Configuration Programming of UCD Devices

This document describes techniques that can be used to download a device configuration to a Texas Instruments UCD device. While this document references version 1.8.95 of the Fusion Digital Power Designer software, you can use versions newer than 1.8.95 as well.

Last Updated 28 September 2011

Michael S Muegel
Bill Waters (JTAG)

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Table of Contents

1 INTRODUCTION

This document describes how configuration data can be written (programmed) to select Texas Instruments UCD devices. Currently this covers UCD92xx digital power controller and UCD90xx sequencers and system health controllers. Generally, any device that is configured with the Fusion Digital Power Designer software and is a UCD device should support the programming options described here. For example, the UCD908x power supply sequencer and monitor is not supported. The UCD908x does not support PMBus and is configured by a different GUI.

Both UCD92xx and UCD90xx device families use the same IC underlying memory, ROM, and PMBus architecture. This IC architecture, generically referred to as the UCD30xx, comes in four different pin/package configurations: 40, 48, 64, and 80 pins. Most devices only come in a single pin package. For example, the UCD9248 uses an 80 pin package. A few, such as the UCD9240, come in multiple packages. As you will see later, there is a unique device identifier (DEVICE_ID) for each UCD device. It normally has the package (# pins) embedded within it. For example, "UCD9240-64|3.25.0.8662|081105" represents a UCD9240 device, 64-pin package, firmware version 3.25.0.8662, compiled on November 5 2008.

Programming techniques described in this document can also be used to program device configuration to custom devices that use the UCD30xx IC family. For example, Texas Instruments works with merchant power customers who develop their own firmware for Isolated power applications. While these customers usually download both firmware and configuration to their devices, some customers may need to download configuration data separately using the techniques described in this document.

2 CONFIGURATION BASICS

UCD devices have two types of flash (EEPROM) memory: program flash and data flash. Program flash is written during Texas Instrument's manufacturing process. It is the firmware that makes the device a UCD9220, UCD9240, UCD90120, etc. The factory does not program any configuration, even a default configuration, into data flash during manufacturing. Thus, devices arrive from the factory un-configured.

When power is first applied to a device that is in the factory un-configured state – technically data flash has been filled with a 1010… bit pattern as part of the test process – the device will load a default configuration referred to as the HARDCODED PARMS configuration:

- UCD92xx: no voltage rails have been configured; global parameters are set to default values by the firmware

- UCD90xx: no rails, GPIs, GPOs, PWMs, or fans have been configured; global parameters are set to default values by the firmware

An un-configured device can therefore be placed on a system board without concern that the device would power an output rail or turn on a sequence. If you use active low polarity for any GPOs defined by your device, note they could be active due to this un-configured state. Contact your Texas Instruments representative for assistance.

3 An Overview of Configuration Programming Options

There are a number of options that affect how a UCD device will be programmed. Some of the programming permutations include:

- Serial bus or JTAG:
  UCD devices support programming via serial bus or JTAG.

  The PMBus (Power Management Bus) protocol uses the SMBus (System Management Bus) protocol to communicate with a controller over serial bus. SMBus in turn is a wrapper around the I^2C (Inter-Integrated Circuit) serial bus protocol. A programmer must have access to I^2C clock and data lines to write a configuration via PMBus.

  Devices can also be programmed via JTAG (Joint Test Action Group). This allows an in-circuit tester (ICT) or dedicated JTAG programmer to write a configuration using existing JTAG TMS, TDI, TDO, and TCK pins.

- Command-based configuration or data flash image:
  When the device is in it's normal program mode state, a host can change the configuration by issuing a series of PMBus commands. For example, to configure the voltage setpoint on a 4 rail system, a GUI or host writes to the command VOUT_COMMAND along with a special command PAGE that selects the output rail that is configured. This type of configuration will be referred to as PMBus-based configuration in this document.

  An alternative to PMBus-based configuration is to write directly to the data flash of the device. This is the EEPROM area where configuration data is stored.

- On board or off board:
  You can pre-program a configuration before the UCD IC is soldered onto your board. Or you can download a configuration once the IC has mounted.

- Fusion tools or 3rd party programmers:
  Texas Instruments provides a number of tools to write configuration, either via PMBus or by writing directly to data flash. Tools include the standard Fusion Digital Power Design (Fusion GUI) software, the Fusion Manufacturing Tool (MFR GUI), and command line tools. These can be used off board or on board. For the later, access to the system board's I^2C bus is required, which will be routed to the TI USB adapter.

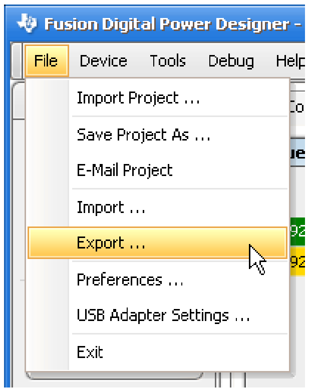
  Dedicated programmers can program via serial bus or JTAG. Dedicated programmers always write configuration directly to data flash.

This document will not describe every possible permutation, but instead focus on common tools and programming use cases.

4 Configuration Export Overview

4.1 Export Using the Fusion GUI

The Fusion GUI is normally used to export device configuration data. To begin, you select Export from the File menu:



The export tool has two modes of operation:

- Multiple format: export more than one file/format with a single click.
- Single format: export only one format at a time.

The formats available:

- **Text File**
  Tab or comma separated list of PMBus settings and readings. This file can be opened by Microsoft Excel or a text editor. Most PMBus parameters – such as VOUT_COMMAND, READ_VOUT, and IOUT_CAL_GAIN – will be listed, one per line. In the case of a multi-rail or multi-phase device, there will be separate entries for each rail/phase.

  If your device contains some configuration items that cannot be presented by a single command, a summary of said item will be included in the export. For example, on UCD92xx devices CLA gains are read and written to the device using a series of commands issued by the Fusion GUI. A text export of a UCD92xx device will include pseudo command entries for CLA_GAINS_BANK_0, CLA_GAINS_BANK_1, and CLA_GAINS_BANK_2.

  This mode is available in online or offline mode.

- **Project File**
  A project file contains a device's PMBus configuration and readings in XML format. It is the primary data file of the Fusion GUI, and allows you to edit a device's configuration and design in 'offline' mode: without a live connection to your device. A project file also contains information about your design and sequencing that is not stored on the device. For example, a definition of the voltage divider network on your system board. Unlike File->Save Project, you can choose not to include non-command data such as UCD92xx designs or UCD90xx pin names. When this information is not included, the project file is smaller and may be easier for you to review/understand.

  This mode is available in online or offline mode.

- **Data Flash File**
  This export format will read the data flash from the device and save it in S-Record or Intel Hex format. Other modes, such as project and text file modes, export the current RAM configuration. This mode will export the data flash configuration. See section 9.1, Exporting Configuration Data Flash Hex File.

  This mode is only available in online mode.

- **Program + Data Flash File**
  This export will read the program and data flash from the device and save it in S-Record or Intel Hex format. You can download the program+data flash through any of the Fusion tools that download "firmware", where the Fusion tools define a firmware image as a single file containing program flash and optionally data flash.

  Only authorized personnel can export program flash, and this tool is password protected. This mode is only available in online mode.

- **Data Flash SVF/JTAG**
  This export format will read the device's data flash from the device and save it in Serial Vector Format (SVF). SVF is a vendor-independent way of representing JTAG test patterns. The SVF file will contain the patterns necessary to write your device's configuration. See section 6.3, Downloading a Configuration via JTAG.

  This mode is only available for devices that support JTAG. This is only available in online mode.

- **Program + Data Flash SVF/JTAG**
  This export format will read the program flash and optionally data flash from the device and save it in Serial Vector Format (SVF). SVF is a vendor-independent way of representing JTAG test patterns. The SVF file will contain the patterns necessary to write the device's program and optionally data flash.

  This mode is only available for devices that support JTAG. This is only available in online mode.

- **PMBus Script**
  This will save a “script” detailing the writes necessary to write your current configuration to a device. Writes are done in terms of standard SMBus commands (WriteByte, WriteWord, and WriteBlock) or I^{2}C WriteBlock. This can be easily translated to other environments. See section 6.4.3, Microcontroller Writes Full Configuration via PMBus and section 6.4.4, Microcontroller Writes Partial Configuration via PMBus.

  This mode is available in online or offline mode.

- **Data Flash Script**
  This export will read the data flash from the device and save a script that can be used by a microcontroller or other device to download data flash to the device. See section 6.4.2, SMBus / I2C Script Overview.

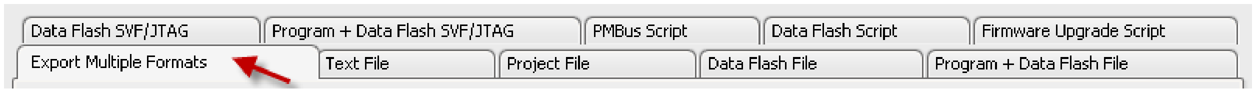
  This mode is only available in online mode.

- **Firmware Upgrade Script**
  This export will read the program and data flash from the device and save a script that can be used by a microcontroller or other device to download program and data flash to the device. While UCD devices firmware can be upgraded, Texas Instruments does not expect this to be generally done nor necessary.

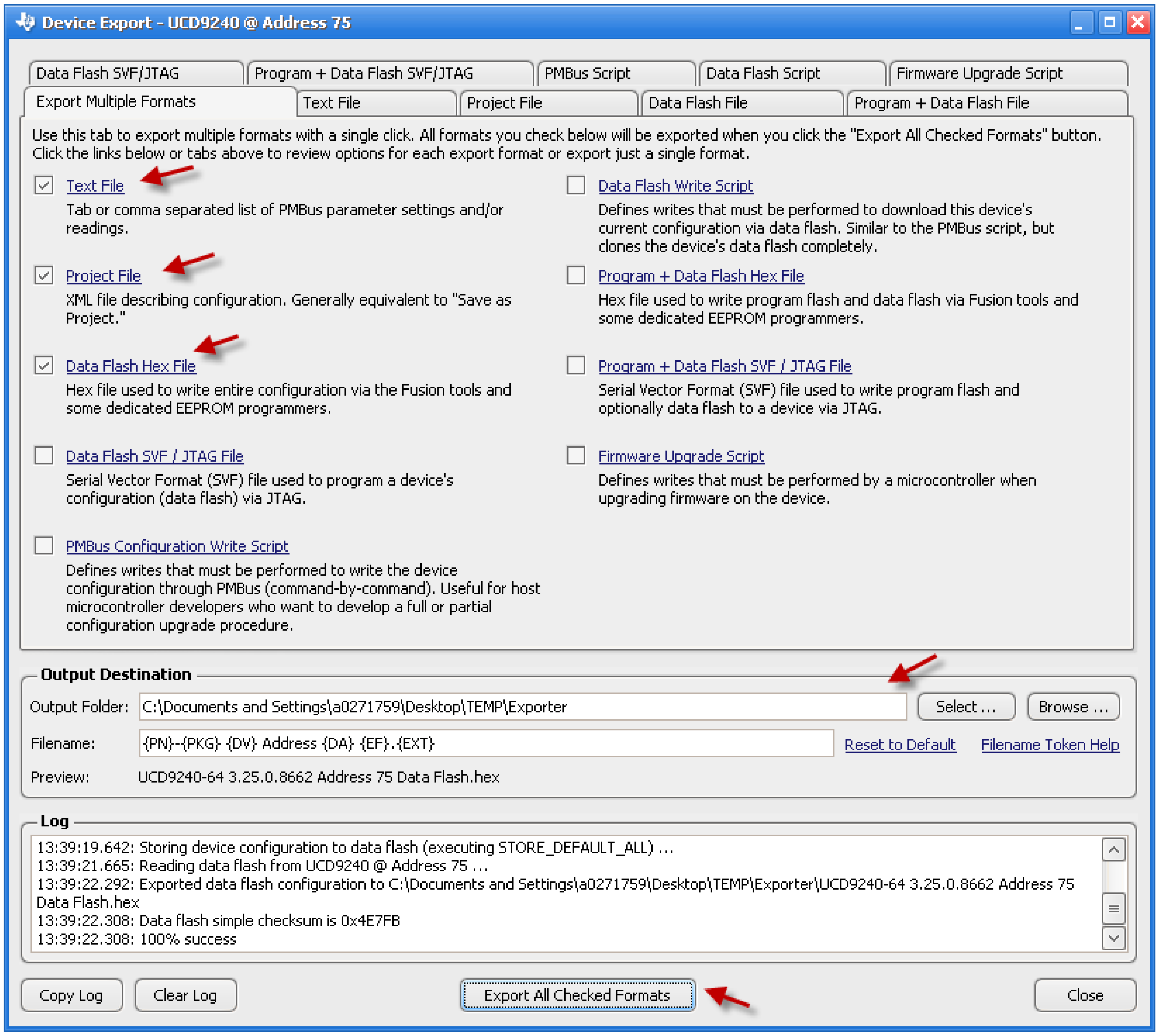
  Only authorized personnel can export program flash, and this tool is password protected. This mode is only available in online mode.

4.2 Exporting to Multiple File Formats

To initiate a multiple format export, select the tab shown below:



You then click the checkboxes next to formats that you want to export. For example, even if you are doing a data flash export, it is recommended that you also export your device configuration to a project file and text file at the same time, for archiving and debug.



Use this tab to export multiple formats with a single click. All formats you check below will be exported when you click the "Export All Checked Formats" button. Click the links below or tabs above to review options for each export format or export just a single format.

- [✓] Text File
  Tab or comma separated list of PMBus parameter settings and/or readings.
- [✓] Project File
  XML file describing configuration. Generally equivalent to "Save as Project."
- [✓] Data Flash Hex File
  Hex file used to write entire configuration via the Fusion tools and some dedicated EEPROM programmers.
- [ ] Data Flash SVF / JTAG File
  Serial Vector Format (SVF) file used to program a device's configuration (data flash) via JTAG.
- [ ] PMBus Configuration Write Script
  Defines writes that must be performed to write the device configuration through PMBus (command-by-command). Useful for host microcontroller developers who want to develop a full or partial configuration upgrade procedure.
- [ ] Data Flash Write Script
  Defines writes that must be performed to download this device's current configuration via data flash. Similar to the PMBus script, but clones the device's data flash completely.
- [ ] Program + Data Flash Hex File
  Hex file used to write program flash and data flash via Fusion tools and some dedicated EEPROM programmers.
- [ ] Program + Data Flash SVF / JTAG File
  Serial Vector Format (SVF) file used to write program flash and optionally data flash to a device via JTAG.
- [ ] Firmware Upgrade Script
  Defines writes that must be performed by a microcontroller when upgrading firmware on the device.

Output Destination

Output Folder: C:\Documents and Settings\a0271759\Desktop\TEMP\Exporter

Filename: {PN}-{PKG} {DV} Address {DA} {EF}.{EXT}

Preview: UCD9240-64 3.25.0.8662 Address 75 Data Flash.hex

Log

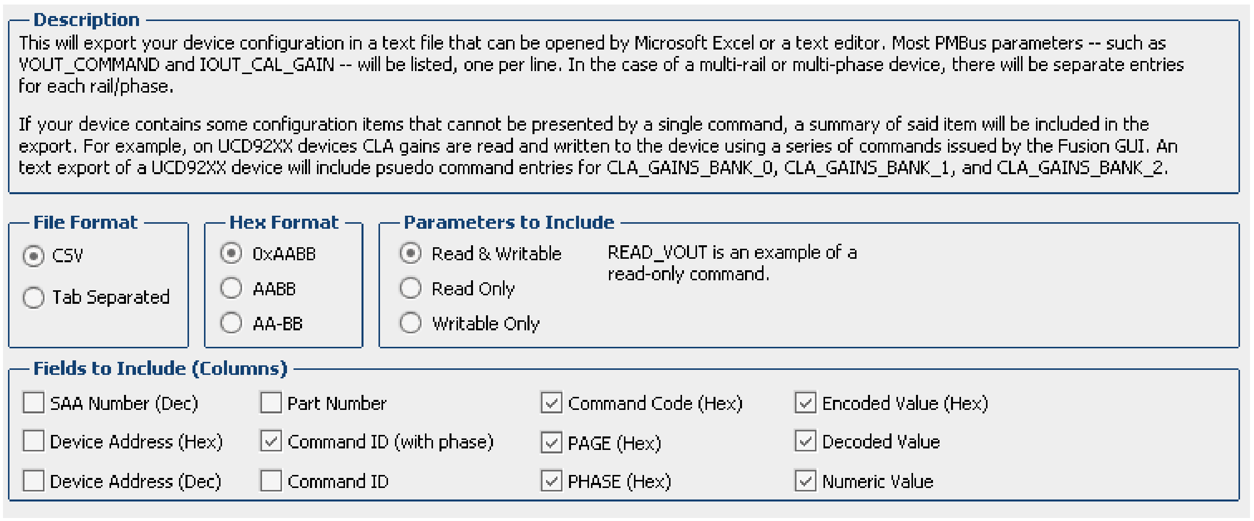
```
13:39:19.642: Storing device configuration to data flash (executing STORE_DEFAULT_ALL) ...
13:39:21.665: Reading data flash from UCD9240 @ Address 75 ...
13:39:22.292: Exported data flash configuration to C:\Documents and Settings\a0271759\Desktop\TEMP\Exporter\UCD9240-64 3.25.0.8662 Address 75
Data Flash.hex
13:39:22.308: Data flash simple checksum is 0x4E7FB
13:39:22.308: 100% success
```

Note that the filename is not a fixed filename. It uses special “macros” to dynamically create a filename. This is primarily needed because the export multiple format mode will write more than one file. You can changed the filename template to suit your project naming conventions; however, it is recommended you keep the {PN}, {PKG}, and {DA} “macros”. In the example above, “210434-02” is a part identifier to be assigned to the programmed IC. You also should keep the {EF} macro if you are exporting multiple formats. It will be used to differentiate between export formats along with the filename extension, {EXT}. The Preview area shows what the actual filename will be for the selected export format.

Select a folder to write files to via the "Select …" button and then click "Export All Checked Formats." This will export using the current settings for each format.

4.3 Configuring Export Options

Most formats have options that control the export. You configure these options by clicking the hyperlink next to the checkbox or the corresponding tab at the top of the form. A description of the format is also available on this tab. For example, the text file format:



Description

This will export your device configuration in a text file that can be opened by Microsoft Excel or a text editor. Most PMBus parameters -- such as VOUT_COMMAND and IOUT_CAL_GAIN -- will be listed, one per line. In the case of a multi-rail or multi-phase device, there will be separate entries for each rail/phase.

If your device contains some configuration items that cannot be presented by a single command, a summary of said item will be included in the export. For example, on UCD92XX devices CLA gains are read and written to the device using a series of commands issued by the Fusion GUI. An text export of a UCD92XX device will include psuedo command entries for CLA_GAINS_BANK_0, CLA_GAINS_BANK_1, and CLA_GAINS_BANK_2.

File Format: [✓ CSV] Tab Separated

Hex Format: [✓ 0xAABB] AABB AA-BB

Parameters to Include: [✓ Read & Writable] Read Only Writable Only

READ_VOUT is an example of a read-only command.

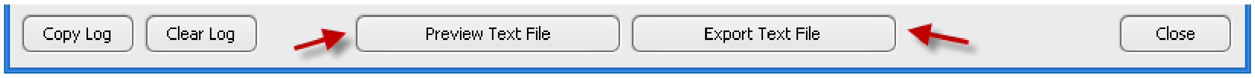
Fields to Include (Columns)

☐ SAA Number (Dec)	☐ Part Number	✓ Command Code (Hex)	✓ Encoded Value (Hex)
☐ Device Address (Hex)	✓ Command ID (with phase)	✓ PAGE (Hex)	✓ Decoded Value
☐ Device Address (Dec)	☐ Command ID	✓ PHASE (Hex)	✓ Numeric Value

Options are saved to your user preferences and restored the next time you start the Fusion GUI.

4.4 Exporting One File at a Time

You can also export or preview the export of a single format at a time once you have jumped to the format's tab:

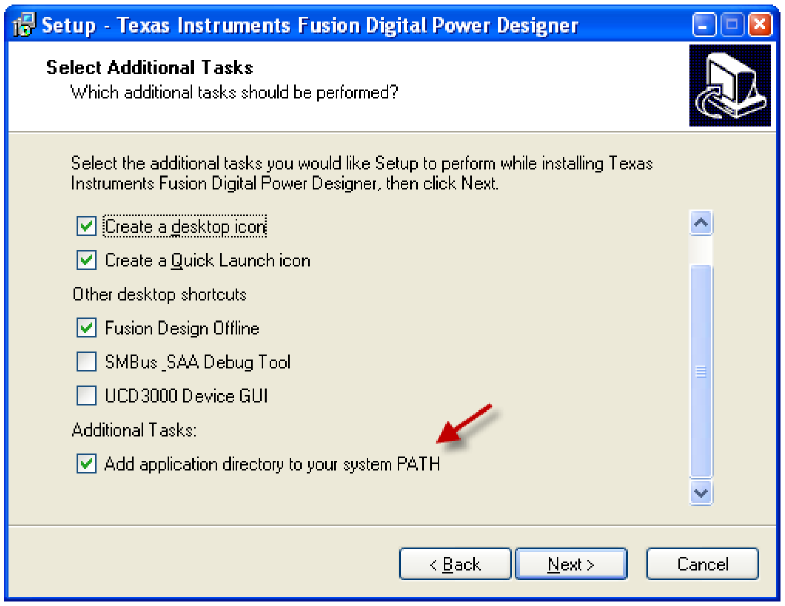


The export option will use the filename template defined on the main tab. The preview option exports to a temporary file and opens up the output in a window. This is handy when you are poking around with different options and file formats.

Section 6.3.4, Exporting Data Flash Configuration as SVF, lists specific instructions for SVF export. Section 9.1, Exporting Configuration Data Flash Hex File, has instructions for data flash hex file export.

4.5 Export Using the FusionDeviceExporter Command Line Tool

A number of command line (aka console aka DOS prompt) tools are bundled with the Fusion GUI. All tools are named FusionSOMETHING. By default, the folder where the tools were installed to was added to your PC's PATH environment variable when you ran the GUI's installer:


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.

- [✓] Create a desktop icon
- [✓] Create a Quick Launch icon

Other desktop shortcuts

- [✓] Fusion Design Offline
- [ ] SMBus_SAA Debug Tool
- [ ] UCD3000 Device GUI

Additional Tasks:

- [✓] Add application directory to your system PATH

If this was not checked, you can re-run the installer and check this option.

The FusionDeviceExporter command line tool that is bundled with the Fusion GUI can export a subset of the formats supported by the export tool described in section 4.1, Export Using the Fusion GUI.

FusionDeviceExporter can export the following formats:

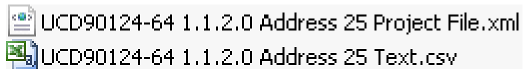
- Text file
- Project file
- Data flash hex file
- Data flash script
- PMBus script

Examples:

- FusionDeviceExporter --address 126 –text
  Dumps the device configuration and readings for the device at address 126 to the console (standard output).

- FusionDeviceExporter --scan --text --project --outfile '{PN}-{PKG} {DV} Address {DA} {EF}.{EXT}'
  Exports configuration/readings for all supported devices found on the bus. Text and project file formats will be exported. The output will be saved to two different files, each defined by the outfile template specified.

