #1]: parameter not supported on the UCD9240
PAGE_ISOLATED [MFR 06,0xD6,Rail #2]: parameter not supported on the UCD9240
PAGE_ISOLATED [MFR 06,0xD6,Rail #3]: parameter not supported on the UCD9240
PAGE_ISOLATED [MFR 06,0xD6,Rail #4]: parameter not supported on the UCD9240
```

Figure 26 Project Import, Configuration Warnings Example 2

10 OFFLINE MODE

Offline mode is a special disconnected operational mode of the GUI. You can review your device configuration or work on its design offline, without the need for the device to be connected to your PC. There are two ways you can start the GUI in offline mode:

1. Launch the GUI's without a device attached to the USB adapter or with the device powered down. The GUI will show this form:



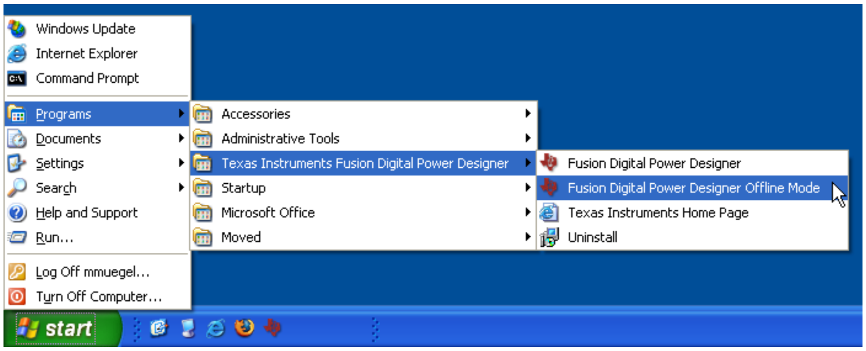
Fusion Digital Power Designer Startup

No Devices Found!

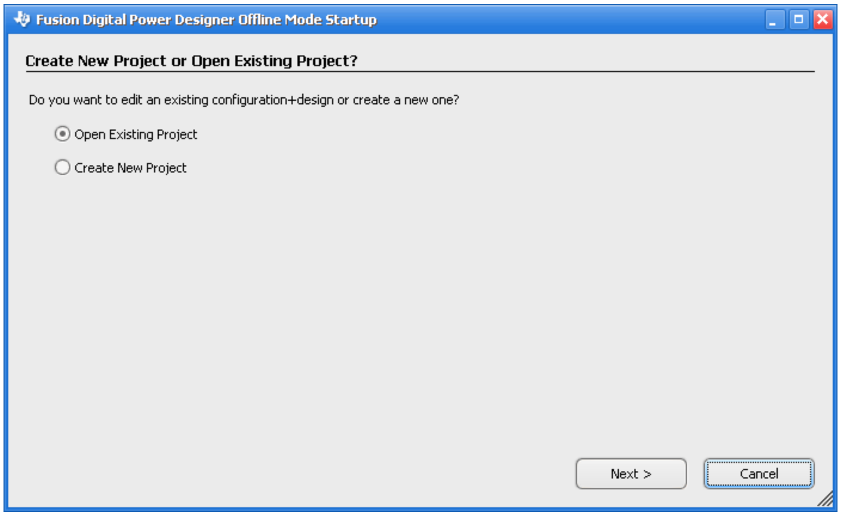
No compatible PMBus devices were found. Please check your USB connection and power to your device.

   Just click the *Offline Mode* button.

2. Launch the special offline mode shortcut in the GUI's Start Menu:



Offline mode launches a wizard similar to the online project import wizard described in Section 9. You have two choices: open an existing project or create a new project:



Fusion Digital Power Designer Offline Mode Startup

Create New Project or Open Existing Project?

Do you want to edit an existing configuration+design or create a new one?

● Open Existing Project

○ Create New Project

Figure 27 Offline Mode Startup Wizard

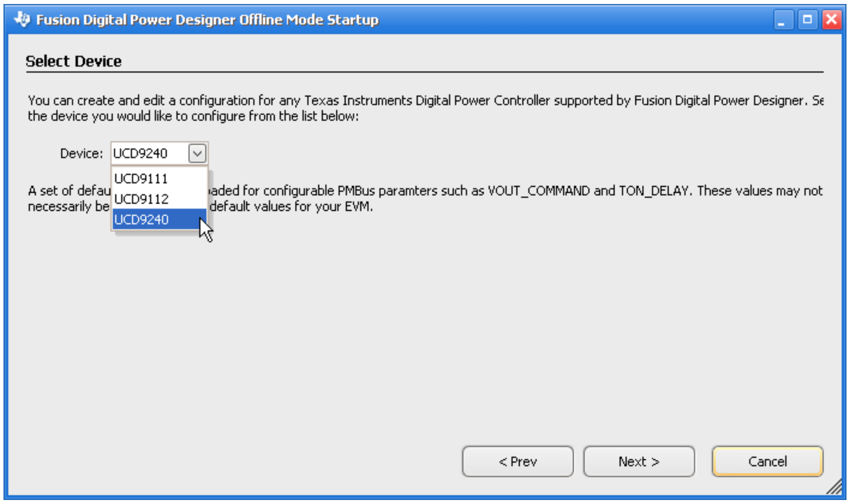
10.1 Open Existing Project

Select this mode to review or edit a project file you or an associate previously saved using *File->Save Project As*. Once you click *Next*, the project file picker is displayed, from which you can select a project file. Remember that project files should use the xml extension. The GUI will automatically detect the type of device that the project file contains, such as a UCD9112 versus a UCD9240.

10.2 Create New Project

This mode creates a new project using the factory defaults for each PMBus configurable parameter. This is a great way to experiment with the GUI or review the capabilities of a particular TI digital power controller without an actual device.

Once you click *Next*, you will be presented with a list of devices that have default offline project files. Pick a device and then click *Next* again.



Fusion Digital Power Designer Offline Mode Startup

Select Device

You can create and edit a configuration for any Texas Instruments Digital Power Controller supported by Fusion Digital Power Designer. Se the device you would like to configure from the list below:

Device: UCD9240

A set of defau aded for configurable PMBus paramters such as VOUT_COMMAND and TON_DELAY. These values may not necessarily be default values for your EVM.

Figure 28 Offline Mode Startup Wizard, New Project Device Selection

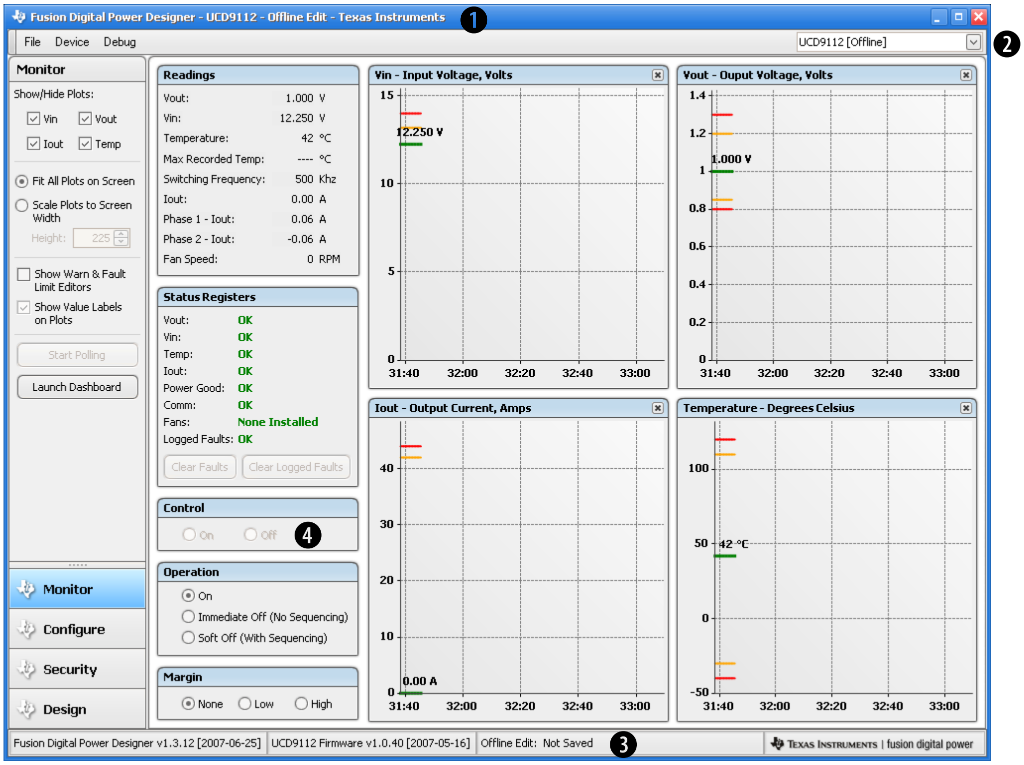
Note that the devices listed are not the complete list of devices the GUI supports. The GUI usually supports a number of in-development devices not shown in the list above. The only difference is that, while these devices can be edited in online or offline mode, you can not create a new project for such devices.