  For example, after running on a UCD90124, the following files might be created:


UCD90124-64 1.1.2.0 Address 25 Project File.xml
UCD90124-64 1.1.2.0 Address 25 Text.csv

Like all Fusion command line tools, you can get detailed help by typing FusionDeviceExporter --help on the command line.

5 Data Flash Considerations

Data flash refers to a section of the device's EEPROM that holds non-volatile device configuration and other operational data. Many UCD devices store more than just configuration information in data flash. For example, UCD92xx and UCD90xx devices log information about faults that occur to data flash.

Each device (UCD9240-64, UCD9240-80, UCD9248, UCD90120, etc.) and possibly the specific firmware release for a given device (UCD9248-80-5.6.0.1123, etc.) will have a "memory map" that defines where in the flash the data that the device maintains is stored. As a device's firmware is updated, the location in data flash where a particular piece of data is stored may change. For example, say that the data flash layout for a device looks like this:

- Address 0x18800: Fault logging information
  - Address 0x18800: Rail #1 faults
  - Address 0x18802: Rail #2 faults
  - Etc.
- Address 0x18A00: Configuration information
  - Address 0x18A00: VOUT_COMMAND rail #1
  - Address 0x18A02: VOUT_OV_FAULT_LIMIT rail #1
  - Etc.

But what if, on a new firmware release, the amount of data that was saved in the fault logged was changed? Or the "memory map" of configuration data was changed, perhaps to optimize the firmware in some way? In either case, the data flash between firmware releases would no longer be compatible.

Another complication is that devices often store information in non-volatile and volatile memory differently than they are passed back and forth via PMBus. For example, the GUI writes VOUT_COMMAND as a 16 bit signed mantissa. The exponent is configured through another command, VOUT_CONFIG. The device does not store this in RAM or flash in the PMBus format. It stores it in a fixed point (Q math) representation. This is only one example of the PMBus $\rightarrow$ device translation. Different commands use other encoding schemes, and these schemes can change between major releases.

PMBus hides the memory map and command encoding issues by providing a command-based front end for reading and writing a device's configuration. In the case of TI UCD devices, special "manufacturing specific" (custom) PMBus commands are also used to read and reset fault logs and other flash-based logged data.

The Fusion GUI normally reads and writes configuration via PMBus and thus avoids these issues. All the GUI needs to worry about between firmware releases is whether a command has been added, removed, or data format modified between firmware releases. The underlying memory map of the device is not tracked by the GUI.

Data flash-based configuration is much more brute force. It is ultimately a bit-by-bit copy of a source data flash image to a target device. Great care must therefore be taken to ensure that the firmware loaded on the "source" – the device that will be used to generate the configuration export – matches the firmware loaded on the "target" device. Because of this, **if your target device version changes, you should normally create a new configuration export from a live device**.

Depending on the method you are using to write data flash, the target device may be validated before flash programming starts. For example, a JTAG SVF data flash programming file will validate that the target device is compatible with the SVF being executed. In the case of SVF, the validation works as follows:

- Engineer connects to a device in “online” mode with the Fusion GUI. The device should have the same firmware loaded that will be on the ICs received from Texas Instruments. For example, if the customer had previously been developing/validating their design with pre-production firmware, the final firmware should be loaded on lab devices.
- Engineer selects File->Export from the Fusion GUI.
- The GUI reads the data flash image from the device.
- The GUI converts this data flash image to a series of SVF instructions that can be used to program data flash on other devices.
- The engineer or contract manufacturer tests the SVF.
- When the SVF is run, one of the first tasks it performs is to read the contents of the device’s DEVICE_ID register. DEVICE_ID is a read-only Texas Instruments PMBus command (MFR_SPECIFIC_45, command code 0xFD, read block) that returns the device part, firmware version, and release date. An example DEVICE_ID is “UCD9240-64|3.25.0.8662”. The GUI normally reads DEVICE_ID via PMBus when it scans for devices during startup. In the case of SVF, the SVF will read DEVICE_ID from program flash memory via JTAG. DEVICE_ID is always stored at a fixed location on TI devices. The SVF will read DEVICE_ID and compare it to what it expects the target to be (the device the export was done on). If there is a mismatch, the SVF will abort with an error.

In section 6, Programming Options and Instructions, device validation – if any – will be described for each programming option.

6 PROGRAMMING OPTIONS AND INSTRUCTIONS

6.1 Downloading a Configuration via Fusion Tools

All Fusion tools use the TI USB adapter for I²C communication. Tools can write via PMBus (project files) or write a data flash image.

Project files are described more fully in the Fusion Digital Power Designer user manual, section 9. A project file is an XML file that contains a device's configuration on a command-by-command basis. Project files may also contain additional GUI-centric information about a device that is not actually stored on a device. For example, the Fusion GUI provides a design tool that is used to create compensation coefficients for a device. Design components are criteria are stored in the project file. This GUI-centric data is not used in the configuration process.

See section 9.1, Exporting Configuration Data Flash Hex File, for instructions on how to export a device configuration to a data flash hex file.

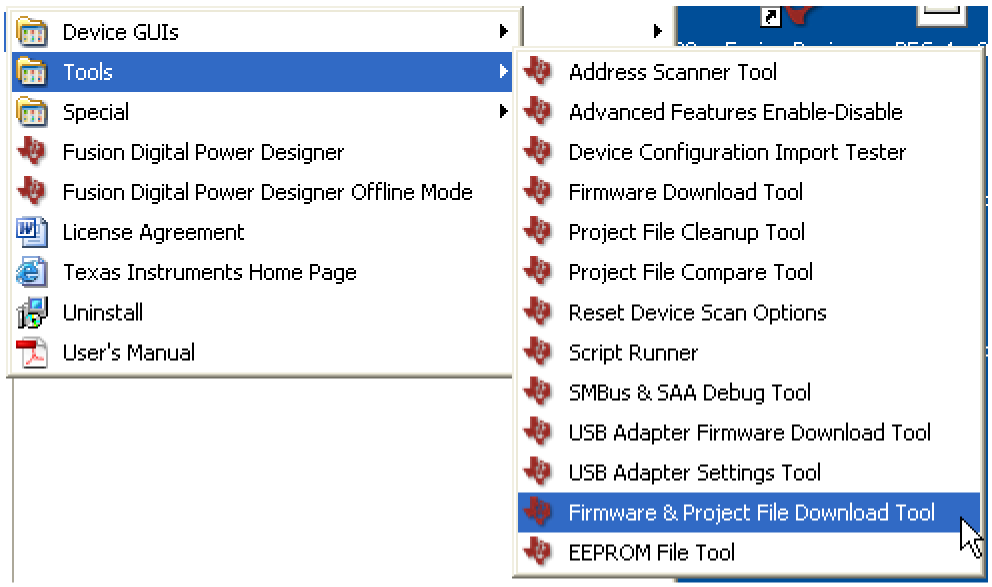
When using Fusion tools, for optimal performance you should hook the TI USB adapter directly to your PC. Do not use a hub/dock of any kind, as this will significantly slow down write times.

6.1.1 Fusion Digital Power Designer

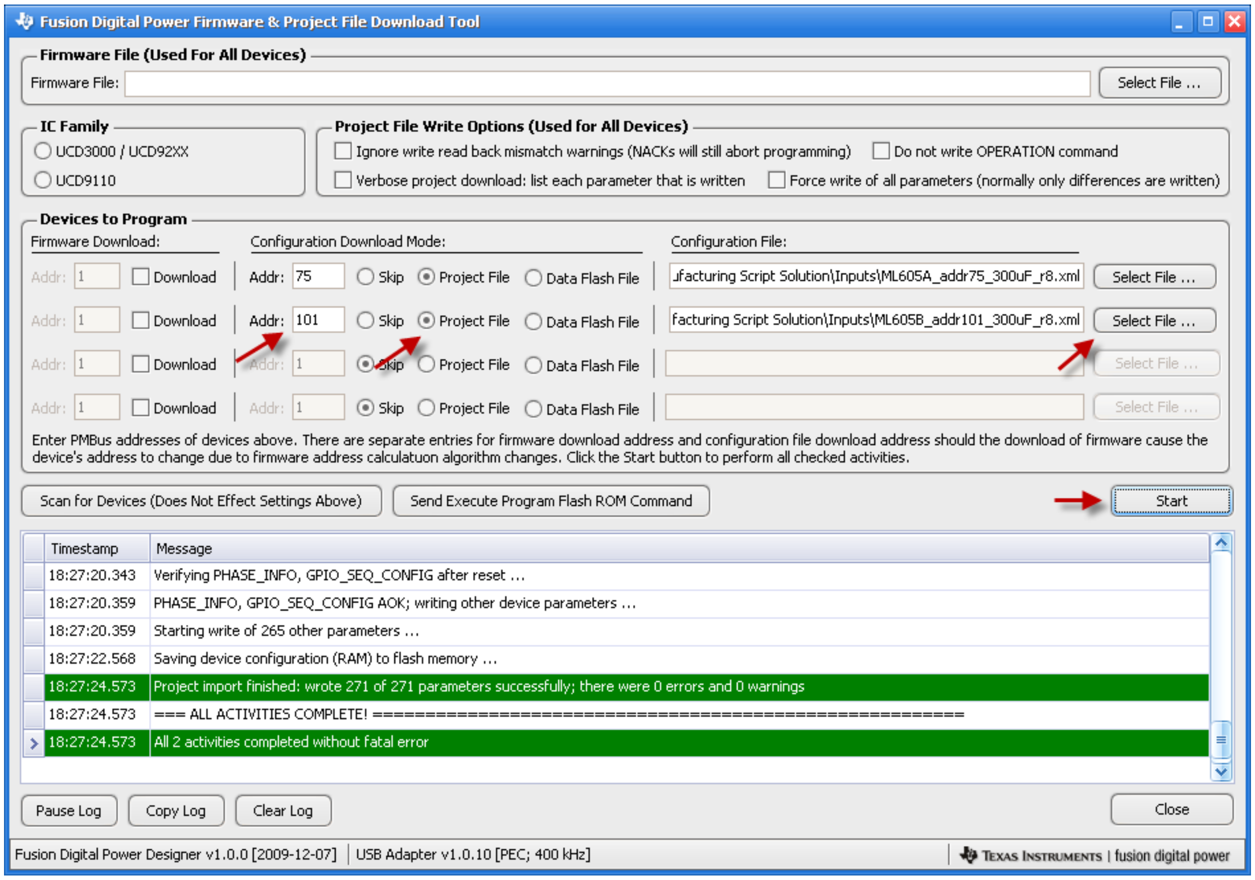
The Fusion GUI can be used to write a configuration for small batch runs. The File->Import tool can be used to import a project file or a data flash image. Normally you will want to stick with project files for the reasons described in section 5, Data Flash Considerations.

6.1.2 Firmware and Project File Download Tool

If you have a number of devices to program, this simple tool that comes bundled with the Fusion GUI may be helpful. You launch the tool from the Start Menu under Texas Instruments Fusion Digital Power Designer:


Device GUIs
Tools
Special
Fusion Digital Power Designer
Fusion Digital Power Designer Offline Mode
License Agreement
Texas Instruments Home Page
Uninstall
User's Manual
Address Scanner Tool
Advanced Features Enable-Disable
Device Configuration Import Tester
Firmware Download Tool
Project File Cleanup Tool
Project File Compare Tool
Reset Device Scan Options
Script Runner
SMBus & SAA Debug Tool
USB Adapter Firmware Download Tool
USB Adapter Settings Tool
Firmware & Project File Download Tool
EEPROM File Tool

It can download firmware and/or configuration to more than one device on the bus. It can download a project file (PMBus) or data flash file. For example:


Fusion Digital Power Firmware & Project File Download Tool
Select File ...
Scan for Devices (Does Not Effect Settings Above)
Send Execute Program Flash ROM Command
Start
Pause Log
Copy Log
Clear Log
Close

Firmware File (Used For All Devices)

Firmware File:

IC Family: UCD3000 / UCD92XX; UCD9110

Project File Write Options (Used for All Devices)

- [ ] Ignore write read back mismatch warnings (NACKs will still abort programming)
- [ ] Do not write OPERATION command
- [ ] Verbose project download: list each parameter that is written
- [ ] Force write of all parameters (normally only differences are written)

Devices to Program

Firmware Download:		Configuration Download Mode:		Configuration File:
Addr: 1	Download	Addr: 75	Skip [✓ Project File] Data Flash File	..facturing Script Solution\Inputs\ML605A_addr75_300uF_r8.xml
Addr: 1	Download	Addr: 101	Skip [✓ Project File] Data Flash File	facturing Script Solution\Inputs\ML605B_addr101_300uF_r8.xml
Addr: 1	Download	Addr: 1	[✓ Skip] Project File Data Flash File	
Addr: 1	Download	Addr: 1	[✓ Skip] Project File Data Flash File	

Enter PMBus addresses of devices above. There are separate entries for firmware download address and configuration file download address should the download of firmware cause the device's address to change due to firmware address calculatuon algorithm changes. Click the Start button to perform all checked activities.

```
Timestamp     Message
18:27:20.343  Verifying PHASE_INFO, GPIO_SEQ_CONFIG after reset ...
18:27:20.359  PHASE_INFO, GPIO_SEQ_CONFIG AOK; writing other device parameters ...
18:27:20.359  Starting write of 265 other parameters ...
18:27:22.568  Saving device configuration (RAM) to flash memory ...
18:27:24.573  Project import finished: wrote 271 of 271 parameters successfully; there were 0 errors and 0 warnings
18:27:24.573  === ALL ACTIVITIES COMPLETE! ==========================================================
18:27:24.573  All 2 activities completed without fatal error
```

Fusion Digital Power Designer v1.0.0 [2009-12-07] | USB Adapter v1.0.10 [PEC; 400 kHz] | Texas Instruments | fusion digital power

Because only configuration is being downloaded, firmware and IC information did not need to be filled in. Only the PMBus address, configuration mode, and configuration file need to be filled in before clicking the Start button.

Your settings are remembered when you exit and restored the next time you run the tool.

6.1.3 FusionConfigWriter Command Line Tool

The Fusion GUI comes bundled with a number of command line (aka console, batch mode) tools. The FusionConfigWriter tool can be used to download a project or data flash file to a device. This tool would be helpful if you have an existing manufacturing test executive such as National Instruments TestStand and want to integrate UCD configuration into your process flow.

The options of these tools are similar to the Firmware and Project File Download Tool described above. If writing a project file:

```
FusionConfigWriter [ scan options ] --project --infile project-file
    [ --skip-operation --force-write --project-file-warnings-ok --device-exact-version version --quiet ]
```

The --skip-operation, --force-write, --project-file-warnings, and –quiet arguments are optional. Scan options is a place holder for arguments used to define the device you are targeting. While you can only write to a single device in each call to FusionConfigWriter, you can invoke the program any number of times if you have multiple UCD devices on the bus. For example:

```
FusionConfigWriter --address 75 --project --infile ML605A_addr75_300uF_r8.xml
FusionConfigWriter --address 101 --project --infile ML605B_addr101_300uF_r8.xml
```

The syntax when writing a data flash image is similar:

```
FusionConfigWriter [ scan options ] --dflash --infile eeprom-file [ --device-exact-version version --quiet ]
```

The --device-exact-version version argument is recommended when writing data flash if you are deploying this as part of a larger manufacturing process. When specified, if the device that is targeted does not match the exact firmware version specified, the tool will exit with an error.

For example:

```
FusionConfigWriter --address 75 --device-exact-version 3.25.0.8663 --dflash --infile UCD9240-64-3.25.0.8662-Address75-DataFlash.hex

FusionConfigWriter --address 101 --device-exact-version 3.25.0.8663 --dflash --infile UCD9240-64-3.25.0.8662-Address101-DataFlash.hex
```

Example output in data flash mode:

```
Sending the device to ROM mode ...
Waiting for ROM mode via ROM version fetch ...
Device in ROM mode; UCD3000 ROM v0.2; IC v0.2
Mass erasing data flash
Writing data flash ...
Wrote data flash without error
Verifying data flash through read back ...
Reading data flash ...
Data flash verified!
Recreating program flash checksum ...
ROM is calculating program flash checksum ...
Reading last segment of existing program flash ...
Erasing last segment of program flash ...
Downloading new segment of program flash ...
Program flash update 100% successful; program will run on device power-up
Executing program flash and waiting for device to come online ...
Device in program mode after 250.8208 msec wait, DEVICE_ID is 'UCD9240-64|3.25.0.8662|081105'
```

Note there are two ways to specify devices to target on the bus. If you have multiple devices on the bus, then --address must be used as shown above. If you have only a single device, you could use the --scan option instead to have the tool use whatever device is found on the bus. This might be useful in a single device setup where the address is not fixed.

The FusionPMBusScan tool can be used to list what devices are on the bus. For example:

```
FusionPMBusScan

Starting scan for SAA #1 from 1-11,13-127
Found device @ address 88d: ReadBlock DEVICE_ID [0xFD] retured UCD3000ISO1|0.0.0|110609
[0x5543443330303049534F317C302E302E307C313130363039 ]
Found device @ address 103d: ReadBlock DEVICE_ID [0xFD] retured UCD9224-48|5.6.0.11224|090922
[0x554344393232342D34387C352E362E302E31313232347C30393039323200 ]

Found 2 device(s)
```

All Fusion command line tools return exit status code of 0 on success and non-0 on failure. This is a DOS/UN*X convention. So you can check for this return status code and simply log the results.

Full documentation of the tool is available by launching a DOS (or similar shell) window and typing FusionConfigWriter --help.

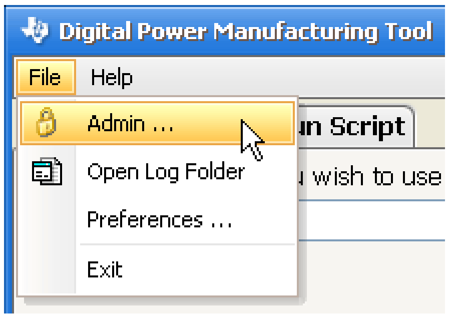
6.1.4 Fusion Manufacturing GUI (MFR GUI)

The MFR GUI provides a framework to perform a variety of manufacturing activities on Texas Instruments UCD device(s) in a lab or factory setting. You can create "scripts" that can:

- Download firmware
- Download configuration (project file or data flash)
- Write serial numbers and date
- Calibrate device (manual or instrumented)
- Test device
- Other: open API for customer to add their own custom processes

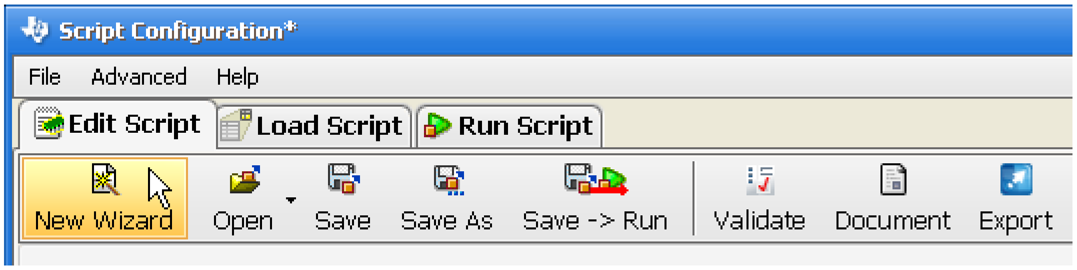
The MFR GUI is driven off of a special XML file called a "manufacturing script." It defines the devices in your system and the activities – called tasks – you want to perform on each device. Tasks are listed in order that they should be executed. If a task fails, the script will stop for the device. Tasks can also have configurable retry. If you are familiar with TestStand, think of the MFR GUI as a mini-TestStand, highly optimized for UCD devices.

The MFR GUI has two distinct operating modes: script editing and script running. Script editing is a one time or maintenance activity where you define the tasks that will be performed on your devices. After you have launched the MFR GUI from the Start Menu, you should enter the "Admin" mode to create a new script:

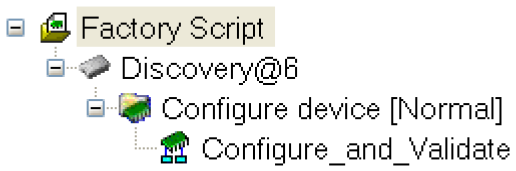


The password is "texas". A script can be created/edited in Admin mode only. This password prevents an "operator" – someone running the script with limited knowledge of the tool/device(s) – from accidently changing the script.

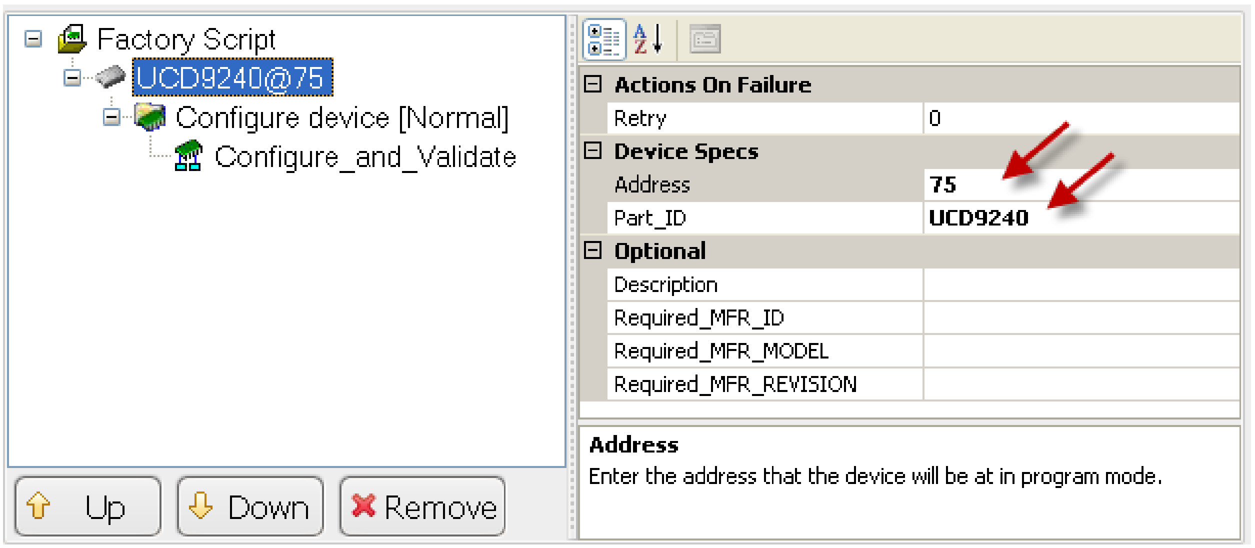
For the purposes of this document, two very simple MFR GUI scripts will be created to download configuration to a device. One script will use project files. The other will use data flash images. To jump start the script creation process, click the "New Wizard" icon in the toolbar:



Select the “Configure_With_Project_File” template and click the Create button. This will yield this simple script:



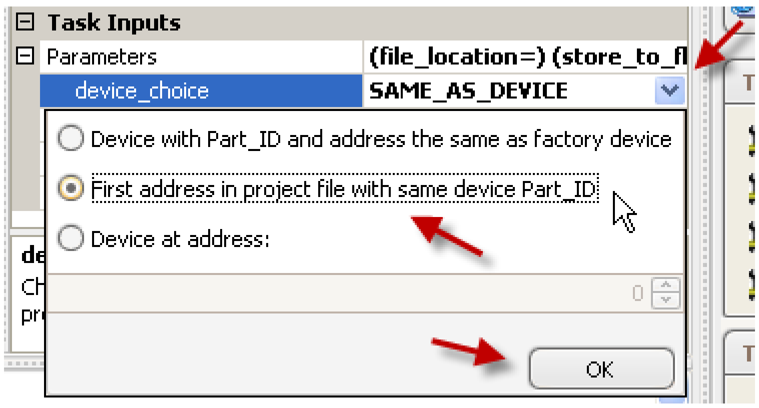
Scripts are organized by device, then by activity, and then by task. In the case of the wizard, a place holder device was defined. Click the “Discovery@6” node in the tree. You’ll notice that the properties area to the right changes after you select the device. You define properties about the selected node in this area. For example, to target a UCD9240 at address 75:



Actions On Failure	
Retry	0
Device Specs	
Address	75
Part_ID	UCD9240
Optional	
Description	
Required_MFR_ID	
Required_MFR_MODEL	
Required_MFR_REVISION	

Address
Enter the address that the device will be at in program mode.