When you create a new project, a project file is not saved to disk until you request it. This is very much like when you create a new document in Microsoft® Word.

10.3 Differences between Offline & Online Mode

The GUI uses the DEVICE_ID parameter embedded inside the file to emulate the firmware version that was loaded in the EVM at the time the project file was created. In essence, the GUI creates a virtual device that you can manage.

Offline mode differs very little cosmetically from online mode, as shown by the following UCD9112 example:



Fusion Digital Power Designer - UCD9112 - Offline Edit - Texas Instruments

UCD9112 [Offline]

Readings

Vout: 1.000 V
Vin: 12.250 V
Temperature: 42 °C
Max Recorded Temp: ---- °C
Switching Frequency: 500 Khz
Iout: 0.00 A
Phase 1 - Iout: 0.06 A
Phase 2 - Iout: -0.06 A
Fan Speed: 0 RPM

Status Registers

Vout: OK
Vin: OK
Temp: OK
Iout: OK
Power Good: OK
Comm: OK
Fans: None Installed
Logged Faults: OK

Control: ○ On ○ Off

Operation: ● On ○ Immediate Off (No Sequencing) ○ Soft Off (With Sequencing)

Margin: ● None ○ Low ○ High

Show/Hide Plots: ☑ Vin ☑ Vout ☑ Iout ☑ Temp

● Fit All Plots on Screen ○ Scale Plots to Screen Width Height: 225

□ Show Warn & Fault Limit Editors ☑ Show Value Labels on Plots

Fusion Digital Power Designer v1.3.12 [2007-06-25] | UCD9112 Firmware v1.0.40 [2007-05-16] | Offline Edit: Not Saved

Figure 29 Offline Mode, UCD9112

In offline mode, read-only parameters are a snapshot of the last value read from the device for each parameter. Note that on the readings plots above, a single data point is plotted multiple times in order to show the plotting feature by example.

When you are in offline mode, the GUI indicates this in several places:

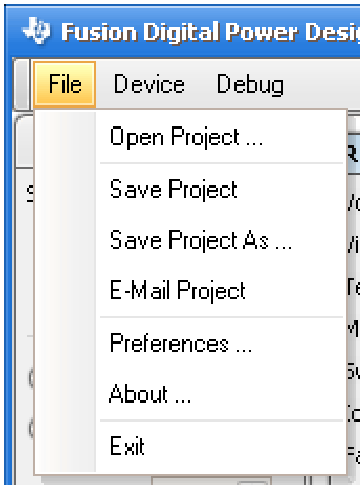
1. The title bar will say "Offline Edit."
2. The device/rail selector will have "[Offline]" appended to it.
3. The footer will contain the filename of the project file or, if this is a new project and it has not been saved, "Not Saved."
4. Some features that can't be accessed in offline mode will be disabled (grayed out). For example, the device's CONTROL Pin can not be set in offline mode.

When editing PMBus configuration parameters like VOUT_COMMAND or coefficient tables/banks, you must still "write" your changes to virtual hardware by clicking buttons such as *Write to Hardware* in the Configure task. This will not write to your project file. It simply commits your changes to the virtual hardware, so that if or when you do save your project, your modifications will be saved.

Don't get too concerned about remembering to write out any changes or save your project file. If you try to quit the GUI or save your project file, you will be warned that your PMBus configuration has not been written to virtual hardware. Similarly, if you quit the GUI and have made any changes to your design or virtually written to the device's configuration, you will be prompted to save your project.

In general, think **Microsoft® Word**: we've mimicked how common Office applications work. You can save your project at any time, and even save to different project files in the same "session" (Project Ver1.xml, Project Ver2.xml, etc). The project files are never written to unless you request it. And the GUI prompts you at exit to save any unwritten changes.

10.4 File Operations in Offline Mode



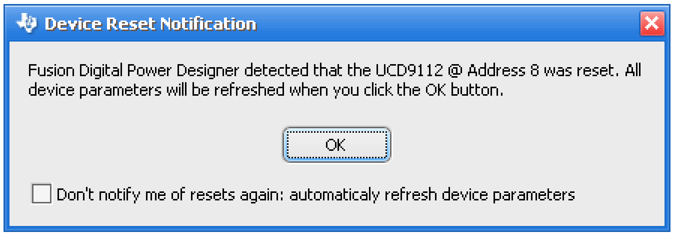
- *Open Project* : Used to change project files. You can only open a project for the same device you are editing. For example, if you are editing a UCD9112 project, you can not open a UCD9240 project. If you want to edit a different device, you must quit the GUI and restart it in offline mode.
- *Save Project* : If this is a new project, the GUI prompts you to enter a filename to save to. For an existing project, the GUI overwrites the project file that was last opened or saved.
- *Save Project As* : The GUI prompts you for a new filename and saves the project. The new filename will appear in the GUI's footer and will be used if you do a *Save Project* in the same session.
- *E-Mail Project* : Saves the project to a temporary file, composes a new e-mail message using your e-mail client, and attaches the project file to it.

11 Device Reset & Reconnect

11.1 Automatic Device Reset Detection

Because the GUI maintains a cached copy of device parameters it reads, it is critical that it handles device reset situations. To facilitate this, the GUI uses a special manufacturer command USER_RAM_00 to automatically detect if the device has been reset. When the GUI first starts up, it writes a value of 0x1 to USER_RAM_00. When background polling is running, the GUI reads USER_RAM_00 and sees if it has changed back to 0x0, the device's boot value for the parameter. It it has changed, a device reset has occurred.

When a device reset is detected, you will be presented with a reset notification form:



Device Reset Notification

Fusion Digital Power Designer detected that the UCD9112 @ Address 8 was reset. All device parameters will be refreshed when you click the OK button.

□ Don't notify me of resets again: automaticaly refresh device parameters

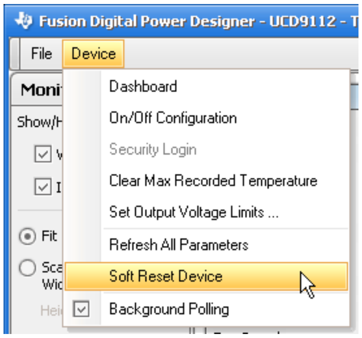
Figure 30 Device Reset Notification Form

Once you acknowledge the reset, all PMBus editor widgets will be cleared and device parameters will be refreshed from the device. Any unwritten PMBus edits will be discarded as well. This ensures that the GUI is again synchronized with the device.

If you would prefer to have the GUI skip the notification and automatically jump to the parameter refresh, just click the checkbox shown in Figure 30 before clicking OK.

Remember, reset detection only occurs if device polling is enabled. If you have disabled polling, the reset will be detected when you re-enable polling.

11.2 Device Reset Initiated from the GUI



The previous section describes how the GUI handles device resets caused by a power cycle or hardware-based reset of the device, such as the UCD9240 EVM's soft reset switch. The GUI can also initiate a reset on supported devices through the Device menu, shown to the left.

The same reset notification form will be shown as described in Section 11.1. It is not a requirement that background polling be running to initiate a reset this way.

11.3 USB Adapter Reconnect

Should it be necessary, the GUI supports hot disconnect and reconnect of the USB adapter. The device is not reset or affected by this.

12 MENU SUMMARY

This section gives brief summaries of all possible menu items (File & Device). Menus are built dynamically based on the attached device, firmware version, and whether you are in online or offline mode. Sometimes menu items may be visible but disabled – grayed out – based on these criteria, while other times a menu item may be hidden entirely.

A “…” in the menu name means that a “modal” dialog box be displayed. You won’t be able to get back to the GUI until you close the dialog box.

12.1 File Menu

Open Project … Offline mode only. Used to change the project file you are editing. You can only edit a project for the same device you currently have loaded. For example, you can not open a UCD9240 project file if you previously opened a UCD9112 project. You must quit the GUI first. See Section 10.4.

Import Project … Online mode only. Starts the project import wizard. You can import all or part of a PMBus configuration, all CLA designs, or both. See Section 9.3.

Save Project Offline mode only. Saves your project. Prompts for a filename if this is a new project, or overwrites the currently open project file. See Section 10.4.

Save Project As … In online mode, saves a snapshot of your device’s PMBus configuration and your CLA designs to a project file. In offline mode, saves the current project to a new filename and makes this the default for future invocations of “Save.” See Section 9.2 for online mode and 10.4 for offline mode.

E-Mail Project Takes a snapshot of your PMBus configuration and CLA designs and attaches it to a new e-mail message. See Section 9.2.