Next, click on the “Configure_and_Validate” node. Click on cell to the right of devce_choice – SAME_AS_DEVICE is the default – and change the selection to “First address in project file with the same device Part_ID” and click OK:

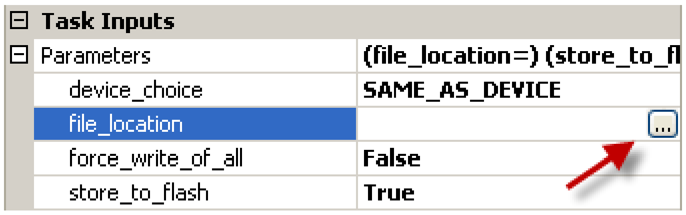


Task Inputs	
Parameters	(file_location=) (store_to_fl
device_choice	SAME_AS_DEVICE

Device with Part_ID and address the same as factory device [✓ First address in project file with same device Part_ID] Device at address:

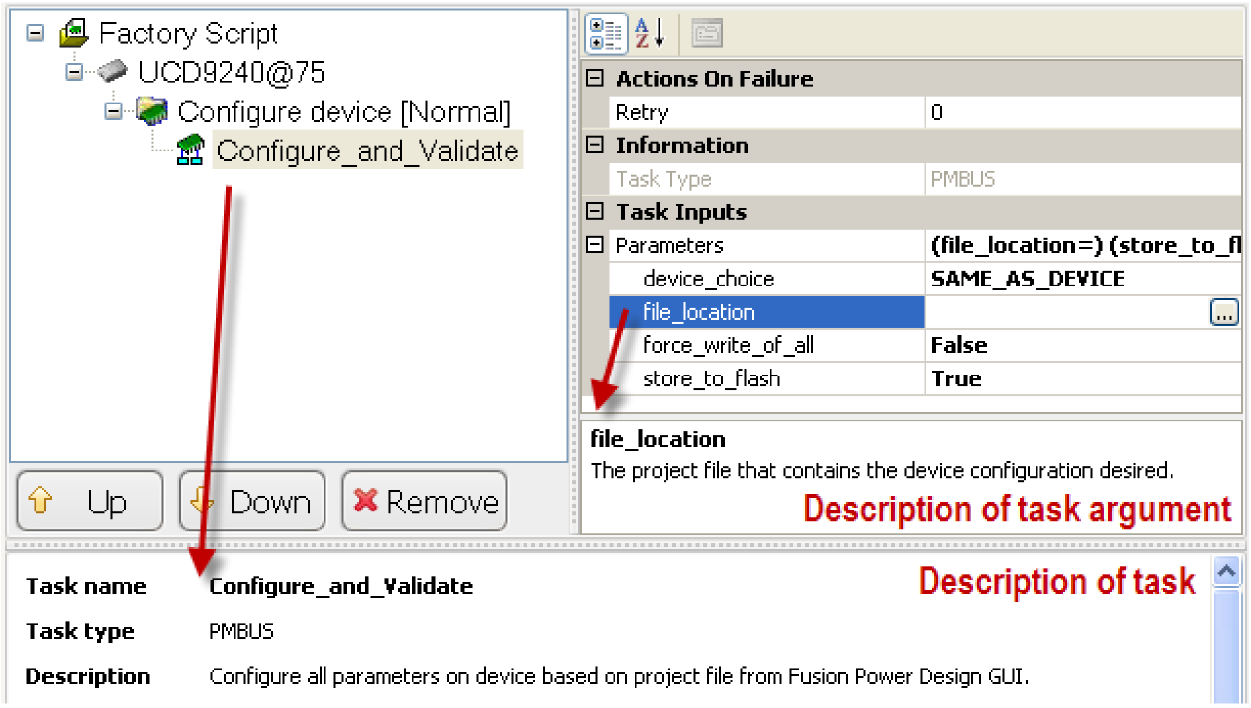
This is usually needed because the PMBus address defined in your project file is often different from the address you are targeting. If, however, yours match up, you can keep the default. In this mode the MFR GUI will enforce that the device address in the project file is an exact match to the device this task is under (address 75).

Next, click on the cell to the right of “file_location” and find the XML project file you want to write:



Task Inputs	
Parameters	(file_location=) (store_to_fl
device_choice	SAME_AS_DEVICE
file_location	
force_write_of_all	False
store_to_flash	True

Keep the default values for force_write_of_all (False) and store_to_flash (True). Context sensitive help on the current task argument is always available below the properties grid. And full documentation of the currently selected task is shown at the bottom of the screen:

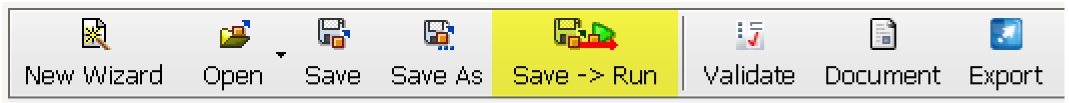


Actions On Failure	
Retry	0
Information	
Task Type	PMBUS
Task Inputs	
Parameters	(file_location=) (store_to_fl
device_choice	SAME_AS_DEVICE
file_location	
force_write_of_all	False
store_to_flash	True

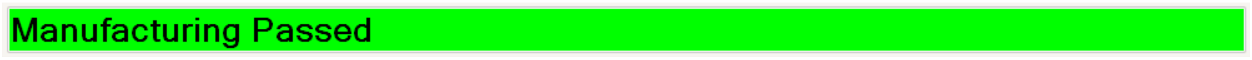
file_location
The project file that contains the device configuration desired.

Task name	**Configure_and_Validate**
Task type	PMBUS
Description	Configure all parameters on device based on project file from Fusion Power Design GUI.

Next, click the “Save -> Run” button on the toolbar:



You’ll be prompted to select a location for your MFR GUI “script.” Note that the extension is the same as project files: .xml. After the save is done, the MFR GUI will jump to the script runner tab. Click the Start button to execute the script. The MFR GUI shows PASS/FAIL via a banner at the bottom of the run tab:

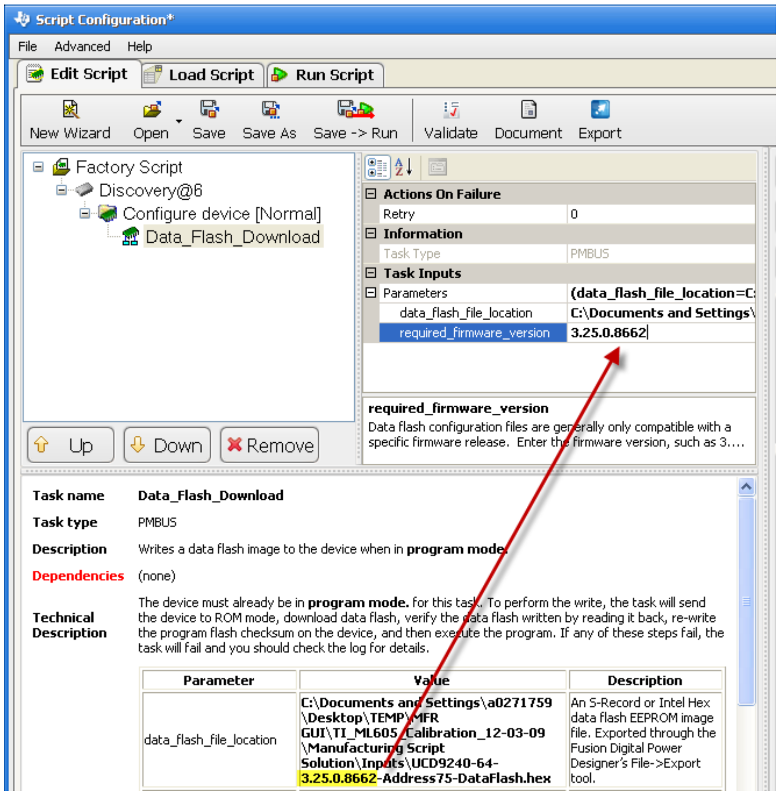


When you are ready to program another part, you do not need to quit the MFR GUI. Simply swap out devices and click the Start button again. The log area will be cleared and the script will restart from the top, including standard device discovery to verify that a device is present.

Detailed log files are saved for each script “run”. See the MFR GUI user manual for complete instructions and details. The MFR GUI can do much more than download configuration files.

If you need to program a **data flash** image instead, select the “Configure_With_Data_Flash_File” template in the “New Wizard”. Follow the steps above to set the device part/address. Then click the “Data_Flash_Download” task and select the data flash hex file to program. Optionally, you can have the MFR GUI validate that the firmware version of the target device is a specific version. One easy way to determine this version is to look at the filename of the data flash hex file.

If you used the default and recommended file name template when you exported your data flash image in the Fusion GUI, the filename will contain the firmware version that the data flash was exported from. In the following example the data flash file was exported from firmware version 3.25.0.8662:



Actions On Failure	
Retry	0
Information	
Task Type	PMBUS
Task Inputs	
Parameters	(data_flash_file_location=C:
data_flash_file_location	C:\Documents and Settings\
required_firmware_version	3.25.0.8662

required_firmware_version
Data flash configuration files are generally only compatible with a specific firmware release. Enter the firmware version, such as 3....

Task name	**Data_Flash_Download**
Task type	PMBUS
Description	Writes a data flash image to the device when in **program mode**.
Dependencies	(none)
Technical Description	The device must already be in **program mode.** for this task. To perform the write, the task will send the device to ROM mode, download data flash, verify the data flash written by reading it back, re-write the program flash checksum on the device, and then execute the program. If any of these steps fail, the task will fail and you should check the log for details.

Parameter	Value	Description
data_flash_file_location	**C:\Documents and Settings\a0271759 \Desktop\TEMP\MFR GUI\TI_ML605_Calibration_12-03-09 \Manufacturing Script Solution\Inputs\UCD9240-64-3.25.0.8662-Address75-DataFlash.hex**	An S-Record or Intel Hex data flash EEPROM image file. Exported through the Fusion Digital Power Designer’s File->Export tool.

6.2 Downloading a Configuration Using a Dedicated EEPROM Programmer

You should inquire about support for your target device as soon as possible. Each EEPROM programming vendor must add support for UCD devices. Some will add generic support, which will work for almost any UCD3000-based device (for example, UCD9240 or UCD90120). Others need to add support for each unique TI device. Section 9.3, Gang Programmer Notes, lists distributors and vendors that TI has worked with to add programming support for UCD devices.

You should perform a sample programming run as early as possible, even before a final device configuration is locked down.

Follow the instructions in section 9.1, Exporting Configuration Data Flash Hex File, to create a hex file for your programming vendor.

6.3 Downloading a Configuration via JTAG

JTAG (Joint Test Action Group) is the common name for the IEEE 1149.1 Standard Test Access Port and Boundary-Scan Architecture. In UCD devices JTAG provides debug facilities for device development within TI and EEPROM download by TI customers.

The Fusion toolset is capable of generating SVF that can be used to configure the device via JTAG. While, in theory, SVF should provide a solution that will port to any given JTAG programming toolset, the reality is that the SVF syntax definition is vulnerable to multiple interpretations. Fusion provides options for generating different forms of the SVF that are compatible with several different JTAG toolsets. **Each customer must confirm that they can reliably configure the device via JTAG with their programming tools.** This can be done by obtaining the appropriate EVM and samples of the device from Texas Instruments.

JTAG programming may occasionally fail on UCD devices due to an internal clocking issue. This issue is limited to the JTAG interface and does not affect any form of normal operation. The failure is not predictable and may not occur in all configurations. If a failure occurs, the customer should reset the device and attempt running the SVF a second time.

6.3.1 System Board Requirements

The JTAG pins (TMS, TDI, TDO, TCK) from the device must be accessible to the JTAG controller. The control and data lines (TMS, TDI, TDO) should be pulled high on the board.

If the device has a TRCK (return clock) pin and the JTAG controller supports that pin as well, the two should be connected. If the JTAG controller has a TRCK pin, but the device does not, the TRCK signal should be connected to the TCK signal on the board.

The nTRST signal should be high with programming the device via JTAG. It should be low for normal operation.

6.3.2 Overview of SVF

SVF (Serial Vector Format) is an ASCII-based standard for expressing test patterns that represent the stimulus, expected response, and mask data for JTAG-based configuration. SVF was selected because it allows Texas Instruments to create vendor-independent JTAG configuration patterns that are transportable across a wide selection of programming software and equipment.

For additional information, please refer to IEEE 1149.1 Testability Primer.

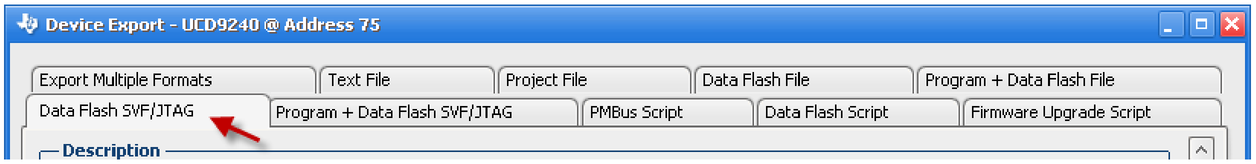
6.3.3 Differences Between IC Packages

Most UCD devices support JTAG. Typically, the PMBus address pins must be shorted to ground to enable the JTAG interface. Some exceptions are noted here:

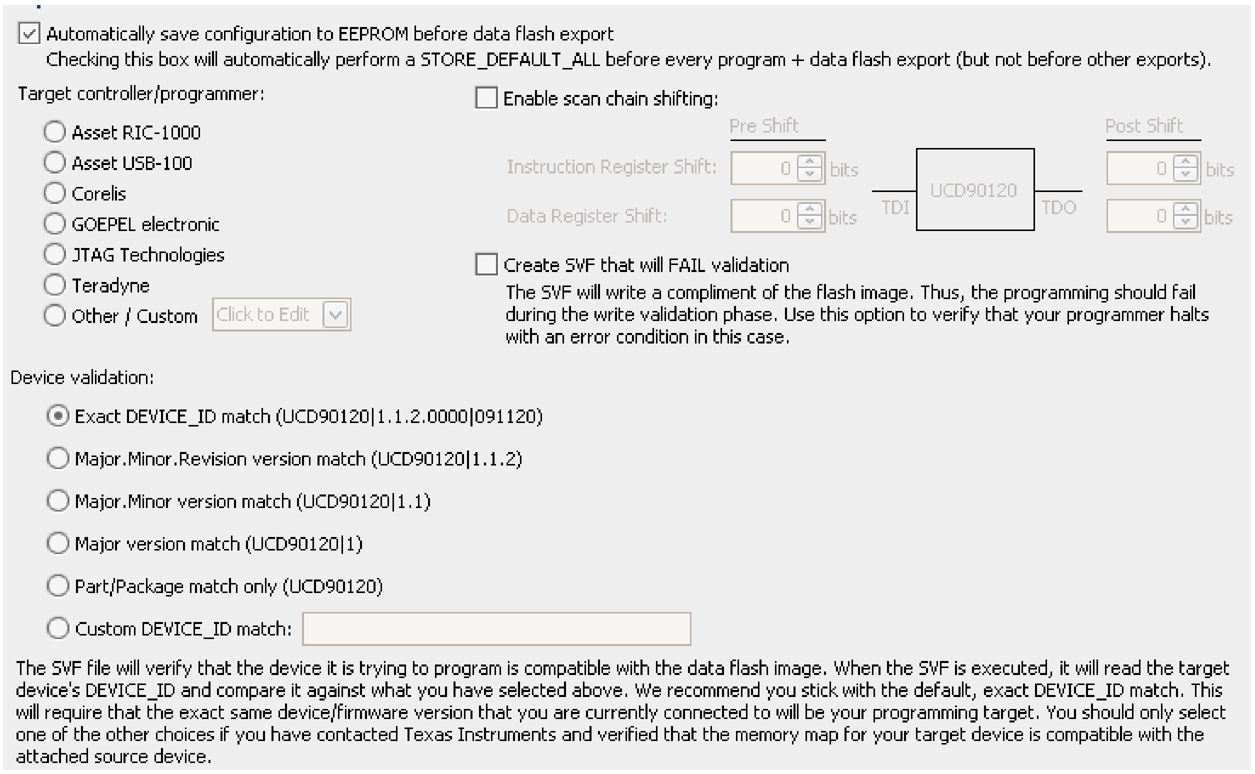
- It is not necessary to short the PMBus address pins to ground when using the UCD9248
- Any 40 pin package does not support JTAG
- UCD3028 does not support JTAG
- The UCD device can be set to PMBus address 126 to leave JTAG always enabled. Note – using this method will disable use of the JTAG pins as GPIO in devices that support multiplexing of these pins. You must also ensure that no other device on the same PMBus could end up at address 126. For example, do not use this method when there are multiple UCD devices on the same PMBus.

6.3.4 Exporting Data Flash Configuration as SVF

The Fusion GUI's File->Export tool is used to generate an SVF file. You should use the "Data Flash SVF/JTAG" export mode:



The default options are:



☑ Automatically save configuration to EEPROM before data flash export
Checking this box will automatically perform a STORE_DEFAULT_ALL before every program + data flash export (but not before other exports).

Target controller/programmer:

- ○ Asset RIC-1000
- ○ Asset USB-100
- ○ Corelis
- ○ GOEPEL electronic
- ○ JTAG Technologies
- ○ Teradyne
- ○ Other / Custom Click to Edit

☐ Enable scan chain shifting:

Pre Shift
Post Shift
Instruction Register Shift: 0 bits
Data Register Shift: 0 bits
TDI
UCD90120
TDO
0 bits
0 bits

☐ Create SVF that will FAIL validation
The SVF will write a compliment of the flash image. Thus, the programming should fail during the write validation phase. Use this option to verify that your programmer halts with an error condition in this case.

Device validation:

- [✓ Exact DEVICE_ID match (UCD90120|1.1.2.0000|091120)]
- ○ Major.Minor.Revision version match (UCD90120|1.1.2)
- ○ Major.Minor version match (UCD90120|1.1)
- ○ Major version match (UCD90120|1)
- ○ Part/Package match only (UCD90120)
- ○ Custom DEVICE_ID match:

The SVF file will verify that the device it is trying to program is compatible with the data flash image. When the SVF is executed, it will read the target device's DEVICE_ID and compare it against what you have selected above. We recommend you stick with the default, exact DEVICE_ID match. This will require that the exact same device/firmware version that you are currently connected to will be your programming target. You should only select one of the other choices if you have contacted Texas Instruments and verified that the memory map for your target device is compatible with the attached source device.

The SVF file will verify that the device it is trying to program is compatible with the data flash image. When the SVF is executed, it will read the target device's DEVICE_ID and compare it against what you have selected above. We recommend you stick with the default, exact DEVICE_ID match. This will require that the exact same device/firmware version that you are currently connected to will be your programming target. You should only select one of the other choices if you have contacted Texas Instruments and verified that the memory map for your target device is compatible with the attached source device.

It is recommend you export your configuration as a project file and data flash hex file at the same time you export SVF. See section 4.2, Exporting to Multiple File Formats, for additional information. While the Fusion tools do not support importing SVF, they can import a data flash file, allowing write to data flash directly.

6.3.5 SVF Flow

The SVF performs the following steps when downloading configuration data:

- Erase data flash

- Write data flash
- Verify data flash

6.3.6 BSDL File

A BSDL (Boundary Scan Description Language) file is available for all UCD30xx-based devices that support JTAG. The file, ucd30xx.bsdl, is located in the misc folder within the Fusion GUI program directory. This is normally C:\Program Files\Texas Instruments Fusion Digital Power Designer\misc.

6.3.7 Supported TCK Frequencies

TCK frequencies up to 5 MHz have been tested using ASSET ScanWorks on a RIC-1000. 4 MHz has been tested on JTAG Technologies boundary scan controllers. For other programmers, you should start at 1 MHz and increase clock frequency until you experience programming errors. Thoroughly test the selected frequency, and consider decreasing the clock speed further to allow for variation in your manufacturing environment.

6.3.8 List of Tested Programmers

The following controllers have been tested and used to configure a device via JTAG (in alphabetical order):

- ASSET
  Tested against USB-100 and RIC-1000 programmers.
- Corelis
  Tested against all currently supported Corelis JTAG controllers, as of August 2010.
- GOEPEL Electronic
  Tested against SFX/USL1149-B controller. All SCANFLEX and ScanBooster controllers will support UCD devices. Requires SYSTEM CASCON software version 4.5.3c or higher.
- JTAG Technologies
  Tested with JT 37x7 / TSI boundary scan controller. Other solutions should work as well.
- Teradyne
  The SVF must be converted to a JTAG control language used by Teradyne. The conversion tool is called ISP 3.0.0. This is a tool written and maintained by Teradyne. SVF produced by the Fusion GUI has been tested and confirmed to work on the 2287LX test system, but should work on any of the Teradyne Test Station systems or the older GenRad 228X systems. While not tested, Teradyne Test Station SE and Spectrum systems should also accept converted files.
- Other In-Circuit Test (ICT) equipment
  Most ICT equipment requires conversion from SVF to a proprietary format. Contact your ICT vendor for assistance.

6.3.9 Troubleshooting

If you are experiencing problems programming via JTAG, please review these troubleshooting hints and steps:

- Have you shorted the address lines to ground during JTAG programming?
- Is the nTRST signal high during JTAG programming?

- If the TRCK is used by the JTAG controller, is it connected to the TRCK signal on the device or the TCK signal?

6.3.10 Additional Information & Help

JTAG vendors should reference Appendix 8.6, Miscellaneous JTAG Questions, for additional information about device memory. Customers who need JTAG programming assistance should contact their TI representative.

6.4 Downloading Configuration Data Using a Microcontroller

Your system board microcontroller (µc) could download a full or partial configuration to a device. This programming would be performed via I^2C. The µc could download one of the following:

- A full configuration via data flash. More recent devices like the UCD90160, UCD9222, and UCD9244 permit update of the device's data flash while the device is operating normally. The device is reset to load the new configuration when download is complete. Other UCD devices require the device be sent to ROM mode before the data flash can be written. Thus, normal device operation is not possible in these devices during data flash download. Section 6.4.2 lists which devices support Normal Mode data flash download and which require ROM Mode download.
- A full configuration via PMBus. The µc will assume the device configuration is in an unknown state or a factory virgin state. The full configuration will be written to the device through standard PMBus commands.
- A partial configuration via PMBus. Your µc assumes that some baseline configuration is in the device and writes an "update" to the device using PMBus commands.

It is recommended you read this entire section to understand the pros and cons of each method.

There are two approaches when developing your configuration download scheme:

- Export a data flash "script" files using the GUI. A script file lists each SMBus/I2C step that is required to download data flash to the device. You will need to develop a "script" execution engine for your microcontroller that parses the script file and converts it to appropriate SMBus/I2C calls. This is explained in detail in the sections that follow.
- Export a data flash hex file using the GUI. Create a custom programming solution on your microcontroller that accepts hex input and writes to the device using the general recipe described in this section. Sample "C" source code that was developed to run on the Texas Instruments' Stellaris LM3S811 device (ARM Cortex-M3 based) is available. Download from http://software-dl.ti.com/analog/analog_public_sw/fusion/UCD9xxx-UCD3xxx-Programming-Example-C-Code.zip.

The script format is the preferred approach, because at any time TI can update the script logic with no changes required on the microcontroller end. Script exports can also be generated for the following activities:

- Downloading a full or partial configuration using PMBus
- Upgrading a device's firmware

Thus, a common script execution engine developed for your microcontroller can be used for a variety of UCD download activities, including for future devices.

6.4.1 SMBus / I^2C Script Overview

Texas Instruments has developed a generic, platform independent method of describing the steps necessary to perform some of the above actions. This is dubbed a "script" and can take one of two forms:

- SMBus Script: describe a series of bus transactions in terms of the high-level System Management Bus (SMBus) protocol. This means "Send Byte", "Write Byte", etc.
- I^2C Script: describes bus transactions in terms of the lower level I^2C protocol.

Which you will use will depend on your microcontroller firmware development environment and APIs. You may already have an API stack that abstracts communication with devices like a UCD9240 in terms of SMBus. For example, to set the OPERATION command to 0x80 (On, No Margin) would mean issuing a Write Byte to command code 0x01 with data byte 0x80. And of course an address of the device is needed. A microcontroller SMBus API might define a function such as:

```
bool write_byte(byte address, byte cmd_code, byte data)
{
   …
}
```

So sending the sample OPERATION command to address 12d would mean calling:

```
write_byte(0x0C, 0x01, 0x80);
```

Not shown here is specification of a Packet Error Check (PEC) byte. This might be an optional argument or some type of global construct: i.e. always attach PEC byte to writes for devices on the bus. A sample “C” function that calculates a PEC byte is in appendix 9.9.

Any SMBus stack will ultimately communicate with the device in terms of I^{2}C reads and writes. SMBus is simply a protocol layer on top of I^{2}C. I^{2}C packs the addressing information, command code, data, and optional PEC byte into a block of data. A bit is used to determine whether the request is a read or write.

In our example above, the OPERATION write byte with PEC appended would translate to an I2C write of:

Address, R/W Bit	Command Code	Data Byte	PEC Byte
0x18	0x01	0x80	0x6F

Scripts are created using the File->Export tool. All script export formats have the following options:

Script Style	Whether to output a script that performs writes in terms of high-level SMBus or low-level I^{2}C.
Store RAM to Flash?	Checking this box will automatically perform a STORE_DEFAULT_ALL before every firmware script export. If this is not checked, any changes you recently made to your config but did not write to non-volatile memory (dflash) will not be included in the script.
PEC	Only used for the I^{2}C format. Checking this will include the Packed Error Code byte in each I^{2}C write.
File Format	Choose between Comma Separated Value (CSV) and tab separated formats.
Hex Format	A variety of hex formats are supported.
Comment Style	A number of comment styles are supported. A comment proceeds each major section of the script, such as “Downloading data flash ...”
How to Handle Multiple Data Bytes	How to format the data field for an SMBus or I^{2}C write command. For example, WriteBlock accepts an array of 1+ bytes. By default – “compact together into one field” – this block of data is concatenated together in one field using the Hex Format style. As an alternative, you can select “break apart into separate fields” to break out the data bytes into different fields (columns).
Security	For devices that support Texas Instruments enhanced command security, you can chose to write a security password to data flash before doing the export. See the Security section

	of the Fusion Digital Power Designer User's Guide for more information about security.
Embedded Device Address	This option allows you to create a script that targets the device address used "in the field," should it differ from the device you are currently attached to.
Add block length byte to read block and write block commands in SMBus mode	Earlier versions of the GUI did not add block length to block reads/writes, and your parser would have to compute them. Export now includes block length by default. The option can be unchecked to create files in the old format.

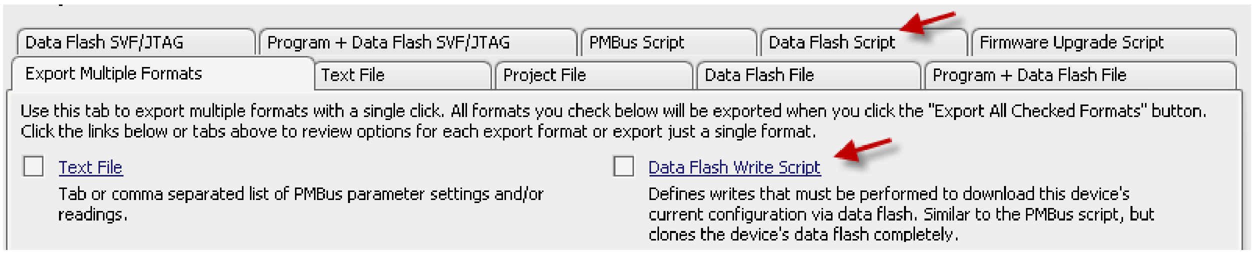
Seesection 4, Configuration Export Overview, for additional tips on using the export tool.

6.4.2 Microcontroller Writes Data Flash

Some UCD devices do not support data flash download while in normal operating mode. These devices must be sent to ROM mode to download a new data flash image. When in ROM mode, the device is not executing its normal firmware program and will not perform its primary function(s): power regulation, sequencing, monitoring, etc. The device will also not respond to system stimulus, such as a GPI state change or a fault condition. Thus, if your microcontroller or other critical component is powered by a rail on the UCD device, this configuration update process is not appropriate. See section 6.4.3 Microcontroller Writes Full Configuration via PMBus and section 6.4.4 Microcontroller Writes Partial Configuration via PMBus for alternatives that allow in-process configuration update on these devices.

Consult section 9.2, Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices, to determine which data flash download scheme is supported by your device.

The "Data Flash Script" export format can be used to generate the recipe needed to write data flash to a device. The Export tool is launched from the Fusion GUI's File menu, under "Export …" The data flash script format is in the upper right corner of the form:



Use this tab to export multiple formats with a single click. All formats you check below will be exported when you click the "Export All Checked Formats" button. Click the links below or tabs above to review options for each export format or export just a single format.

☐ Text File
Tab or comma separated list of PMBus parameter settings and/or readings.

☐ Data Flash Write Script
Defines writes that must be performed to download this device's current configuration via data flash. Similar to the PMBus script, but clones the device's data flash completely.

The data flash config script can only be generated in online mode. All the usual caveats about firmware versioning apply. The GUI will read the device's current configuration from EEPROM and create a "script" detailing the steps your microcontroller must perform to update data flash. The GUI will automatically select the appropriate scheme – Normal Mode or ROM Mode – based on the device that is attached.

6.4.2.1 Microcontroller Writes Data Flash, Normal Mode Scheme

In this scheme, a new data flash image is written to the device while it continues to operate. The general recipe for writing data flash using this scheme is:

- Verify the target device is the correct part and at the expected firmware revision
- Disable data flash write protection (normally the device does not allow data flash to be written to).
- Erase data flash.

- Write data flash.
- Verify data flash (read back).
- Reset the device.
- Verify that the device is running again (DEVICE_ID or other check).
- Erase data flash logs.

The device will operate normally during the data flash download with one exception: data flash logging will not occur. For example, if your device supports fault logging, is configured to log a certain fault, and that fault occurs, the device will not log the fault to data flash. It will, however, continue to update status registers such as STATUS_VOUT.

An abbreviated example script is in section 9.6, Data Flash Download Script Example – Normal Mode. The full recipe for writing data flash in normal mode is described in more detail in section 9.5, Detailed Recipe for Device Writes Data Flash, Normal Mode Scheme.

6.4.2.2 Microcontroller Writes Data Flash, ROM Mode Scheme

In this scheme, the device must be sent to ROM mode to write data flash. When in ROM mode, the device will not perform normal operations, such as power conversion, monitoring, or sequencing. The general recipe of writing to data flash is:

- Verify the target device is the correct part and at the expected firmware revision
- Send the device to ROM mode.
- Erase data flash.
- Write data flash.
- Verify data flash (read back).
- Recreate the program flash checksum.
- Verify the program flash by comparing ROM calculated checksum against the checksum that was written.
- Issue a ROM command to execute the device program.
- Verify that the device is running again (DEVICE_ID or other check).
- Erase data flash logs.

The sequence is complicated because of the need to send the device to ROM mode.

The firmware gets the device to ROM mode by clearing the program flash checksum and then resetting the device. After reset, the device will stay in ROM mode. UCD devices provide a MFR_SPECIFIC PMBus command to do this, ENABLE_ROM. When in ROM mode, the device responds at a hard coded address, 11d. You should therefore not use address 11 for any other devices on the same bus. When data flash write is completed, the program flash checksum will need to be recreated. Because flash memory can only be written when it is in an “erased” state, the script will erase an entire segment of program flash and then recreate it.

The UCD ROM requires a PEC byte on writes and always sends a PEC byte on reads. While devices in program mode (UCD9240, UCD9240, UCD90120, etc) do not require PEC, it is recommended if your I2C bus has excessive noise or other limitations. A sample “C” function that calculates a PEC byte is in appendix 9.9.

An abbreviated example script for data flash download via ROM is in section 9.5, Data Flash Download Script Example – ROM Mode.

6.4.3 Microcontroller Writes Full Configuration via PMBus

The Fusion GUI loads project files by writing to the device using PMBus commands. Your µc could do the same. The PMBus Script export format is used to generate the series of PMBus writes necessary to configure a device. The script generated is very "dumb": it assumes the device is in a completely unconfigured state. For UCD92xx devices, the script will even reset the device, as this is required after setting the rail/phase configuration of the device.

A PMBus config script for a UCD9224 with two rails follows is included in section 9.8, UCD9224 PMBus Config Script Example. A UCD90124 example is listed in section 9.8.2, UCD90124 PMBus Config Script Example. PMBus scripts can be generated online or offline.

6.4.4 Microcontroller Writes Partial Configuration via PMBus

While updating a configuration in the field using the "full" configuration scripts described in section 6.4.2 and 6.4.3 is possible, with UCD92xx parts the device must be taken offline for a short period during the write sequence (to perform a soft reset). It is also likely that only a small number of parameters need to be updated. Thus, you may want to use a subset of the script export when writing a configuration update via your µc.

It is recommended you use one of the MFR_ commands to store a unique configuration identifier in each UCD device. For example, MFR_REVISION may have a configuration ID embedded within it, such as REVC. The µc firmware can use this to determine whether it needs to upgrade a configuration on a UCD device. The µc could store a "script" that would take the device from REVA or REVB to REVC.

The GUI does not include any tools to assist in generating such a configuration upgrade script. But generating a script for REVA and REVC, then doing a "diff" between the two will provide clues on what the upgrade script should do. KDiff3 is an open-source, free file compare tool you can use.

6.4.5 Testing the Export Using the Script Runner Tool

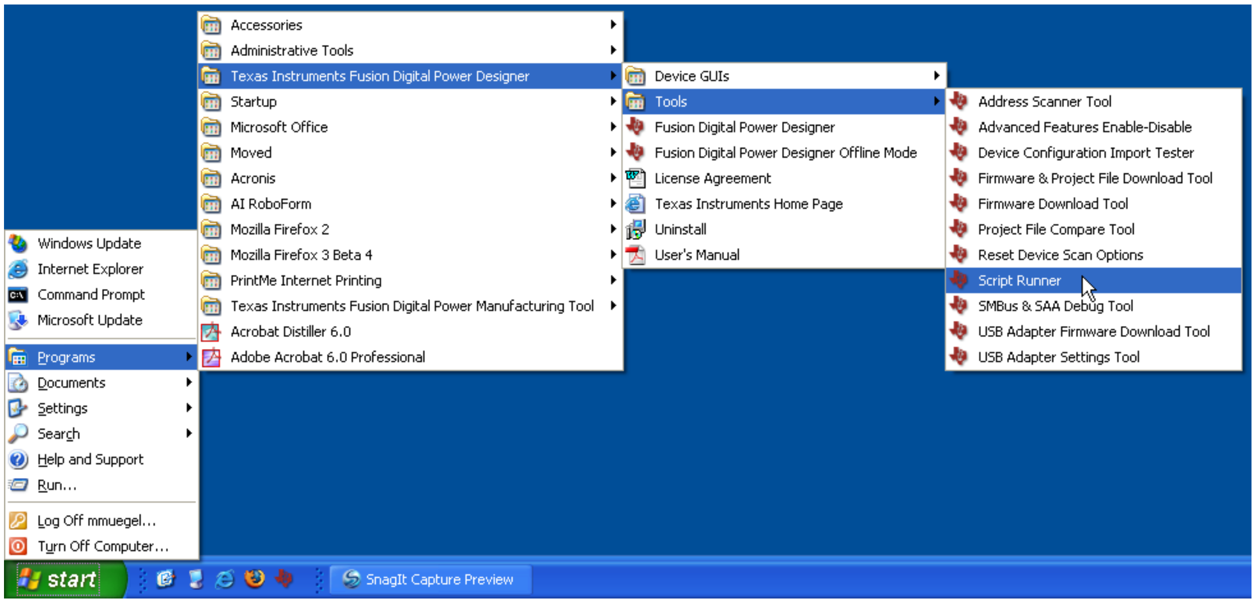
You can run scripts three ways:

- The File->Import wizard has a script option
- Use the stand alone Script Runner tool that is bundled in the Fusion GUI
- Use the FusionScriptRunner command line tool

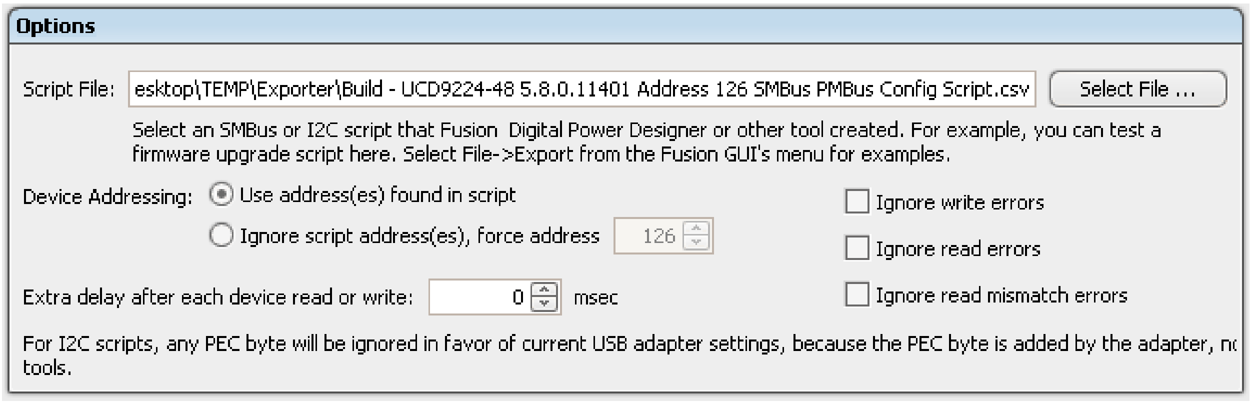
These tools will execute any script matching one of the SMBus/I^{2}C script formats supported by the File→Export tool.

6.4.5.1 Script Runner GUI Tool

Launch the It is available from the GUI's Start Menu Tools folder:


Accessories
Administrative Tools
Texas Instruments Fusion Digital Power Designer
Startup
Microsoft Office
Moved
Acronis
AI RoboForm
Mozilla Firefox 2
Mozilla Firefox 3 Beta 4
PrintMe Internet Printing
Texas Instruments Fusion Digital Power Manufacturing Tool
Acrobat Distiller 6.0
Adobe Acrobat 6.0 Professional
Device GUIs
Tools
Fusion Digital Power Designer
Fusion Digital Power Designer Offline Mode
License Agreement
Texas Instruments Home Page
Uninstall
User's Manual
Address Scanner Tool
Advanced Features Enable-Disable
Device Configuration Import Tester
Firmware & Project File Download Tool
Firmware Download Tool
Project File Compare Tool
Reset Device Scan Options
Script Runner
SMBus & SAA Debug Tool
USB Adapter Firmware Download Tool
USB Adapter Settings Tool
Windows Update
Internet Explorer
Command Prompt
Microsoft Update
Programs
Documents
Settings
Search
Help and Support
Run...
Log Off mmuegel...
Turn Off Computer...
start
SnagIt Capture Preview

The tool has options to control how the script is executed:



Options

Script File: esktop\TEMP\Exporter\Build - UCD9224-48 5.8.0.11401 Address 126 SMBus PMBus Config Script.csv

Select an SMBus or I2C script that Fusion Digital Power Designer or other tool created. For example, you can test a firmware upgrade script here. Select File->Export from the Fusion GUI's menu for examples.

Device Addressing: [✓ Use address(es) found in script] Ignore script address(es), force address 126

☐ Ignore write errors

☐ Ignore read errors

Extra delay after each device read or write: 0 msec

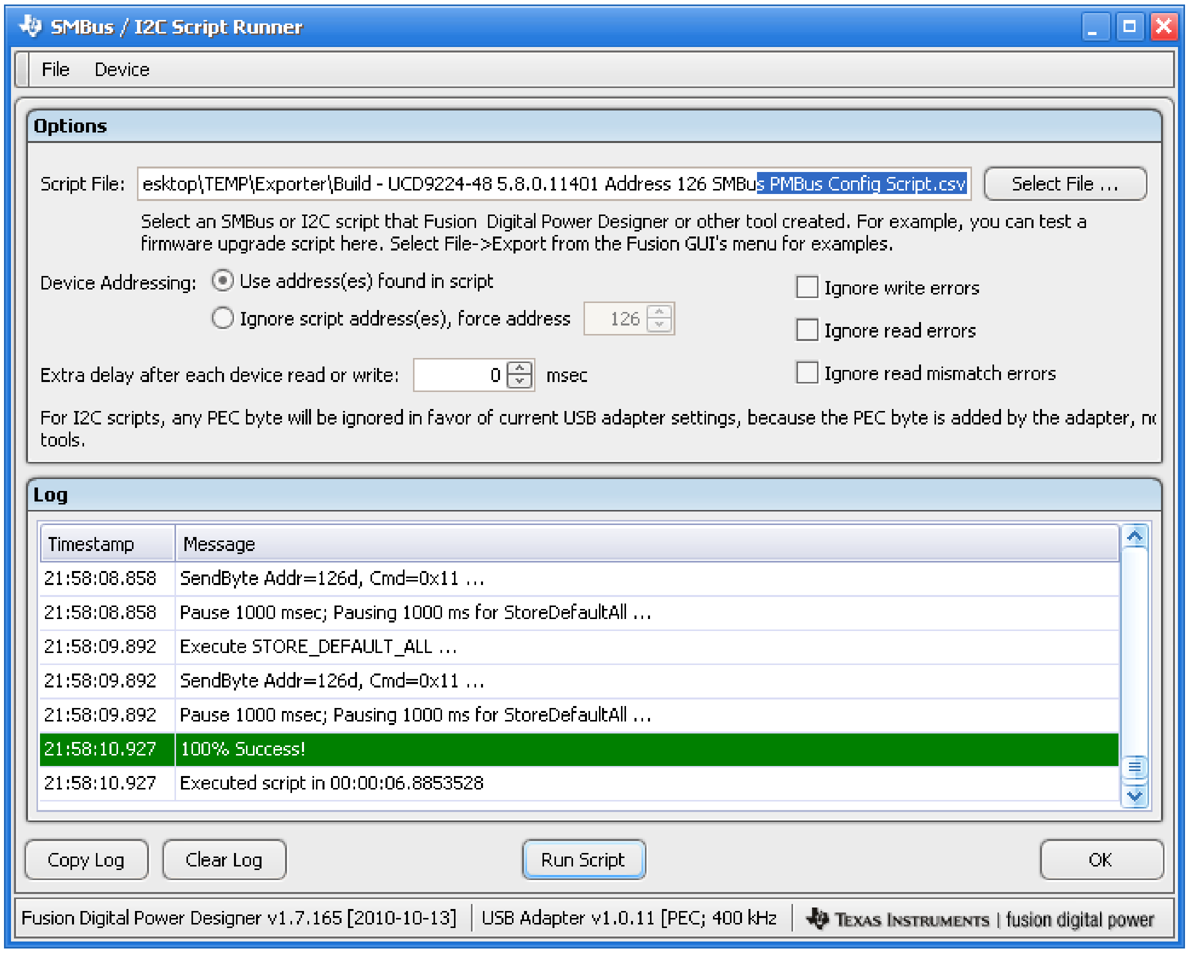
☐ Ignore read mismatch errors

For I2C scripts, any PEC byte will be ignored in favor of current USB adapter settings, because the PEC byte is added by the adapter, nc
tools.

The device address option will <u>not</u> work with ROM mode data flash configuration download scripts, because this mode uses two addresses:

- One for the address the device runs on when in program mode
- A second, fixed at address 11d, for the address the device runs at when in ROM mode

As the script is run, a progress bar indicates how many of the script's steps have been performed. At the end of script execution, a log of every script action that was performed will be written to the log area. An example run is shown below:



Script File: esktop\TEMP\Exporter\Build - UCD9224-48 5.8.0.11401 Address 126 SMBus PMBus Config Script.csv

Select an SMBus or I2C script that Fusion Digital Power Designer or other tool created. For example, you can test a firmware upgrade script here. Select File->Export from the Fusion GUI's menu for examples.

Device Addressing: [✓ Use address(es) found in script] Ignore script address(es), force address 126

Ignore write errors
Ignore read errors
Ignore read mismatch errors

Extra delay after each device read or write: 0 msec

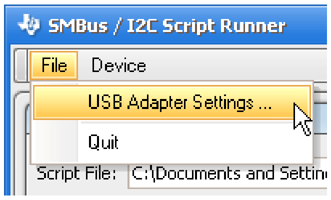
For I2C scripts, any PEC byte will be ignored in favor of current USB adapter settings, because the PEC byte is added by the adapter, n tools.

Timestamp	Message
21:58:08.858	SendByte Addr=126d, Cmd=0x11 ...
21:58:08.858	Pause 1000 msec; Pausing 1000 ms for StoreDefaultAll ...
21:58:09.892	Execute STORE_DEFAULT_ALL ...
21:58:09.892	SendByte Addr=126d, Cmd=0x11 ...
21:58:09.892	Pause 1000 msec; Pausing 1000 ms for StoreDefaultAll ...
21:58:10.927	100% Success!
21:58:10.927	Executed script in 00:00:06.8853528

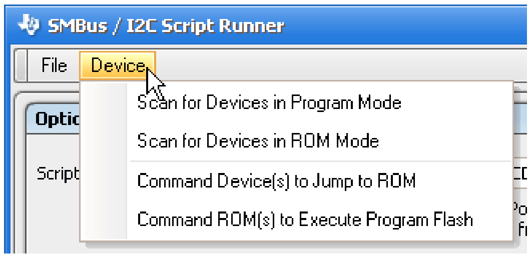
Fusion Digital Power Designer v1.7.165 [2010-10-13] | USB Adapter v1.0.11 [PEC; 400 kHz | Texas Instruments | fusion digital power

Scripts cannot be cancelled once they have started execution.