Preferences … While most program preferences are set as you use the GUI – for example, your latest designs are a program preference – there are a few preferences you can set using this form.

Exit Same as clicking the close button in the titlebar, ☒. Checks to see if you have any unwritten PMBus configuration changes. Also warns you if your project file has not been saved since you updated your design or wrote out PMBus changes to the virtual device.

12.2 Device Menu

Dashboard Launches the readings dashboard in a separate form. See Section 5.

On/Off Configuration Launches the PMBus ON_OFF_CONFIG editor in a separate form. Useful when experimenting with how different ON_OFF_CONFIG settings affect how the device interprets the CONTROL pin and OPERATION command. Changes to this form are immediately written to the device.

Security Login Online mode only. If your device supports TI enhanced security, this provides a shortcut to temporarily disable security and "login" to the device. See Section 7.3.

Clear Max Recorded Temperature Online mode only. If your device supports the TI LOGGED_MAX_TEMPERATURE parameter, selecting this menu item will clear the maximum temperature reading. The device will then log the next temperature that exceeds OT_WARN_LIMIT.

Soft Reset Device Online mode only. Executes the SOFT_RESET command on the device. This will simulate a power cycle and restore the device to it's power on defaults. The GUI will detect when the reset is complete and refresh all parameters. See Section 11.2.

Background Polling Status Online mode only. Displays a form showing what PMBus parameters are currently being polled in the background. This form updates in real time. See Section 5.3.

Background Polling Online mode only. Toggle background polling on and off. If a checkmark is beside the menu item, background polling is on. See Section 5 for more information about readings and polling.

12.3 Help Menu

User's Guide & Documentation Launches an electronic copy of this user's guide in Adobe Acrobat.

Contact TI for Support Provides information on how to get application support for the GUI and your controller.

TI Digital Power Homepage Launches the Digital Fusion Power homepage in your browser.

TI Homepage Launches the Texas Instruments homepage in your browser.

About … Displays summary information about the GUI.

13 To Add

Calculation of Output Impedance

An ideal power supply acts like an ideal voltage source in series with a impedance that feeds the load. So the lower the series impedance, the better the power supply will perform. This makes calculating or measuring the output impedance a useful indicator of the performance of the power supply.

For a Buck regulator, the open loop output impedance is the parallel combination of the series impedance elements (Z_S), RDSon, inductor DCR and inductance with the parallel impedance elements (Z_P) ESR and capacitance:

$$Z_{\mathrm{OutputOpenLoop}} = \frac{Z_S Z_P}{Z_S + Z_P}$$

$$Z_S = R + s \cdot L$$

$$R = DCR + (D \cdot R_{DS(ON)HI} + (1 - D) \cdot R_{DS(ON)LO}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

This is the open loop output impedance. When feedback is applied to the power supply the output impedance is further improved. In fact, a useful design criteria for defining the feedback compensation coefficients is to try to minimize the output impedance over all frequencies.

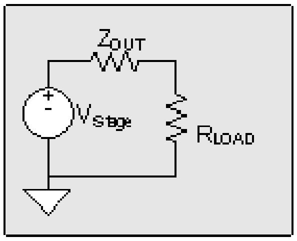


Figure 2 Output impedance model

The calculation of closed loop output impedance follows:

$$Z_{\mathrm{OutputClosedLoop}} = \frac{Z_{\mathrm{OutputOpenLoop}}}{1 + G_{\mathrm{OpenLoop}}}$$

G_{OpenLoop} is the product of the plant gain and the compensator gain so the effect of increasing the compensator gain has the effect of decreasing the output impedance, which should improve the performance of the power supply.

14 REFERENCES, RELATED MATERIAL, AND LINKS

[1] USB Interface Adapter EVM (HPA172)

[2] *Configuration Security for the UCD91XX Digital Controllers, Texas Instruments.*

[3] *Designing the Digital Compensator For UCD91xx based Digital Power Supply,* Texas Instruments. Available on the UCD9112 product page at a later date.

[4] *UCD9240 Digital Point of Load System Controller Device and EVM Description,* Texas Instruments. Available from your TI representative.

[5] See http://en.wikipedia.org/wiki/XML for an overview of XML.

PMBus Support in UCD911X Family of Digital Power Controllers, Texas Instruments.

USB Interface Adapter Evaluation Module User's Guide, Texas Instruments

Texas Instruments Digital Power Homepage - http://www.ti.com/digitalpower