Although an I²C script may include a PEC byte, the PEC byte is actually ignored by the Script Runner. This is because the TI USB adapter handles adding the PEC byte to all SMBus and I2C writes. You can globally turn PEC mode on and off by adjusting the USB adapter's settings from the File menu:

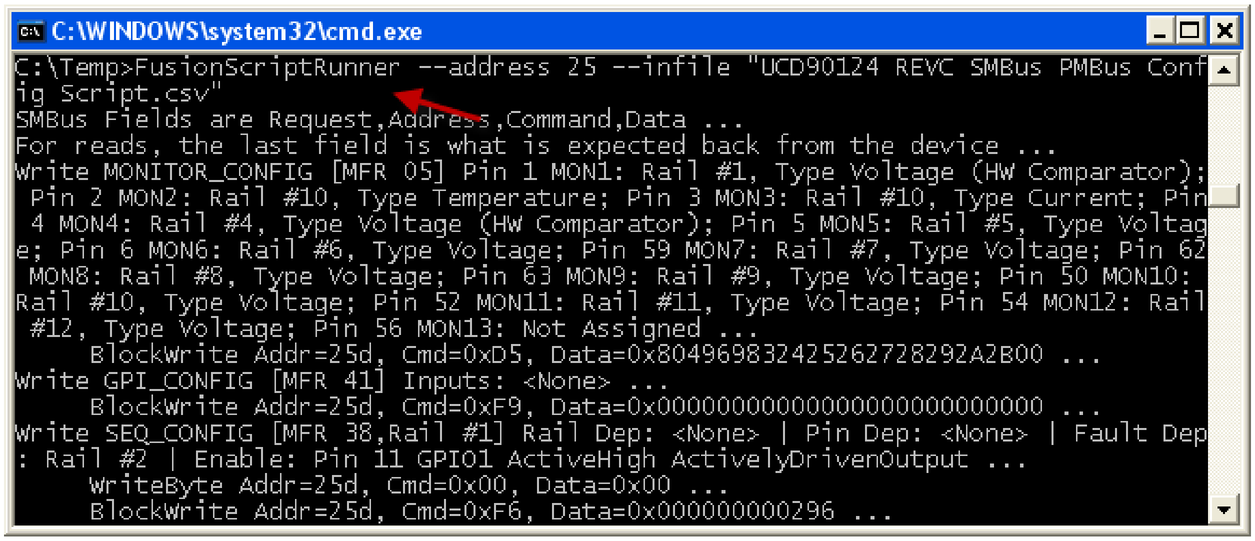

SMBus / I2C Script Runner
File
Device
USB Adapter Settings ...
Quit
Script File: C:\Documents and Settin

Script Runner also has several tools to scan for devices and command devices to jump to and from program/ROM modes:


SMBus / I2C Script Runner
File
Device
Scan for Devices in Program Mode
Scan for Devices in ROM Mode
Command Device(s) to Jump to ROM
Command ROM(s) to Execute Program Flash

6.4.5.2 FusionScriptRunner Command Line Tool

You can type FusionScriptRunner --help (two dashes) to display documentation. The tool accepts an optional --address argument similar to the Script Runner GUI. For example:



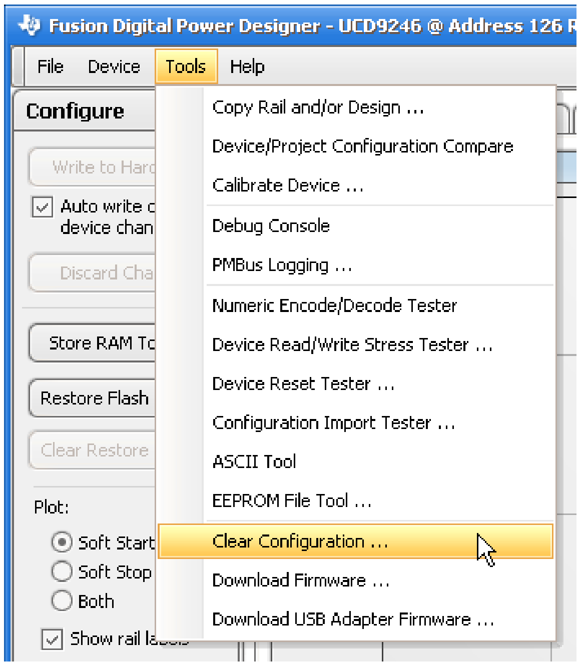
```
C:\Temp>FusionScriptRunner --address 25 --infile "UCD90124 REVC SMBus PMBus Conf
ig Script.csv"
SMBus Fields are Request,Address,Command,Data ...
For reads, the last field is what is expected back from the device ...
Write MONITOR_CONFIG [MFR 05] Pin 1 MON1: Rail #1, Type Voltage (HW Comparator);
 Pin 2 MON2: Rail #10, Type Temperature; Pin 3 MON3: Rail #10, Type Current; Pin
 4 MON4: Rail #4, Type Voltage (HW Comparator); Pin 5 MON5: Rail #5, Type Voltag
e; Pin 6 MON6: Rail #6, Type Voltage; Pin 59 MON7: Rail #7, Type Voltage; Pin 62
 MON8: Rail #8, Type Voltage; Pin 63 MON9: Rail #9, Type Voltage; Pin 50 MON10:
Rail #10, Type Voltage; Pin 52 MON11: Rail #11, Type Voltage; Pin 54 MON12: Rail
 #12, Type Voltage; Pin 56 MON13: Not Assigned ...
     BlockWrite Addr=25d, Cmd=0xD5, Data=0x80496983242526272829 2A2B00 ...
Write GPI_CONFIG [MFR 41] Inputs: <None> ...
     BlockWrite Addr=25d, Cmd=0xF9, Data=0x000000000000000000000000000 ...
Write SEQ_CONFIG [MFR 38,Rail #1] Rail Dep: <None> | Pin Dep: <None> | Fault Dep
: Rail #2 | Enable: Pin 11 GPIO1 ActiveHigh ActivelyDrivenOutput ...
     WriteByte Addr=25d, Cmd=0x00, Data=0x00 ...
     BlockWrite Addr=25d, Cmd=0xF6, Data=0x000000000296 ...
```

If you do a lot of work with command line tools, we recommend you review the Cygwin toolset. It provides a Linux/UNIX-like environment for DOS, including a much-improved command shell.

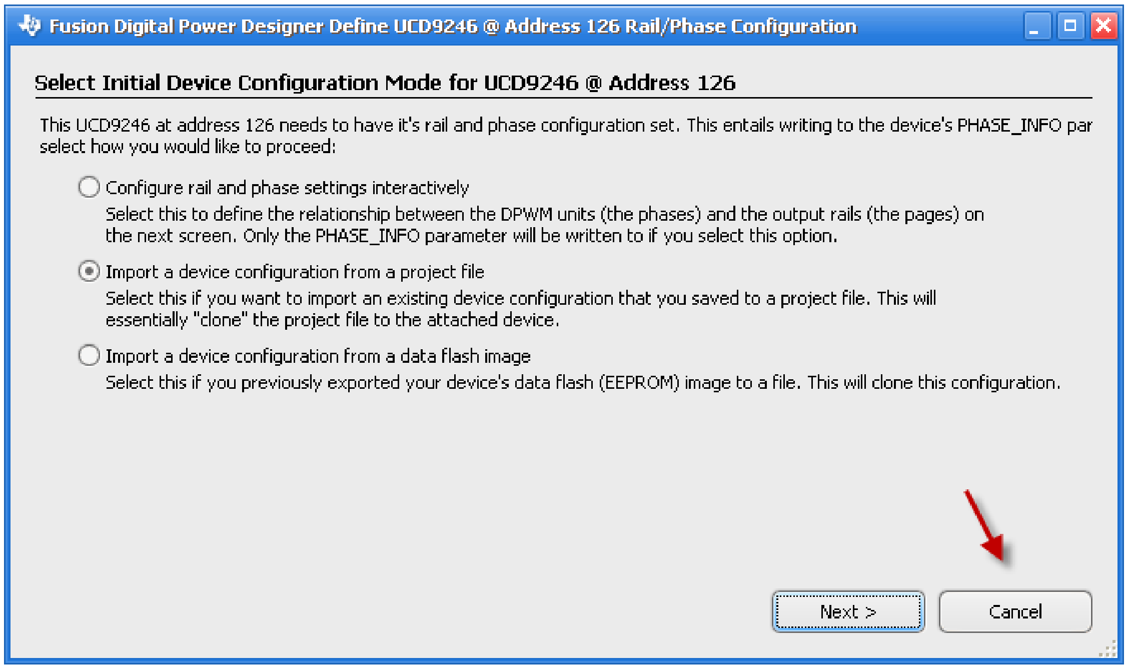
7 TIPS

When using Fusion tools, for optimal performance you should hook the TI USB adapter directly to your PC. Do not use a hub/dock of any kind, as this will significantly slow down write times.

You can clear a device's data flash through the Fusion GUI to simulate how a device will arrive from TI (un-configured). Select "Clear Configuration" from the Tools menu:



The GUI will restart after erasing data flash and writing the factory 1010… bit pattern. If you wanted to experiment with using tools other than the GUI to import data flash, simply Cancel the wizard that will appear after restart:


Fusion Digital Power Designer Define UCD9246 @ Address 126 Rail/Phase Configuration

Select Initial Device Configuration Mode for UCD9246 @ Address 126

This UCD9246 at address 126 needs to have it's rail and phase configuration set. This entails writing to the device's PHASE_INFO par select how you would like to proceed:

( ) Configure rail and phase settings interactively
Select this to define the relationship between the DPWM units (the phases) and the output rails (the pages) on the next screen. Only the PHASE_INFO parameter will be written to if you select this option.

(●) Import a device configuration from a project file
Select this if you want to import an existing device configuration that you saved to a project file. This will essentially "clone" the project file to the attached device.

( ) Import a device configuration from a data flash image
Select this if you previously exported your device's data flash (EEPROM) image to a file. This will clone this configuration.

8 FREQUENTLY ASKED QUESTIONS (FAQS)

8.1 Why do I need to be connected to a device to export hex or SVF?

Texas Instruments digital power controllers and sequencers use the PMBus protocol to configure devices. This protocol acts as a middleman between the device's volatile memory (RAM), non-volatile memory (flash), and the host (GUI). The GUI writes a device configuration through a series of PMBus commands. For example, output voltage may be configured by the PMBus VOUT_COMMAND command, while turn on delay is configured by the PMBus TON_DELAY command.

When the host writes a configuration, it is actually not writing directly to flash memory. It is writing to volatile RAM memory. The device accepts incoming "write" requests for commands, and maps these to an area in RAM, possibly translating the configuration data written via PMBus to an internal device-specific format.

Because PMBus command writes are to volatile RAM memory, an engineer can test changes safely. If there is an error, they can recover their previous configuration by issuing a device reset. When the engineer determines that a configuration is valid, they can commit the configuration to non-volatile flash memory. This is done by issuing the special PMBus STORE_DEFAULT_ALL command. The device handles copying parts of RAM to flash memory.

Devices often store information in non-volatile and volatile memory differently than they are passed back and forth via PMBus. For example, the GUI writes VOUT_COMMAND as a 16 bit signed mantissa. The exponent is configured through another command, VOUT_CONFIG. The device does not store this in RAM or flash in the PMBus format. It stores it in a fixed point (Q math) representation.

This is only one example of the PMBus → device translation. Devices may change what information they store to flash, where they store it, and what the encoding of that information is between device release cycles. Due to this complexity, it is not possible for the Fusion tools to translate a project file to a data flash hex or SVF file.

See section 5, Data Flash Considerations, for additional information.

8.2 Do I need to be connected to my system board to export data flash or SVF, or will any board do?

Normally you can export flash by connecting to any device that has the exact same IC package (pin count) and firmware version load that will be present at manufacturing. This can be an "open loop" board with a compatible UCD IC on it, with the production firmware loaded.

For example, if you are targeting a UCD9246 (64 pin) but have a UCD9240-64 open loop board available, you can:

- Download the production UCD9246 firmware to this board using the Firmware Download Tool
- Launch the Fusion GUI
- Import your project file
- Export data flash

Please contact your Texas Instruments representative if you need an open loop board to assist in programming activities.

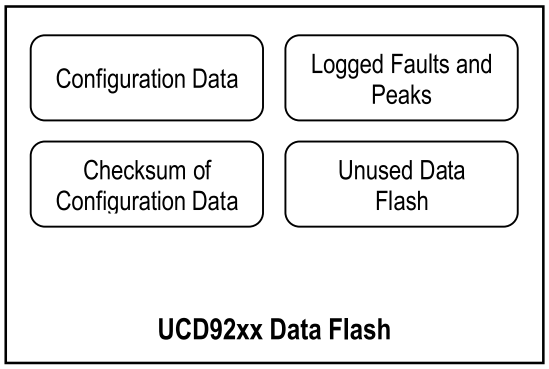
8.3 Is there a data flash checksum I can read to validate that the flash has been programmed correctly?

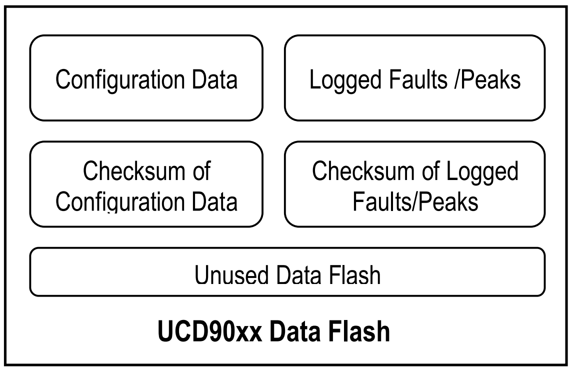
A checksum for the entire contents of data flash cannot be used to validate flash-based configuration programming. The UCD92xx and UCD90xx devices update data flash as part of their normal operation. For example, both have facilities to log faults and peak readings to data flash. Once the data flash has been downloaded and the device resumes normal operation, it is likely that the device will update flash on its own to log new peak readings. Thus, any data flash checksum calculated would be different from the checksum for the flash image that was downloaded.

Please see FAQ 8.4 and 8.5 for an explanation of internal (not host addressable) data flash checksum(s) that UCD devices maintain to ensure integrity of data flash. These FAQs also describe how the device responds to corrupt data flash conditions.

8.4 How does the device validate that its data flash has not been corrupted?

Each device maintains a checksum for the configuration section of data flash. Generically, data flash is segmented in the following way:





When the device powers up and executes its program, it computes the checksum of the configuration section of data flash. It compares this to the checksum section. If there is no match, this is an error condition and the device does the following:

- The device loads a default configuration into operational memory (RAM). This is the configuration that is read and written via PMBus. This configuration is referred to as the HARDCODED PARMS configuration. The HARDCODED PARMS config does not have any rails, fans, GPOs, or GPIs defined (UCD92xx and UCD90xx) nor any monitors or PWMs defined (UCD90xx only). On the UCD92xx, the device will not convert power because no rails are defined. On the UCD90xx, the device will not perform any monitoring or sequencing operations because no rails/monitors have been defined.

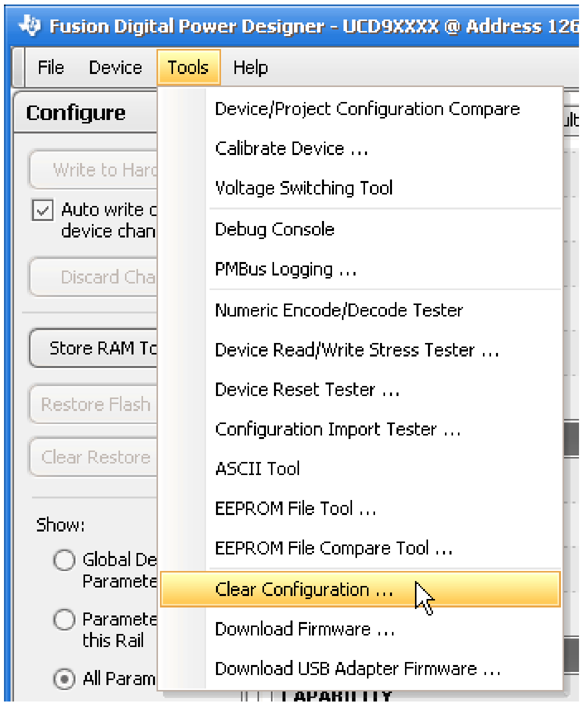
- The configuration also loads default values for the MFR_XXX commands. For example:

Command	Code	HARDCODED PARMS Value
MFR_DATE	0x9D	YYMMDD
MFR_ID	0x99	MFR_ID
MFR_LOCATION	0x9C	MFR_LOCATION
MFR_MODEL	0x9A	MFR_MODEL
MFR_REVISION	0x9B	MFR_REVISION
MFR_SERIAL	0x9E	000000

These commands are implemented as read/write block commands. The text is ASCII encoded. Depending on the device, the defaults may be spaced padded to fill in the maximum size of the string.

- On the UCD92xx, bit 2 (“Hardcoded Parms”) in STATUS_MFR_SPECIFIC is asserted. On the UCD90xx, bit 2 (“Hardcoded Parms”) in MFR_STATUS is asserted.

You can force HARDCODED PARMS condition by erasing the device’s data flash. Fusion Digital Power Designer provides a built-in tool to erase data flash:



The GUI will restart after data flash is erased. Note that the GUI will detect that the device does not have any rails defined or configured. While you cannot launch the GUI in a full HARDCODED PARMS config, you can add a single rail and inspect/review the default configuration that was loaded into device RAM. For example, even if you add a single rail to the device, VOUT_COMMAND is still 0.0 V, no coefficients are loaded (UCD92xx), etc.

The data flash checksum is recreated each time STORE_DEFAULT_ALL is executed.

UCD90xx Sequencer and Health Monitor devices also have a checksum for the logged fault and peak reading data that it stores in data flash. The device updates this checksum whenever it logs a new fault or peak reading, or if the host clears faults or peaks through PMBus. The device validates this checksum at power-up. If the checksum does not match what it calculates, it will clear all logged faults and peak readings and assert bit 7 in MFR_STATUS, “Invalid Logs.”

8.5 How can I verify that my configuration programming process downloaded the correct file and the configuration was loaded by the device without error?

All of the configuration download techniques described in section 6, Programming Options and Instructions, validate the programming:

- Fusion download tools:
  - During project file download, each command (VOUT_COMMAND, MFR_REVISION, etc.) is verified by reading the command back after the write and comparing against what was written.
  - During data flash hex file download, the data flash is read back and a bit-by-bit comparison is done to validate the data flash write.
- Dedicated EEPROM programmer: all devices listed in section 9.3, Gang Programmer Notes, validate the programming by reading back the flash and comparing against the input hex file.
- JTAG/SVF: the SVF file that Fusion Digital Power Designer generates validates the flash write by reading back the contents of flash via JTAG and doing a bit-by-bit comparison against the downloaded flash image.

Per FAQ 8.4, on startup the device validates the configuration data using a checksum. If the checksum is not correct, the device loads a HARDCODED PARMS configuration and sets the MFR "Hardcoded Parms" status bit. Your microcontroller could look for this condition in any situation where the UCD device could be reset.

Another best practice is to save a unique ID for your configuration in one of the MFR_XXX PMBus commands. MFR_REVISION and MFR_MODEL are recommended. Your microcontroller or test system could inspect one or both of these commands to verify that the correct configuration has been loaded onto a UCD device. If you have multiple UCD devices in your system, you should put a device identifier of some kind in one of these MFR_XXX commands, to catch situations where a configuration was loaded on the wrong device.

As long as you set one of the MFR_XXX commands to a value that differs from the HARDCODED PARMS defaults defined in FAQ 8.4, validating one or more MFR_XXX command values is sufficient to validate that the device configuration data is 100% valid. Why? If the data flash was corrupt in any way, the HARDCODED PARMS config would have been loaded by the device and the MFR_XXX commands would contain the HARDCODED PARMS defaults.

8.6 Miscellaneous JTAG Questions

Q: What is the start address of RAM and the size?

From the ARM's point of view, the RAM is located at 0x19000. It is 4kB in size.

Q: Is there cache in the ARM core?

A: No. The program flash, data flash, and RAM are all single-cycle access – so, in a way, it is all cache.

Q: What are the address ranges for flash memory?

A: See table below:

Program Flash	0x00000000, 32kB	(Program Mode)
Program Flash	0x00010000, 32k	(ROM Mode)
Data Flash	0x00018800, 2kB	

Q: What registers control flash read/write?

A: See table below.

Program Flash Control Register (PFLASHCTRL)

Address FFFFFE60

Bit Number	**11**	**10**	**9**	**8**	**7:5**	**4:0**
Bit Name	BUSY	INFO_BLOCK_ENA	PAGE_ERASE	MASS_ERASE	RESERVED	PAGE_SEL
Access	R	R/W	R/W	R/W	R/W	R/W
Default	-	0	0	0	000	00000

Bit 11: BUSY – Program Flash Busy Indicator
0 = Program Flash available for read/write/erase access
1 = Program Flash unavailable for read/write/erase access
Bit 10: INFO_BLOCK_ENA – Program Flash Information Block Enable. Test use only.
0 = Access enabled to main memory block (Default)
1 = Access enabled to information block
Bit 9: PAGE_ERASE – Program Flash Page Erase Enable
0 = No Page Erase initiated on Program Flash (Default)
1 = Page Erase on Program Flash enabled. Page erased is based on PAGE_SEL (Bits 4-0). This bit is cleared upon completion of Page Erase cycle.
Bit 8: MASS_ERASE – Program Flash Mass Erase Enable
0 = No Mass Erase initiated on Program Flash (Default)
1 = Mass Erase of Program Flash enabled. This bit is cleared upon completion of Mass Erase cycle.
Bits 4-0: PAGE_SEL – Selects page to be erased during Page Erase Cycle

Data Flash Control Register (DFLASHCTRL)

Address FFFFFE64

Bit Number	**11**	**10**	**9**	**8**	**7:6**	**5:0**
Bit Name	BUSY	INFO_BLOCK_ENA	PAGE_ERASE	MASS_ERASE	RESERVED	PAGE_SEL
Access	R	R/W	R/W	R/W	-	R/W
Default	-	0	0	0	-	000000

Bit 11: BUSY – Data Flash Busy Indicator
0 = Data Flash available for read/write/erase access
1 = Data Flash unavailable for read/write/erase access
Bit 10: INFO_BLOCK_ENA – Data Flash Information Block Enable. Test use only.
0 = Access enabled to main memory block (Default)
1 = Access enabled to information block
Bit 9: PAGE_ERASE – Data Flash Page Erase Enable
0 = No Page Erase initiated on Data Flash (Default)
1 = Page Erase Cycle on Data Flash enabled. Page erased is based on PAGE_SEL (Bits 4-0). This bit is cleared upon completion of Page Erase cycle.
Bit 8: MASS_ERASE – Data Flash Mass Erase Enable
0 = No Mass Erase initiated on Data Flash (Default)
1 = Mass Erase of Data Flash enabled. Bit is cleared upon completion of mass erase.
Bits 5-0: PAGE_SEL – Selects page to be erased during Page Erase Cycle

Program Flash Interlock Register (PFLASHILOCK)

Address FFFFFE68

Bit Number	**31:0**
Bit Name	INTERLOCK_KEY
Access	R/W
Default	0000_0000_0000_0000_0000_0000_0000_0000

Bit 31-0: INTERLOCK_KEY – Program Flash Interlock Key. Register must be set to 0x42DC157E prior to every Program Flash write. If the Interlock Key is not set, the write to the Program Flash will not proceed. This register will clear upon the completion of a write to the Program Flash.

9 APPENDICES

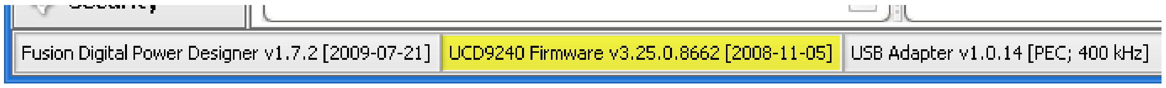
9.1 Exporting Configuration Data Flash Hex File

If you will be doing data flash-based configuration programming, you will normally need to prepare a data flash file. This can only be done by connecting to a UCD IC device in "online" mode. There is no way to convert an XML project file to a data flash hex file. Please follow these steps:

1. Attach the TI USB-TO-GPIO adapter to your PC.

2. Launch the Fusion Digital Power Designer software.

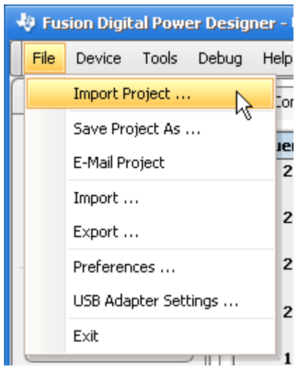
3. Verify that the device and firmware version reported in the footer of the GUI matches the device that will ultimately be programmed:

   
   Fusion Digital Power Designer v1.7.2 [2009-07-21] | UCD9240 Firmware v3.25.0.8662 [2008-11-05] | USB Adapter v1.0.14 [PEC; 400 kHz]

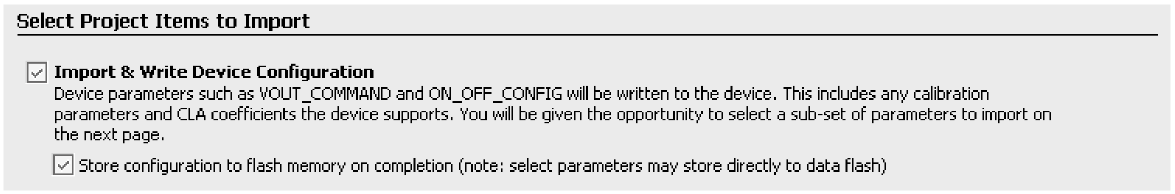
   Section 1.1 lists the firmware version numbers for all production (released to manufacturing) UCD devices that the GUI supports. If you do not see your device listed or the firmware version on your device does not match what is listed in the table, please contact your Texas Instruments representative immediately and do not proceed further. Per section 5, Data Flash Considerations, configuration "layout" in data flash varies for each device and can vary for different firmware builds within a device. For example, if you have prototype boards running pre-production firmware, may not be able to use data flash exported from this board and program on production ICs.

4. Optionally, if this device's configuration does not match the configuration you want to export, you should import/write your project file to the device.

   Select File->Import Project:

   Select your file and click Next. Ensure that the following options are checked:

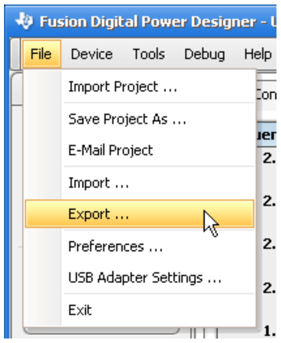
   
   Select Project Items to Import

   ☑ **Import & Write Device Configuration**
   Device parameters such as VOUT_COMMAND and ON_OFF_CONFIG will be written to the device. This includes any calibration parameters and CLA coefficients the device supports. You will be given the opportunity to select a sub-set of parameters to import on the next page.

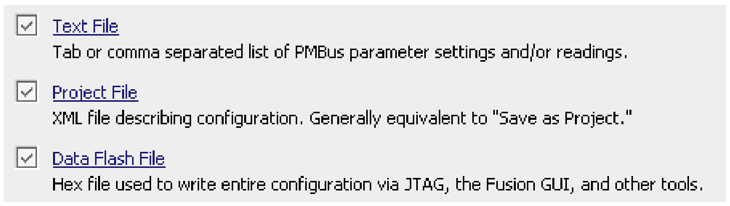
   ☑ Store configuration to flash memory on completion (note: select parameters may store directly to data flash)

Click Next. On the next screen, click the "Write Check" button. This will update the device's configuration to match the project file.

5. Export your configuration to data flash. Select File->Export:



The export tool has a number of export formats. You want to export the "Data Flash File" format. The first tab, "Export Multiple Formats," allows for the easy export of more than one format. For example, a text file summary, a project file, and a data flash file. We recommend doing this so you can archive all three ways of describing the device configuration:



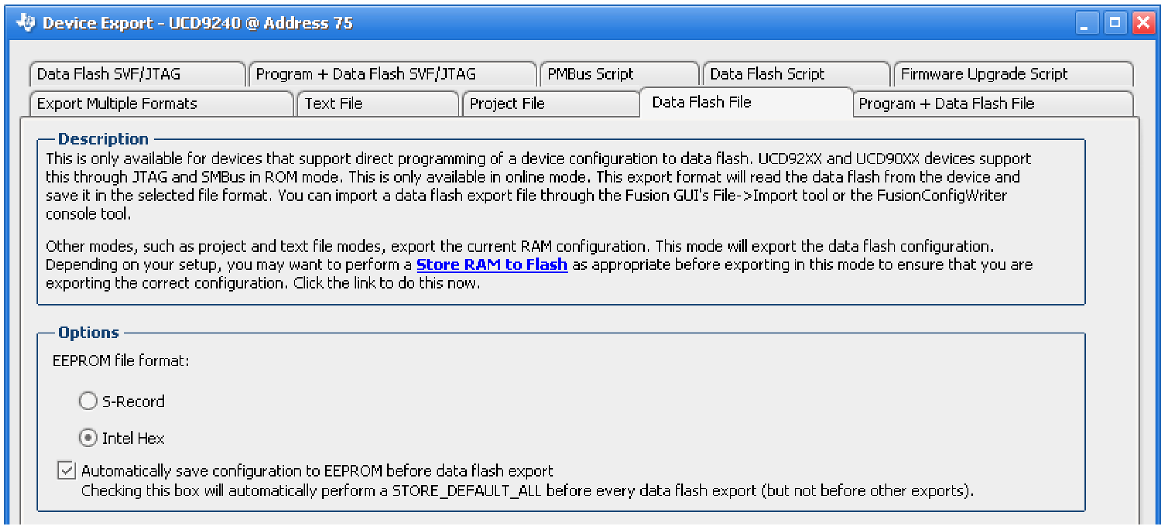
☑ Text File
Tab or comma separated list of PMBus parameter settings and/or readings.

☑ Project File
XML file describing configuration. Generally equivalent to "Save as Project."

☑ Data Flash File
Hex file used to write entire configuration via JTAG, the Fusion GUI, and other tools.

Before proceeding, you need to configure the data flash export. Your vendor may require the hex be formatted in a certain format. The GUI supports Motorola S-Record and Intel Hex formats. The default is S-Record. See section 9.3 for a list of recommended formats for gang programmers that are known to support UCD devices. If you do not know what gang programmer will be used or it is not listed, please have your vendor contact your Texas Instruments representative.

To change the data flash format, click the "Data Flash File" tab:



Description

This is only available for devices that support direct programming of a device configuration to data flash. UCD92XX and UCD90XX devices support this through JTAG and SMBus in ROM mode. This is only available in online mode. This export format will read the data flash from the device and save it in the selected file format. You can import a data flash export file through the Fusion GUI's File->Import tool or the FusionConfigWriter console tool.

Other modes, such as project and text file modes, export the current RAM configuration. This mode will export the data flash configuration. Depending on your setup, you may want to perform a **Store RAM to Flash** as appropriate before exporting in this mode to ensure that you are exporting the correct configuration. Click the link to do this now.

Options

EEPROM file format:

○ S-Record

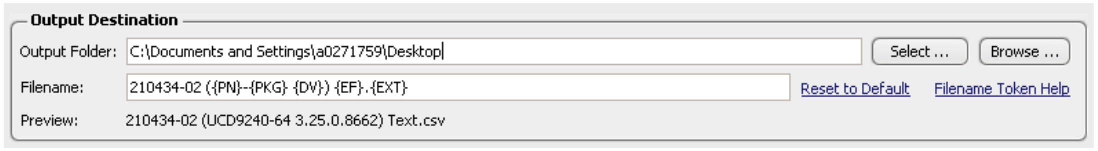
[✓ Intel Hex]

☑ Automatically save configuration to EEPROM before data flash export
Checking this box will automatically perform a STORE_DEFAULT_ALL before every data flash export (but not before other exports).

The checkbox can be left checked. In the previous step of importing the project file, the configuration was written to data flash, but doing so a second time will not have any negative effect and will slow the export minimally.

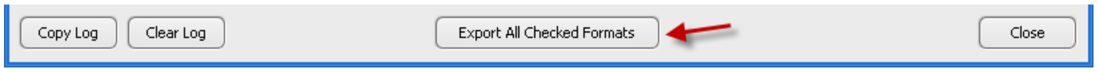
You can also review the Text and Project File export options.

One final area to review is the output folder and filename template. This is in the “Output Destination” area of the form:

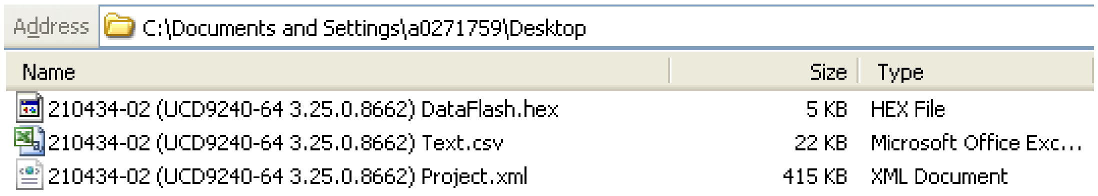

Output Destination
Output Folder: C:\Documents and Settings\a0271759\Desktop
Filename: 210434-02 ({PN}--{PKG} {DV}) {EF}.{EXT}
Preview: 210434-02 (UCD9240-64 3.25.0.8662) Text.csv

Change the filename template to suit your project naming conventions; however, it is recommended you keep the {PN}, {PKG}, and {DA} “macros”. In the example above, “210434-02” is a part identifier to be assigned to the programmed IC. You also should keep the {EF} macro if you are exporting multiple formats. It will be used to differentiate between export formats along with the filename extension, {EXT}. The Preview area shows what the actual filename will be for the selected export format.

When ready, click back to the “Export Multiple Formats” tab and click the this button:



In the example above, three files will be saved on the Desktop:


Address C:\Documents and Settings\a0271759\Desktop

Name	Size	Type
210434-02 (UCD9240-64 3.25.0.8662) DataFlash.hex	5 KB	HEX File
210434-02 (UCD9240-64 3.25.0.8662) Text.csv	22 KB	Microsoft Office Exc...
210434-02 (UCD9240-64 3.25.0.8662) Project.xml	415 KB	XML Document

Archive these files and send your vendor the hex file.

9.2 Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices

Device	Pkg	DFlash Prog. Modes	Build Date (YYYY-MM-DD)	Program Flash Checksum	DEVICE_ID
UCD92xx Fusion Digital Power Controllers					
UCD9240-80	80	ROM	2008-09-15	0x002D2539	UCD9240-80|3.24.0.8163|080915 0x554344393234302D38307C332E32342E302E383136337C30383039313500
UCD9240-64	64	ROM	2008-11-05	0x002D320F	UCD9240-64|3.25.0.8662|081105 0x554344393234302D36347C332E32352E302E383636327C30383131303500
UCD9220	48	ROM	2009-01-27	0x002F90AE	UCD9220-48|3.26.0.9077|090127 0x554344393232302D34387C332E32362E302E393037377C30393031323700
UCD9246	64	ROM	2009-09-22	0x002C55D6	UCD9246-64|5.6.0.11220|090922 0x554344393234362D36347C352E362E302E31313232307C30393039323200
UCD9248	80	ROM	2009-11-12	0x002C5D61	UCD9248-80|5.8.0.11400|091112 0x554344393234382D38307C352E382E302E31313430307C30393131313200
UCD9224	48	ROM	2009-11-12	0x002D4975	UCD9224-48|5.8.0.11401|091112 0x554344393232342D34387C352E382E302E31313430317C30393131313200
UCD9211	40	ROM	2010-05-21	0x0030FD5C	UCD9211-40|4.52.0.11735|100521 0x554344393231312D34307C342E35322E302E31313733357C31303035323100
UCD9212	40	ROM	2010-10-20	0x002F7F98	UCD9212-40|4.54.0.12607|101020 0x554344393231322D34307C342E35342E302E31323630377C31303130323000
UCD9246F In production	64	ROM, NormalL	2010-11-11	0x002C5D61	UCD9246F-64|5.14.0.12640|101111 0x5543443932343646 2D36347C352E31342E302E31323634307C31303131313100
UCD9244	64	ROM, NormalL	2010-12-15	0x0031F1D0	UCD9244-64|6.4.0.12746|101215 0x554344393234342D36347C362E342E302E31323734367C31303132313500
UCD9222	48	ROM, NormalL	2010-12-15	0x002C5D61	UCD9222-48|6.4.0.12747|101215 0x554344393232322D34387C362E342E302E31323734377C31303132313500

Device	Pkg	DFlash Prog. Modes	Build Date (YYYY-MM-DD)	Program Flash Checksum	DEVICE_ID
UCD90xx Sequencers and System Health Controllers					
UCD90120	64	ROM	2009-11-20	0x0037EA60	UCD90120|1.1.2.0000|091120 0x5543443930313230 7C312E312E322E303030307C303931313230 00
UCD90124	64	ROM	2009-11-20	0x002F8A04	UCD90124|1.1.2.0000|091120 0x55434439303132347C312E312E322E303030307C30393131323000
UCD90910	64	ROM, NormalM	2010-08-05	0x00329F99	UCD90910|2.0.9.0001|100805 0x55434439303931307C322E302E392E303030317C31303038303500

DFlash Programming Mode Description:

- NormalL/M: Data flash can be written while the device is in normal (aka program) mode. If the device supports this mode, this is the preferred scheme. During the write phase, each chunk of data is written either LSB first (L designation) or MSB first (M designnation). See section 6.4.2.1, Microcontroller Writes Data Flash, Normal Mode Scheme.

- ROM: Device must be sent to ROM mode to program data flash. When in ROM mode, the device will not perform normal operations, such as power conversion, monitoring, or sequencing. See section 6.4.2.2, Microcontroller Writes Data Flash, ROM Mode Scheme.

9.3 Gang Programmer Notes

Vendor	Notes
System General	Support UCD9240-64 and UCD9240-80 data flash programming. Also support program flash + data flash programming to UCD92xx, UCD3020, and any UCD3000-based IC. Export in Intel Hex format. Known supported models: T9x00 (T9200, T9600, T9800, etc); APxxx (AP600, AP700, AP900, etc). In general if the socket is supported, SG programmer should support with up-to-date SG software release.

9.4 Comparison of Write Times

Target device: UCD9240.

Tool	**Write Time**	**Read Back Validation Performed?**
FusionConfigWriter console tool --dflash mode --project mode	 6.8 sec 5.0 sec	Yes
MFR GUI task Data flash task Project file task	 5.5 sec 10.2 sec	Yes
ASSET USB-100	~ 30 sec	Yes
ASSET RIC-1000	~ 10 sec	Yes
System General 9x00	22 sec	Yes

9.5 Detailed Recipe for Device Writes Data Flash, Normal Mode Scheme

This section describes in detail the recipe that is used to write a data flash configuration image using SMBus/I2C while the device is operating in normal (aka program) mode. Only select UCD devices support this method of configuration programming. Refer to section 9.2, Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices, for a list of UCD devices that support this programming scheme.

Portions of an example “script” for this sequence will be shown below. This script is also shown in abbreviated form in section9.6, Data Flash Download Script Example – Normal Mode. In the script, the device is at address 0x7E (126 decimal).

Step 1 – Read Data Flash Hex File and Verify Range

Data flash hex files are created by the customer using the Fusion Digital Power Designer (GUI). The tool can export Intel Hex or S-Record. You should instruct your customers to use the format that is best suited to your tool.

Data flash addressing starts at 0x18800 and ends at 0x18FFF. There are a total of 2048 bytes in the data flash. You should verify that all bytes are defined in the flash file. The GUI will always include each byte, and will not skip bytes or segments. Programming should abort if the full address range is not present.

A sample from an Intel hex file:

```
:020000040001F9
:20880000124D46525F49442020202020202020202020200C4D46525F4D4F44454C202020D4
:208820000C4D46525F5245564953494F4E0C4D46525F4C4F434154494F4E0659594D4D443A
```

The same sample but in S-Record format:

```
S0220000687474703A2F2F737265636F72642E736F75726365666F7267652E6E65742F1D
S224018800124D46525F49442020202020202020202020200C4D46525F4D4F44454C202020CE
S2240188200C4D46525F5245564953494F4E0C4D46525F4C4F434154494F4E0659594D4D4434
```

Step 2 – Verify Target Device is Compatible with Firmware Image

It is important to verify that the attached device contains firmware that is compatible with the hex file that is to be programmed. This can be done by performing a BlockRead on command code 0xFD. This corresponds to the UCD DEVICE_ID command. This contains a part number, version number, and firmware build date encoded as ASCII text. Section 9.2, Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices, lists the DEVICE_CODE values for each released version of UCD firmware.

Example:

BlockRead,0x7E,**0xFD**,0x1C55434439303136307C322E322E31352E303030307C31303039323400

The format for these examples is:

Activity,Address,CommandCode[,ExcptedResult for reads]

So in this example address is 0x7E, the command code is 0xFD, and the expected return from the block read is 0x1C55434439303136307C322E322E31352E303030307C31303039323400. Fixed items will be shown in **bold**. Items that are not bold vary based on device or flash input file.

Your algorithm should verify that the value read is the hex value expected. Block counts are shown in the examples on this section (0x1C in this example). When TI sends out updates to support new devices, the block count will generally not be included. Only the DEVICE_ID value in both hex and ASCII will be provided. For this example TI would document:

```
UCD90160|2.2.15.0000|100924
0x55434439303136307C322E322E31352E303030307C31303039323400
```

Note that the trailing 0x00 byte may not always be present. The Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices table will define whether it is.

Programming should be aborted if the DEVICE_ID does not match the expected value. This may be due to the incorrect device being loaded onto the programmer.

Step 3 – Unlock data flash and erase data flash

You must disable the data flash write protect bit. The device will suspend any flash logging it might perform – such as fault logging – until the device is reset. Data flash must then be erased and the programming must pause 25 ms to allow the erase to complete.

Example sequence:

```
// Clearing data flash write protect bit; any flash logging will be disabled until device reset ...
BlockWrite,0x7E,0xE2,0x050400000104
BlockWrite,0x7E,0xE3,0x0400008820

// Erasing data flash ...
BlockWrite,0x7E,0xE2,0x050414000104
BlockWrite,0x7E,0xE3,0x0400000100

Pause,25,Pausing 25 ms
```

Only the address will change in this sequence. The command codes and blocks to write are fixed. Block count is shown in these examples. PEC code is not. PEC is optional on these devices.

Step 4 – Write data flash

Data flash is written in 4 byte chunks. There is a delay of 200 usec between each write. Data flash addressing starts at 0x18800 and ends at 0x188FFF, for a total of 2048 bytes in the data flash. Each 4 byte write requires two SMBus block writes.

Block write #1 sets the address that will be written. The command code is 0xE2. A 5 byte-wide block is written:

- Block[0]: always 0x02
- Block[1]: Chunk index LSB -- chunk_index & 0xFF]
- Block[2]: Chunk index MSB -- (chunk_index >> 8) & 0xFF;
- Block[3]: always 0x01
- Block[4]: always 0x04

So flash bytes 0-3 have chunk offset 0, bytes 4-7 have offset 1, and so on. The last chunk should have offset of 511d.

Block write #2 performs the actual write. A 4 byte-wide block is written to command code 0xE3:

Write LSB First Devices:

- Block[0]: Flash[chunk_index*4+0]
- Block[1]: Flash[chunk_index*4+1]
- Block[2]: Flash[chunk_index*4+2]
- Block[3]: Flash[chunk_index*4+3]

Write MSB First Devices:

- Block[0]: Flash[chunk_index*4+3]
- Block[1]: Flash[chunk_index*4+2]
- Block[2]: Flash[chunk_index*4+1]
- Block[3]: Flash[chunk_index*4+0]

Section 9.2, Firmware Versions, Program Flash Checksums, and Programming Modes for Released Devices, defines whether data is written LSB first or MSB first.

Here is an example for writing the first two and last two chunks of the sample. To make it easier to read, bytes are broken out using a dash separator:

// Write chunk @ index 0
BlockWrite,0x7E,**0xE2**,0x**05-02**-00-00-**01-04**
BlockWrite,0x7E,**0xE3**,0x**04**-06-4D-46-52
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite

// Write chunk @ index 1
BlockWrite,0x7E,**0xE2**,0x**05-02**-01-00-**01-04**
BlockWrite,0x7E,**0xE3**,0x**04**-5F-49-44-20
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite

...

// Write chunk @ index 510d
BlockWrite,0x7E,**0xE2**,0x**05-02**-FE-01-**01-04**
BlockWrite,0x7E,**0xE3**,0x**04**-FF-FF-FF-FF
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite

// Write chunk @ index 511d
BlockWrite,0x7E,**0xE2**,0x**05-02**-FF-01-**01-04**
BlockWrite,0x7E,**0xE3**,0x**04**-FF-FF-FF-FF
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite

Step 5 – Verify Data Flash

Data flash will now be read back in 16 byte chunks (reading back 16 bytes at a time is faster than 4 bytes at a time). Two SMBus commands are required. The first command will set address for the read (write block). The second will read the data (read block).

A block write to command code 0xE2 sets the address that will be read. A 5 byte-wide block is written:

- Block[0]: always 0x02
- Block[1]: data offset LSB – data_offset & 0xFF]
- Block[2]: data offset MSB -- (data_offset >> 8) & 0xFF;
- Block[3]: always 0x10
- Block[4]: always 0x01

data_offset starts at 0 and increments by 16. The last data_offset should be 0x7F0 (2032d).

A block read at command code 0xE3 is then performed to read the data flash. The data that is returned is in this order:

- Block[0]: Flash[data_offset +0]
- Block[1]: Flash[data_offset +1]
- …
- Block[2]: Flash[data_offset +14]
- Block[3]: Flash[data_offset +15]

The order is always as-shown, LSB first, regardless of the write order in step 4.

Here is an example of the read back of the sample. A reminder that block counts are included in the "script" examples:

// Read chunk @ offset 0d
BlockWrite,0x7E,**0xE2**,0x**05-02**-00-00-**10-01**
BlockRead,0x7E,**0xE3**,0x10064D46525F494420202020202020202020

// Read chunk @ offset 32d
BlockWrite,0x7E,**0xE2**,0x**05-02**-10-00-**10-01**
BlockRead,0x7E,**0xE3**,0x10202020084D554547454C20334C202020

...

// Read chunk @ offset 2000d
BlockWrite,0x7E,**0xE2**,0x**05-02**-E0-07-**10-01**
BlockRead,0x7E,**0xE3**,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

// Read chunk @ offset 2032d
BlockWrite, 0x7E,**0xE2**,0x**05-02**-F0-07-**10-01**
BlockRead, 0x7E,**0xE3**,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

Step 6 – Reset the Device and Validate DEVICE_ID

As a final step, the device will be reset by issuing a send byte to command code 0xDB. You should pause 1500 msec to give plenty of time for the device to load its program. After this delay, validate that a read block of DEVICE_ID at command code 0xFD matches the expected value.

For example:

// Resetting the device
SendByte,0x7E,**0xDB**

Pause,1500,Waiting for UCD90160 program to startup

// Verifying DEVICE_ID matches expected firmware [""UCD90160|2.2.15.0000|100924""]
BlockRead,0x7E,**0xFD**,0x1C55434439303136307C322E322E31352E303030307C31303039323400

9.6 Data Flash Download Script Example – Normal Mode

```
Comment,Format=CSV; Hex=CoderUpper; BreakOutBytes=False; IncludeBlockLength=True [DO NOT
REMOVE THIS LINE IF YOU WANT TO IMPORT USING A FUSION TOOL]
Comment,"SMBus Fields are Request,Address,Command,Data"
Comment,"For reads, the last field is what is expected back from the device"
Comment,"Verifying DEVICE_ID matches expected firmware [""UCD90160|2.2.15.0000|100924""]"
BlockRead,0x7E,0xFD,0x1C55434439303136307C322E322E31352E303030307C31303039323400
Comment,Clearing data flash write protect bit; any flash logging will be disabled until device reset ...
BlockWrite,0x7E,0xE2,0x050400000104
BlockWrite,0x7E,0xE3,0x0400008820
Comment,Erasing data flash ...
BlockWrite,0x7E,0xE2,0x050414000104
BlockWrite,0x7E,0xE3,0x0400000100
Pause,25,Pausing 25 ms
Comment,Writing data flash in 4 byte chunks ...
BlockWrite,0x7E,0xE2,0x050200000104
BlockWrite,0x7E,0xE3,0x04064D4652
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x7E,0xE2,0x050201000104
BlockWrite,0x7E,0xE3,0x045F494420
…
BlockWrite,0x7E,0xE2,0x0502FE010104
BlockWrite,0x7E,0xE3,0x04FFFFFFFF
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x7E,0xE2,0x0502FF010104
BlockWrite,0x7E,0xE3,0x04FFFFFFFF
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
Comment,Verifying data flash
BlockWrite,0x7E,0xE2,0x050200001001
BlockRead,0x7E,0xE3,0x10064D46525F49442020202020202020
BlockWrite,0x7E,0xE2,0x050210001001
BlockRead,0x7E,0xE3,0x10202020084D554547454C20334C202020
...
BlockWrite,0x7E,0xE2,0x0502E0071001
BlockRead,0x7E,0xE3,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
BlockWrite, 0x7E,0xE2,0x0502F0071001
BlockRead, 0x7E,0xE3,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
Comment,Resetting the device
SendByte,0x7E,0xDB
Pause,1500,Waiting for UCD90160 program to startup
Comment,"Verifying DEVICE_ID matches expected firmware [""UCD90160|2.2.15.0000|100924""]"
BlockRead,0x7E,0xFD,0x1C55434439303136307C322E322E31352E303030307C31303039323400
Comment,Clearing data flash logs
WriteByte,0x65,0x00,0xFF
BlockWrite,0x65,0xED,0x020000
Pause,1500,"Pausing 1,500.00 ms for LOGGED_PAGE_PEAKS flash write"
BlockWrite,0x65,0xEA,0x12000000000000000000000000000000000000
Pause,1000,"Pausing 1,000.00 ms for LOGGED_FAULTS flash write"
```

9.7 Data Flash Download Script Example – ROM Mode

Flash read/write sections are abbreviated. The device this script was generated against was at address 126d (0x65). This example shows how device ROM commands use address 11d (0xB).

```
Comment,Format=CSV; Hex=CoderUpper; BreakOutBytes=False; IncludeBlockLength=True [DO NOT
REMOVE THIS LINE IF YOU WANT TO IMPORT USING A FUSION TOOL]
Comment,"SMBus Fields are Request,Address,Command,Data"
Comment,"For reads, the last field is what is expected back from the device"
Comment,"Verifying DEVICE_ID matches expected firmware [""UCD9246-64|5.6.0.11220|090922""]"
BlockRead,0x7E,0xFD,0x1E554344393234362D36347C352E362E302E31313232307C30393039323200
Comment,Sending device at address 126d to ROM mode via ENABLE_ROM_MODE program mode command
SendByte,0x7E,0xD9
Pause,50,Give device time to get to ROM mode
Comment,Verifying in ROM mode
BlockRead,0x0B,0xEC,0x0400020002
Comment,Starting download ...
Comment,Mass erasing data flash
WriteByte,0x0B,0xF2,0x00
Pause,25,Pausing 25 ms
Comment,Downloading data flash ...
BlockWrite,0x0B,0xF4,0x140001880002C00B300215000104EA0F1600000000
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x0B,0xF4,0x1400018810841C81C804033C3B02C00B3002150001
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
…
BlockWrite,0x0B,0xF4,0x1400018F40430100410041004100410000266C6C66
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x0B,0xF4,0x1400018F50670000000000000000000000000000000
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
Comment,Verifying data flash
BlockWrite,0x0B,0xFD,0x0400018800
BlockRead,0x0B,0xF9,0x1002C00B300215000104EA0F1600000000
BlockWrite,0x0B,0xFD,0x0400018810
BlockRead,0x0B,0xF9,0x10841C81C804033C3B02C00B3002150001
…
BlockWrite,0x0B,0xFD,0x0400018FE0
BlockRead,0x0B,0xF9,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
BlockWrite,0x0B,0xFD,0x0400018FF0
BlockRead,0x0B,0xF9,0x10FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
Comment,Erasing last segment of program flash ...
BlockWrite,0x0B,0xF1,0x04011F0000
Pause,25,Flash erase time
Comment,Downloading new segment of program flash w/ pflash checksum ...
BlockWrite,0x0B,0xF4,0x1400017C00100010001000100000000000000000
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x0B,0xF4,0x1400017C1000000000000000000000000FFFFFFFF
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
…
BlockWrite,0x0B,0xF4,0x1400017FE000000000EDF9ABEEEDEA898DEDEEBBA2
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
BlockWrite,0x0B,0xF4,0x1400017FF066DBEBB2EEEBBBB833B5EE00002C55D6
```

```
Pause,0.2,Pausing 0.2 ms for UCD3000FlashWrite
Comment,Having ROM calculate the program flash checksum ...
BlockWrite,0x0B,0xEF,0x080001000000007FFC
Pause,1000,Give ROM time to read flash
Comment,Verifying checksum ROM calculated matches what we wrote ...
BlockRead,0x0B,0xEE,0x04002C55D6
Comment,Sending the device to program mode via ROM mode command
Comment,Executing program ...
SendByte,0x0B,0xF0
Pause,1500,Waiting for UCD9246 program to startup
Comment,"Verifying DEVICE_ID matches expected firmware [""UCD9246-64|5.6.0.11220|090922""]"
BlockRead,0x7E,0xFD,0x1E554344393234362D36347C352E362E302E31313232307C30393039323200
Comment,Clearing data flash logs
BlockWrite,0x7E,0xEA,0x09000000000000000000
Pause,1000,"Pausing 1,000.00 ms for LOGGED_FAULTS flash write"
BlockWrite,0x7E,0xE9,0x110000000000000000000000000000000000
Pause,1000,"Pausing 1,000.00 ms for LOGGED_PEAKS flash write"
```

9.8 PMBus Config Script Examples

UCD9224 and UCD90124 examples follow.

9.8.1 UCD9224 PMBus Config Script Example

This example was generated for a UCD9224 with two rails configured. Configuration of rail #1 is shown in full, but rail #2 is abbreviated. Comment lines are automatically generated by the export. Additional comments have been included for this document and are prefixed by //.

Comment,Format=CSV; Hex=CoderUpper; BreakOutBytes=False; IncludeBlockLength=True [DO NOT REMOVE THIS LINE IF YOU WANT TO IMPORT USING A FUSION TOOL]
Comment,"SMBus Fields are Request,Address,Command,Data"
Comment,"For reads, the last field is what is expected back from the device"
// Begin write of common (not PAGEd) parameters

```
Comment,Write PHASE_INFO [MFR 02] Rail #1: 1 Phase: 1A; Rail #2: 1 Phase: 2A; Rail #3: Not Configured; Rail #4: Not Configured
BlockWrite,0x7E,0xD2,0x0401040000
Comment,"Write GPIO_SEQ_CONFIG [MFR 35] Input Pins: <None> | Output Pins: Pin 26 PGOOD ActiveHigh ActivelyDrivenOutput POWER_GOOD | Turn On Dep: <None> | Stay On Dep: <None> | Stay On Shutdown Modes: Rail #1: Soft Off, Rail #2: Soft Off | Fault Slaves: <None>"
BlockWrite,0x7E,0xF3,0x1E0000000000000002000000000000000000C60000000000000000000000
Comment,Write FREQUENCY_SWITCH [Rail #1] 751.0 kHz
WriteByte,0x7E,0x00,0x00
WriteWord,0x7E,0x33,0xEF02
Comment,Write FREQUENCY_SWITCH [Rail #2] 751.0 kHz
WriteByte,0x7E,0x00,0x01
WriteWord,0x7E,0x33,0xEF02
Comment,Execute STORE_DEFAULT_ALL
SendByte,0x7E,0x11
Pause,1000,Pausing 1000 ms for StoreDefaultAll
Comment,Execute STORE_DEFAULT_ALL
SendByte,0x7E,0x11
Pause,1000,Pausing 1000 ms for StoreDefaultAll
Comment,Execute SOFT_RESET [MFR 11]
SendByte,0x7E,0xDB
Pause,2000,Pausing 2000 ms
Comment,Write IIN_SCALE_MONITOR [MFR 12] 0.200 ohm
WriteWord,0x7E,0xDC,0x33A3
Comment,Write MFR_DATE 090320
BlockWrite,0x7E,0x9D,0x06303930333230
Comment,Write MFR_ID TEXAS_INSTRUMENTS
BlockWrite,0x7E,0x99,0x1254455841535F494E535452554D454E545320
Comment,Write MFR_LOCATION Dallas
BlockWrite,0x7E,0x9C,0x0644616C6C6173
Comment,Write MFR_MODEL HPA464
BlockWrite,0x7E,0x9A,0x06485041343634
Comment,Write MFR_REVISION E1
BlockWrite,0x7E,0x9B,0x024531
Comment,Write MFR_SERIAL #2
BlockWrite,0x7E,0x9E,0x022332
```

```
Comment,Write SECURITY_BIT_MASK [MFR 36]
000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000
BlockWrite,0x7E,0xF4,0x200000000000000000000000000000000000000000000000000000000000000000
Comment,Write SYNC_IN_OUT [MFR 17] No Slaves; Master: None
WriteWord,0x7E,0xE1,0x00FF
Comment,Write USER_DATA_00 User_Data_00
BlockWrite,0x7E,0xB0,0x20557365725F446174615F3030202020202020202020202020202020202020202020
Comment,Write VIN_OFF 4.500 V
WriteWord,0x7E,0x36,0x40CA
Comment,Write VIN_ON 4.703 V
WriteWord,0x7E,0x35,0x5ACA
Comment,Write VIN_OV_FAULT_LIMIT 16.500 V
WriteWord,0x7E,0x55,0x10DA
Comment,"Write VIN_OV_FAULT_RESPONSE Response=2,Restart=0,Delay=0"
WriteByte,0x7E,0x56,0x80
Comment,Write VIN_OV_WARN_LIMIT 16.000 V
WriteWord,0x7E,0x57,0x00DA
Comment,Write VIN_SCALE [MFR 03] 0.130
WriteWord,0x7E,0xD3,0x13A2
Comment,Write VIN_UV_FAULT_LIMIT 4.500 V
WriteWord,0x7E,0x59,0x40CA
Comment,"Write VIN_UV_FAULT_RESPONSE Response=2,Restart=0,Delay=0"
WriteByte,0x7E,0x5A,0x80
Comment,Write VIN_UV_WARN_LIMIT 4.703 V
WriteWord,0x7E,0x58,0x5ACA
// Begin write of rail #1 parameters
Comment,Write VOUT_MAX [Rail #1] 2.875 V
// Set PAGE to rail #1
WriteByte,0x7E,0x00,0x00
WriteWord,0x7E,0x24,0x002E
Comment,"Write ON_OFF_CONFIG [Rail #1] OperationOnly, UseDelay, ActiveHigh"
WriteByte,0x7E,0x02,0x1A
Comment,"Write CLA_GAINS_BANK_0 [META,Rail #1] B1=[3.05078 -5.40234 2.37109] A1=[1.00000 -1.00000
0.00000] B2=[1.00000 0.00000] A2=[1.00000 0.00000] AFE_Gain=4 Limits=[-6.00,-4.00,3.00,5.00]
Gains=[2.00,1.75,1.00,1.50,2.00]"
WriteByte,0x7E,0xD4,0x00
BlockWrite,0x7E,0xD5,0x18030D0A99025F00030100000000000000841881C805033C3A
Comment,"Write CLA_GAINS_BANK_1 [META,Rail #1] B1=[3.05078 -5.40234 2.37109] A1=[1.00000 -1.00000
0.00000] B2=[1.00000 0.00000] A2=[1.00000 0.00000] AFE_Gain=4 Limits=[-5.00,-3.00,3.00,5.00]
Gains=[2.00,1.25,1.00,1.25,2.00]"
WriteByte,0x7E,0xD4,0x01
BlockWrite,0x7E,0xD5,0x18030D0A99025F000301000000000000008414814805033D3B
Comment,"Write CLA_GAINS_BANK_2 [META,Rail #1] B1=[3.05078 -5.40234 2.37109] A1=[1.00000 -1.00000
0.00000] B2=[1.00000 0.00000] A2=[1.00000 0.00000] AFE_Gain=4 Limits=[-5.00,-3.00,3.00,5.00]
Gains=[2.00,1.25,1.00,1.25,2.00]"
WriteByte,0x7E,0xD4,0x02
BlockWrite,0x7E,0xD5,0x18030D0A99025F000301000000000000008414814805033D3B
Comment,"Write DRIVER_CONFIG [MFR 06,Rail #1] DPWM Shutdown Action: DriveLow, Fault Pin On Restart
Mode: IgnoreFaultPin, Interrupt Pin Polarity: ActiveHigh"
```

```
WriteByte,0x7E,0xD6,0x00
Comment,"Write DRIVER_MIN_PULSE [MFR 15,Rail #1] 50 ns"
WriteWord,0x7E,0xDF,0x20E3
Comment,"Write EADC_SAMPLE_TRIGGER [MFR 07,Rail #1] 228 ns"
WriteWord,0x7E,0xD7,0x90F3
Comment,"Write FAST_OC_FAULT_LIMIT [MFR 39,Rail #1] 15.00 A/Phase"
WriteWord,0x7E,0xF7,0xC0D3
Comment,Write IOUT_OC_FAULT_LIMIT [Rail #1] 12.50 A
WriteWord,0x7E,0x46,0x20D3
Comment,"Write IOUT_OC_FAULT_RESPONSE [Rail #1] Response=2,Restart=0,Delay=0"
WriteByte,0x7E,0x47,0x80
Comment,Write IOUT_OC_LV_FAULT_LIMIT [Rail #1] 2.175 V
WriteWord,0x7E,0x48,0xCC22
Comment,"Write IOUT_OC_LV_FAULT_RESPONSE [Rail #1] Response=2,Restart=0,Delay=0"
WriteByte,0x7E,0x49,0x80
Comment,Write IOUT_OC_WARN_LIMIT [Rail #1] 10.50 A
WriteWord,0x7E,0x4A,0xA0D2
Comment,Write IOUT_UC_FAULT_LIMIT [Rail #1] -5.00 A
WriteWord,0x7E,0x4B,0x80CD
Comment,"Write IOUT_UC_FAULT_RESPONSE [Rail #1] Response=0,Restart=0,Delay=0"
WriteByte,0x7E,0x4C,0x00
Comment,"Write LIGHT_LOAD_CONFIG [MFR 29,Rail #1] CLA Gain Control: NormalLoad; Phase Control:
NormalLoad; Num Light Load Phases: 1"
WriteByte,0x7E,0xED,0x00
Comment,"Write LIGHT_LOAD_LIMIT_HIGH [MFR 27,Rail #1] 0.00 A"
WriteWord,0x7E,0xEB,0x0080
Comment,"Write LIGHT_LOAD_LIMIT_LOW [MFR 38,Rail #1] 0.00 A"
WriteWord,0x7E,0xF6,0x0080
Comment,Write OT_FAULT_LIMIT [Rail #1] 125 C
WriteWord,0x7E,0x4F,0xE8EB
Comment,"Write OT_FAULT_RESPONSE [Rail #1] Response=2,Restart=0,Delay=0"
WriteByte,0x7E,0x50,0x80
Comment,Write OT_WARN_LIMIT [Rail #1] 85 C
WriteWord,0x7E,0x51,0xA8EA
Comment,"Write PHASE_DROP_CAL [MFR 42,Rail #1] 1.000 "
WriteWord,0x7E,0xFA,0x00BA
Comment,Write POWER_GOOD_OFF [Rail #1] 2.125 V
WriteWord,0x7E,0x5F,0x0022
Comment,Write POWER_GOOD_ON [Rail #1] 2.250 V
WriteWord,0x7E,0x5E,0x0024
Comment,"Write SEQ_TIMEOUT [MFR 00,Rail #1] 0.0 ms"
WriteWord,0x7E,0xD0,0x0080
Comment,"Write SYNC_OFFSET [MFR 43,Rail #1] 0 ns"
WriteWord,0x7E,0xFB,0x0000
Comment,"Write TEMP_BALANCE_IMIN [MFR 37,Rail #1] 511.50 A"
WriteWord,0x7E,0xF5,0xFFFB
Comment,"Write THERMAL_COEFF [MFR 13,Rail #1] 0.000 %/C"
WriteWord,0x7E,0xDD,0x0080
Comment,Write TOFF_DELAY [Rail #1] 0.0 ms
WriteWord,0x7E,0x64,0x0080
Comment,Write TOFF_FALL [Rail #1] 10.0 ms
```

```
WriteWord,0x7E,0x65,0x80D2
Comment,Write TOFF_MAX_WARN_LIMIT [Rail #1] <No Limit>
WriteWord,0x7E,0x66,0xFF7F
Comment,Write TON_DELAY [Rail #1] 0.0 ms
WriteWord,0x7E,0x60,0x0080
Comment,Write TON_MAX_FAULT_LIMIT [Rail #1] <No Limit>
WriteWord,0x7E,0x62,0x0080
Comment,"Write TON_MAX_FAULT_RESPONSE [Rail #1] Response=3,Restart=0,Delay=0"
WriteByte,0x7E,0x63,0xC0
Comment,Write TON_RISE [Rail #1] 10.0 ms
WriteWord,0x7E,0x61,0x80D2
Comment,"Write TRACKING_MODE [MFR 22,Rail #1] Off"
WriteByte,0x7E,0xE6,0x80
Comment,"Write TRACKING_SCALE_MONITOR [MFR 23,Rail #1] 1.000 "
WriteWord,0x7E,0xE7,0x00BA
Comment,"Write VOUT_CAL_MONITOR [MFR 01,Rail #1] -0.010 V"
WriteWord,0x7E,0xD1,0xD9FF
Comment,Write VOUT_CAL_OFFSET [Rail #1] 0.020 V
WriteWord,0x7E,0x23,0x5300
Comment,Write VOUT_COMMAND [Rail #1] 2.500 V
WriteWord,0x7E,0x21,0x0028
Comment,Write VOUT_MARGIN_HIGH [Rail #1] 2.625 V
WriteWord,0x7E,0x25,0x002A
Comment,Write VOUT_MARGIN_LOW [Rail #1] 2.375 V
WriteWord,0x7E,0x26,0x0026
Comment,Write VOUT_OV_FAULT_LIMIT [Rail #1] 2.875 V
WriteWord,0x7E,0x40,0x002E
Comment,"Write VOUT_OV_FAULT_RESPONSE [Rail #1] Response=0,Restart=0,Delay=0"
WriteByte,0x7E,0x41,0x00
Comment,Write VOUT_OV_WARN_LIMIT [Rail #1] 2.750 V
WriteWord,0x7E,0x42,0x002C
Comment,Write VOUT_SCALE_LOOP [Rail #1] 0.439
WriteWord,0x7E,0x29,0x84AB
Comment,Write VOUT_SCALE_MONITOR [Rail #1] 0.441
WriteWord,0x7E,0x2A,0x87AB
Comment,Write VOUT_TRANSITION_RATE [Rail #1] 0.303 mV/us
WriteWord,0x7E,0x27,0x6CAA
Comment,Write VOUT_UV_FAULT_LIMIT [Rail #1] 2.125 V
WriteWord,0x7E,0x44,0x0022
Comment,"Write VOUT_UV_FAULT_RESPONSE [Rail #1] Response=0,Restart=0,Delay=0"
WriteByte,0x7E,0x45,0x00
Comment,Write VOUT_UV_WARN_LIMIT [Rail #1] 2.250 V
WriteWord,0x7E,0x43,0x0024
Comment,Write IOUT_CAL_GAIN_1 [Rail #1] 128.25 mohm
WriteWord,0x7E,0x38,0x01F2
Comment,Write IOUT_CAL_OFFSET_1 [Rail #1] 0.00 A
WriteWord,0x7E,0x39,0x0080
Comment,"Write TEMPERATURE_CAL_GAIN_1 [MFR 20,Rail #1] 125.0 C/V"
WriteWord,0x7E,0xE4,0xE8EB
Comment,"Write TEMPERATURE_CAL_OFFSET_1 [MFR 21,Rail #1] -65.00 C"
WriteWord,0x7E,0xE5,0xF8ED
```

// Begin write of rail #2 parameters
Comment,Write VOUT_MAX [Rail #2] 1.380 V
// Set PAGE to rail #2
WriteByte,0x7E,0x00,0x01
WriteWord,0x7E,0x24,0x1416
Comment,"Write ON_OFF_CONFIG [Rail #2] OperationOnly, UseDelay, ActiveHigh"
WriteByte,0x7E,0x02,0x1A
…
Comment,Store configuration to data flash
Comment,Execute STORE_DEFAULT_ALL
SendByte,0x7E,0x11
Pause,1000,Pausing 1000 ms for StoreDefaultAll
Comment,Execute STORE_DEFAULT_ALL
SendByte,0x7E,0x11
Pause,1000,Pausing 1000 ms for StoreDefaultAll

The extra STORE_DEFAULT_ALL provides a work around for a UCD9220/UCD9240 bug. When data flash was in its factory default state, the first STORE_DEFAULT_ALL would not function properly. The second STORE_DEFAULT_ALL would. This double STORE_DEFAULT_ALL is done in a low-level API and may therefore be done more than necessary.

9.8.2 UCD90124 PMBus Config Script Example

```
Comment,Format=CSV; Hex=CoderUpper; BreakOutBytes=False; IncludeBlockLength=True [DO NOT
REMOVE THIS LINE IF YOU WANT TO IMPORT USING A FUSION TOOL]
Comment,"SMBus Fields are Request,Address,Command,Data"
Comment,"For reads, the last field is what is expected back from the device"
// Begin write of pin configuration parameters
Comment,"Write MONITOR_CONFIG [MFR 05] Pin 1 MON1: Rail #1, Type Voltage; Pin 2 MON2: Rail #10, Type
Temperature; Pin 3 MON3: Rail #10, Type Current; Pin 4 MON4: Rail #4, Type Voltage; Pin 5 MON5: Rail #5, Type
Voltage; Pin 6 MON6: Rail #6, Type Voltage; Pin 59 MON7: Rail #7, Type Voltage; Pin 62 MON8: Rail #8, Type
Voltage; Pin 63 MON9: Rail #9, Type Voltage; Pin 50 MON10: Rail #10, Type Voltage; Pin 52 MON11: Rail #11,
Type Voltage; Pin 54 MON12: Rail #12, Type Voltage; Pin 56 MON13: Not Assigned"
BlockWrite,0x7E,0xD5,0x0D2049692324252627282 92A2B00
Comment,Write GPI_CONFIG [MFR 41] Inputs: <None>
BlockWrite,0x7E,0xF9,0x0D00000000000000000000000000
Comment,"Write SEQ_CONFIG [MFR 38,Rail #1] Rail On Dep: <None> | GPI On Dep: <None> | Fault Dep: Rail #2 |
Enable: Pin 11 GPIO1 ActiveHigh ActivelyDrivenOutput"
WriteByte,0x7E,0x00,0x00
BlockWrite,0x7E,0xF6,0x06000000000296
...
Comment,"Write SEQ_CONFIG [MFR 38,Rail #12] Rail On Dep: <None> | GPI On Dep: <None> | Fault Dep:
<None> | Enable: Pin 39 TMS_GPIO22 ActiveHigh ActivelyDrivenOutput"
WriteByte,0x7E,0x00,0x0B
BlockWrite,0x7E,0xF6,0x06000000000086
Comment,Write GPO_CONFIG_1 [MFR 40] Unassigned; No Mask
WriteByte,0x7E,0xF7,0x00
BlockWrite,0x7E,0xF8,0x1D0000000000000000000000000000000000000000000000000000000000
...
Comment,Write GPO_CONFIG_12 [MFR 40] Unassigned; No Mask
WriteByte,0x7E,0xF7,0x0B
BlockWrite,0x7E,0xF8,0x1D0000000000000000000000000000000000000000000000000000000000
Comment,Write PWM_CONFIG_0 [MFR 17] Duty Cycle: 21.0 %; Frequency: 0 Hz; Phase: 0.0 deg
WriteByte,0x7E,0xE0,0x00
BlockWrite,0x7E,0xE1,0x08DAA1000000008000
...
Comment,Write PWM_CONFIG_11 [MFR 17] Duty Cycle: 0.0 %; Frequency: 0 Hz; Phase: 0.0 deg
WriteByte,0x7E,0xE0,0x0B
BlockWrite,0x7E,0xE1,0x088800000000008000
Comment,Write FAN_CONFIG_1 [MFR 24] Installed: yes; Tach: Not Assigned; PWM: 20 FPWM4_GPIO8; PWM
Mode: SimpleEnable; Enable Polarity: ActiveHigh; Speed Fault Limit: 0.00 RPM; Fan Speed Auto Adjusted via Rail
#1; Temp Off: 24 C; Temp On: 28 C
WriteByte,0x7E,0xE7,0x00
BlockWrite,0x7E,0xE8,0x1503000091181C000000000000000000000000000000
...
Comment,Write FAN_CONFIG_4 [MFR 24] Installed: yes; Tach: 30 GPIO15; Tach Pules Per Rev: 2; PWM: 19
FPWM3_GPIO7; PWM Mode: VariablePWM; Auto Calibration Off; Duty On/Off/Max: 20/10/98%; Speed Type:
PctOperatingSpeed; Speed Fault Limit: 200.00 RPM; Speed Change: 0.125%; Fault Increase Speed: 0%
WriteByte,0x7E,0xE7,0x03
BlockWrite,0x7E,0xE8,0x15020D902300000000000000000000000000C8140A62
Comment,"Write MARGIN_CONFIG [MFR 37,Rail #1] Margin Enable: False; Calibrated: False; Ignore Faults: False;
PWM Pin: ID 0, # 17 FPWM1_GPIO5"
WriteByte,0x7E,0x00,0x00
```

```
WriteByte,0x7E,0xF5,0x00
...
Comment,"Write MARGIN_CONFIG [MFR 37,Rail #12] Margin Enable: False; Calibrated: False; Ignore Faults: False;
PWM Pin: ID 0, # 17 FPWM1_GPIO5"
WriteByte,0x7E,0x00,0x0B
WriteByte,0x7E,0xF5,0x00
Comment,Write GPIO_CONFIG_0 [MFR 43] Enable: False; Out_Enable: False; Out_Value: False; Status: False
WriteByte,0x7E,0xFA,0x00
WriteByte,0x7E,0xFB,0x00
...
Comment,Write GPIO_CONFIG_17 [MFR 43] Enable: False; Out_Enable: False; Out_Value: False; Status: False
WriteByte,0x7E,0xFA,0x11
WriteByte,0x7E,0xFB,0x00
// VOUT_MODE defines the exponent for VOUT related commands on each rail
Comment,Write VOUT_MODE [Rail #1] EXP -12
WriteByte,0x7E,0x00,0x00
WriteByte,0x7E,0x20,0x14
...
Comment,Write VOUT_MODE [Rail #12] EXP -12
WriteByte,0x7E,0x00,0x0B
WriteByte,0x7E,0x20,0x14
Comment,Write FAN_COMMAND_1 0.0 %
WriteWord,0x7E,0x3B,0x0088
Comment,Write FAN_COMMAND_2 0.0 %
WriteWord,0x7E,0x3C,0x0088
Comment,Write FAN_COMMAND_3 0.0 %
WriteWord,0x7E,0x3E,0x0088
Comment,Write FAN_COMMAND_4 0.0 %
WriteWord,0x7E,0x3F,0x0088
Comment,"Write LOGGED_FAULT_DETAIL_ENABLES [MFR 31] Common:
LOG_NOT_EMPTY,RESERVED1,RESEQUENCE_ERROR,WATCHDOG_TIMEOUT,FAN_1,FAN_2,FAN_3,FAN_4;
Rail #1:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#2: VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT;
Rail #3:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#4: VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT;
Rail #5:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#6: VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT;
Rail #7:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#8: VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT;
Rail #9:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#10:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#11:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT; Rail
#12:
VOUT_OV,VOUT_UV,TON_MAX,IOUT_OC,IOUT_UC,TEMPERATURE_OT,SEQ_TIMEOUT,SLAVED_FAULT"
```

```
BlockWrite,0x7E,0xEF,0x0DFFFFFFFFFFFFFFFFFFFFFFFFFF
// Begin write of common (not PAGEd) parameters
Comment,Write MFR_DATE 090401
BlockWrite,0x7E,0x9D,0x06303930343031
Comment,Write MFR_ID TEXAS_INSTRUMENTS
BlockWrite,0x7E,0x99,0x1254455841535F494E535452554D454E545320
Comment,Write MFR_LOCATION DALLAS
BlockWrite,0x7E,0x9C,0x0C44414C4C4153202020202020
Comment,Write MFR_MODEL PR651_REVA
BlockWrite,0x7E,0x9A,0x0C50523635315F524556412020
Comment,Write MFR_REVISION REV_F
BlockWrite,0x7E,0x9B,0x0C5245565F4620202020202020
Comment,Write MFR_SERIAL 000000
BlockWrite,0x7E,0x9E,0x0C303030303030202020202020
Comment,Write MISC_CONFIG [MFR 44] Time Between Resequences: 0 msec; Resequence Abort: no; Max
Resequences: 1; FIFO Mode: Disabled; Brownout Enable: no
BlockWrite,0x7E,0xFC,0x020000
Comment,Write RUN_TIME_CLOCK_TRIM [MFR 08] 0.00 %
WriteWord,0x7E,0xD8,0x0088
Comment,Write SYSTEM_RESET_CONFIG [MFR 02] Disabled
BlockWrite,0x7E,0xD2,0x0400000000
Comment,Write SYSTEM_WATCHDOG_CONFIG [MFR 03] Disabled
BlockWrite,0x7E,0xD3,0x0400000000
// Begin write of rail #1 parameters
Comment,"Write ON_OFF_CONFIG [Rail #1] ControlOnly, UseDelay, ActiveHigh"
WriteByte,0x7E,0x00,0x00
WriteByte,0x7E,0x02,0x16
Comment,"Write FAULT_RESPONSES [MFR 25,Rail #1] Retry Time: 255 msec| Max Volt Glitch Time: 98.0 msec|
Max Other Glitch Time: 25,500 msec| VOUT_OV: Resequence: Disabled; Glitch filter: Disabled; Response: Ignore;
Restart: N/A| VOUT_UV: Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart: N/A| IOUT_OC:
Resequence: Disabled; Glitch filter: Disabled; Response: Shut down with delay; Restart: Do not restart| IOUT_UC:
Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart: N/A| OT: Resequence: Disabled; Glitch
filter: Disabled; Response: Ignore; Restart: N/A| TON_MAX: Resequence: Disabled; Glitch filter: Disabled; Response:
Ignore; Restart: N/A"
BlockWrite,0x7E,0xE9,0x090000A0000000FFF5FF
Comment,Write IOUT_CAL_GAIN [Rail #1] 33.875 mohm
WriteWord,0x7E,0x38,0x1EE2
Comment,Write IOUT_CAL_OFFSET [Rail #1] -18.06 A
WriteWord,0x7E,0x39,0xBEDD
Comment,Write IOUT_OC_FAULT_LIMIT [Rail #1] 8.00 A
WriteWord,0x7E,0x46,0x00D2
Comment,Write IOUT_OC_WARN_LIMIT [Rail #1] 52.50 A
WriteWord,0x7E,0x4A,0x48E3
Comment,Write IOUT_UC_FAULT_LIMIT [Rail #1] -12.50 A
WriteWord,0x7E,0x4B,0xE0D4
Comment,Write OT_FAULT_LIMIT [Rail #1] 80 C
WriteWord,0x7E,0x4F,0x80EA
Comment,Write OT_WARN_LIMIT [Rail #1] 75 C
WriteWord,0x7E,0x51,0x58EA
Comment,Write POWER_GOOD_OFF [Rail #1] 3.000 V
WriteWord,0x7E,0x5F,0x0030
```

```
Comment,Write POWER_GOOD_ON [Rail #1] 3.177 V
WriteWord,0x7E,0x5E,0xD432
Comment,"Write SEQ_TIMEOUT [MFR 00,Rail #1] 0.0 ms"
WriteWord,0x7E,0xD0,0x0080
Comment,"Write TEMPERATURE_CAL_GAIN [MFR 20,Rail #1] 200.0 C/V"
WriteWord,0x7E,0xE4,0x20F3
Comment,"Write TEMPERATURE_CAL_OFFSET [MFR 21,Rail #1] -50.00 C"
WriteWord,0x7E,0xE5,0xE0E4
Comment,Write TOFF_DELAY [Rail #1] 550.0 ms
WriteWord,0x7E,0x64,0x2602
Comment,Write TOFF_MAX_WARN_LIMIT [Rail #1] <No Limit>
WriteWord,0x7E,0x66,0xFF7F
Comment,Write TON_DELAY [Rail #1] 5.0 ms
WriteWord,0x7E,0x60,0x80CA
Comment,Write TON_MAX_FAULT_LIMIT [Rail #1] <No Limit>
WriteWord,0x7E,0x62,0x0080
Comment,"Write VOUT_CAL_MONITOR [MFR 01,Rail #1] 0.000 V"
WriteWord,0x7E,0xD1,0x0000
Comment,Write VOUT_COMMAND [Rail #1] 3.530 V
WriteWord,0x7E,0x21,0x7A38
Comment,Write VOUT_MARGIN_HIGH [Rail #1] 3.707 V
WriteWord,0x7E,0x25,0x4F3B
Comment,Write VOUT_MARGIN_LOW [Rail #1] 3.353 V
WriteWord,0x7E,0x26,0xA535
Comment,Write VOUT_OV_FAULT_LIMIT [Rail #1] 4.060 V
WriteWord,0x7E,0x40,0xF540
Comment,Write VOUT_OV_WARN_LIMIT [Rail #1] 3.883 V
WriteWord,0x7E,0x42,0x203E
Comment,Write VOUT_SCALE_MONITOR [Rail #1] 0.500
WriteWord,0x7E,0x2A,0x00B2
Comment,Write VOUT_UV_FAULT_LIMIT [Rail #1] 3.000 V
WriteWord,0x7E,0x44,0x0030
Comment,Write VOUT_UV_WARN_LIMIT [Rail #1] 3.177 V
WriteWord,0x7E,0x43,0xD432
// Begin write of rail #2 parameters
Comment,"Write ON_OFF_CONFIG [Rail #2] ControlOnly, UseDelay, ActiveHigh"
// Set PAGE to rail #2
WriteByte,0x7E,0x00,0x01
WriteByte,0x7E,0x02,0x16
Comment,"Write FAULT_RESPONSES [MFR 25,Rail #2] Retry Time: 0 msec| Max Volt Glitch Time: 0.0 msec| Max
Other Glitch Time: 0 msec| VOUT_OV: Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart:
N/A| VOUT_UV: Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart: N/A| IOUT_OC:
Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart: N/A| IOUT_UC: Resequence: Disabled;
Glitch filter: Disabled; Response: Ignore; Restart: N/A| OT: Resequence: Disabled; Glitch filter: Disabled; Response:
Ignore; Restart: N/A| TON_MAX: Resequence: Disabled; Glitch filter: Disabled; Response: Ignore; Restart: N/A"
BlockWrite,0x7E,0xE9,0x09000000000000000000
…
Comment,Write VOUT_UV_WARN_LIMIT [Rail #12] 1.728 V
WriteWord,0x7E,0x43,0xA51B
Comment,Store configuration to data flash
Comment,Execute STORE_DEFAULT_ALL
```

```
SendByte,0x7E,0x11
Pause,1500,Pausing 1500 ms for StoreDefaultAll
```

9.9 Packet Error Checking (PEC) Algorithm Sample C Code

```
// CRC-8 look-up table for PEC byte calculation
unsigned char crc8_table[] = {
    0x00, // entry 0x00
    0x07, // entry 0x01
    0x0E, // entry 0x02
    0x09, // entry 0x03
    0x1C, // entry 0x04
    0x1B, // entry 0x05
    0x12, // entry 0x06
    0x15, // entry 0x07
    0x38, // entry 0x08
    0x3F, // entry 0x09
    0x36, // entry 0x0A
    0x31, // entry 0x0B
    0x24, // entry 0x0C
    0x23, // entry 0x0D
    0x2A, // entry 0x0E
    0x2D, // entry 0x0F
    0x70, // entry 0x10
    0x77, // entry 0x11
    0x7E, // entry 0x12
    0x79, // entry 0x13
    0x6C, // entry 0x14
    0x6B, // entry 0x15
    0x62, // entry 0x16
    0x65, // entry 0x17
    0x48, // entry 0x18
    0x4F, // entry 0x19
    0x46, // entry 0x1A
    0x41, // entry 0x1B
    0x54, // entry 0x1C
    0x53, // entry 0x1D
    0x5A, // entry 0x1E
    0x5D, // entry 0x1F
    0xE0, // entry 0x20
    0xE7, // entry 0x21
    0xEE, // entry 0x22
    0xE9, // entry 0x23
    0xFC, // entry 0x24
    0xFB, // entry 0x25
    0xF2, // entry 0x26
    0xF5, // entry 0x27
    0xD8, // entry 0x28
    0xDF, // entry 0x29
    0xD6, // entry 0x2A
    0xD1, // entry 0x2B
    0xC4, // entry 0x2C
    0xC3, // entry 0x2D
    0xCA, // entry 0x2E
    0xCD, // entry 0x2F
    0x90, // entry 0x30
    0x97, // entry 0x31
    0x9E, // entry 0x32
    0x99, // entry 0x33
    0x8C, // entry 0x34
    0x8B, // entry 0x35
    0x82, // entry 0x36
    0x85, // entry 0x37
    0xA8, // entry 0x38
    0xAF, // entry 0x39
    0xA6, // entry 0x3A
    0xA1, // entry 0x3B
    0xB4, // entry 0x3C
    0xB3, // entry 0x3D
    0xBA, // entry 0x3E
    0xBD, // entry 0x3F
    0xC7, // entry 0x40
    0xC0, // entry 0x41
    0xC9, // entry 0x42
    0xCE, // entry 0x43
    0xDB, // entry 0x44
    0xDC, // entry 0x45
    0xD5, // entry 0x46
    0xD2, // entry 0x47
    0xFF, // entry 0x48
    0xF8, // entry 0x49
    0xF1, // entry 0x4A
    0xF6, // entry 0x4B
    0xE3, // entry 0x4C
    0xE4, // entry 0x4D
    0xED, // entry 0x4E
    0xEA, // entry 0x4F
    0xB7, // entry 0x50
    0xB0, // entry 0x51
    0xB9, // entry 0x52
    0xBE, // entry 0x53
    0xAB, // entry 0x54
    0xAC, // entry 0x55
    0xA5, // entry 0x56
    0xA2, // entry 0x57
    0x8F, // entry 0x58
    0x88, // entry 0x59
    0x81, // entry 0x5A
    0x86, // entry 0x5B
    0x93, // entry 0x5C
    0x94, // entry 0x5D
    0x9D, // entry 0x5E
    0x9A, // entry 0x5F
    0x27, // entry 0x60
    0x20, // entry 0x61
    0x29, // entry 0x62
    0x2E, // entry 0x63
    0x3B, // entry 0x64
    0x3C, // entry 0x65
    0x35, // entry 0x66
    0x32, // entry 0x67
    0x1F, // entry 0x68
    0x18, // entry 0x69
    0x11, // entry 0x6A
    0x16, // entry 0x6B
    0x03, // entry 0x6C
    0x04, // entry 0x6D
    0x0D, // entry 0x6E
    0x0A, // entry 0x6F
    0x57, // entry 0x70
    0x50, // entry 0x71
    0x59, // entry 0x72
    0x5E, // entry 0x73
    0x4B, // entry 0x74
    0x4C, // entry 0x75
    0x45, // entry 0x76
    0x42, // entry 0x77
    0x6F, // entry 0x78
    0x68, // entry 0x79
    0x61, // entry 0x7A
    0x66, // entry 0x7B
    0x73, // entry 0x7C
    0x74, // entry 0x7D
    0x7D, // entry 0x7E
    0x7A, // entry 0x7F
    0x89, // entry 0x80
    0x8E, // entry 0x81
    0x87, // entry 0x82
    0x80, // entry 0x83
    0x95, // entry 0x84
    0x92, // entry 0x85
    0x9B, // entry 0x86
    0x9C, // entry 0x87
    0xB1, // entry 0x88
    0xB6, // entry 0x89
    0xBF, // entry 0x8A
    0xB8, // entry 0x8B
    0xAD, // entry 0x8C
    0xAA, // entry 0x8D
    0xA3, // entry 0x8E
    0xA4, // entry 0x8F
    0xF9, // entry 0x90
    0xFE, // entry 0x91
    0xF7, // entry 0x92
    0xF0, // entry 0x93
    0xE5, // entry 0x94
    0xE2, // entry 0x95
    0xEB, // entry 0x96
    0xEC, // entry 0x97
    0xC1, // entry 0x98
    0xC6, // entry 0x99
    0xCF, // entry 0x9A
    0xC8, // entry 0x9B
    0xDD, // entry 0x9C
    0xDA, // entry 0x9D
    0xD3, // entry 0x9E
    0xD4, // entry 0x9F
    0x69, // entry 0xA0
    0x6E, // entry 0xA1
    0x67, // entry 0xA2
    0x60, // entry 0xA3
    0x75, // entry 0xA4
    0x72, // entry 0xA5
    0x7B, // entry 0xA6
    0x7C, // entry 0xA7
    0x51, // entry 0xA8
    0x56, // entry 0xA9
    0x5F, // entry 0xAA
    0x58, // entry 0xAB
    0x4D, // entry 0xAC
    0x4A, // entry 0xAD
    0x43, // entry 0xAE
    0x44, // entry 0xAF
    0x19, // entry 0xB0
    0x1E, // entry 0xB1
    0x17, // entry 0xB2
    0x10, // entry 0xB3
    0x05, // entry 0xB4
    0x02, // entry 0xB5
    0x0B, // entry 0xB6
    0x0C, // entry 0xB7
    0x21, // entry 0xB8
    0x26, // entry 0xB9
    0x2F, // entry 0xBA
    0x28, // entry 0xBB
    0x3D, // entry 0xBC
    0x3A, // entry 0xBD
    0x33, // entry 0xBE
    0x34, // entry 0xBF
    0x4E, // entry 0xC0
    0x49, // entry 0xC1
    0x40, // entry 0xC2
    0x47, // entry 0xC3
    0x52, // entry 0xC4
    0x55, // entry 0xC5
    0x5C, // entry 0xC6
    0x5B, // entry 0xC7
    0x76, // entry 0xC8
    0x71, // entry 0xC9
    0x78, // entry 0xCA
    0x7F, // entry 0xCB
    0x6A, // entry 0xCC
    0x6D, // entry 0xCD
    0x64, // entry 0xCE
    0x63, // entry 0xCF
    0x3E, // entry 0xD0
    0x39, // entry 0xD1
    0x30, // entry 0xD2
    0x37, // entry 0xD3
    0x22, // entry 0xD4
    0x25, // entry 0xD5
    0x2C, // entry 0xD6
    0x2B, // entry 0xD7
    0x06, // entry 0xD8
    0x01, // entry 0xD9
    0x08, // entry 0xDA
    0x0F, // entry 0xDB
    0x1A, // entry 0xDC
    0x1D, // entry 0xDD
    0x14, // entry 0xDE
    0x13, // entry 0xDF
    0xAE, // entry 0xE0
    0xA9, // entry 0xE1
    0xA0, // entry 0xE2
    0xA7, // entry 0xE3
    0xB2, // entry 0xE4
    0xB5, // entry 0xE5
    0xBC, // entry 0xE6
    0xBB, // entry 0xE7
    0x96, // entry 0xE8
    0x91, // entry 0xE9
    0x98, // entry 0xEA
    0x9F, // entry 0xEB
    0x8A, // entry 0xEC
    0x8D, // entry 0xED
    0x84, // entry 0xEE
    0x83, // entry 0xEF
    0xDE, // entry 0xF0
    0xD9, // entry 0xF1
    0xD0, // entry 0xF2
    0xD7, // entry 0xF3
    0xC2, // entry 0xF4
    0xC5, // entry 0xF5
    0xCC, // entry 0xF6
    0xCB, // entry 0xF7
    0xE6, // entry 0xF8
    0xE1, // entry 0xF9
    0xE8, // entry 0xFA
    0xEF, // entry 0xFB
    0xFA, // entry 0xFC
    0xFD, // entry 0xFD
    0xF4, // entry 0xFE
    0xF3  // entry 0xFF
};


// function: calculate PEC byte based on a 256-entry CRC-8 look-up table
//
// entries: start_addr - starting address of memory, based on where a
//                       PEC byte will be calculated
//          start_crc8 - the starting CRC-8 value
//          length     - # of bytes to calculate on
//
// return: an 8-bit CRC-8 that will be used as the PEC byte
unsigned char calc_pec(unsigned char start_crc8, unsigned long length,
                       unsigned char* start_addr)
{
    unsigned char crc8 = start_crc8;
    unsigned long i;

    for (i = 0; i < length; i++)
    {
        // XOR the previous CRC-8 result with the new byte of data
        crc8 ^= *(start_addr + i);

        crc8 = crc8_table[crc8];
    }

    return crc8;
}
```