Introduction

PowerNavigator is a development tool that allows easy control and monitoring of Zilker Labs Digital-DC™ devices via the SMBus interface. PowerNavigator can be used with evaluation boards (EVB) or with customer boards that have access to the SMBus.

This document describes the various screens and features available in PowerNavigator.

PowerNavigator is shipped with Zilker Labs Evaluation Kits (EVK) and is also available for download from the My ZL page at www.zilkerlabs.com. The web page should be checked for the latest version of PowerNavigator.

The complete evaluation system (EVB, PowerNavigator, and CompZL), enables a power engineer to optimize a complex power system configuration before committing to a firm hardware design. Using this document, the user will be able to fully configure either a single converter or as many boards/rails as desired.

Using PowerNavigator with a Zilker Labs Evaluation Board

Before you begin, it is recommended that you read and understand the product data sheets, EVB data sheet, AN2033 *PMBus Command Set*, and the PMBus Specification.

Upon power-up, the Digital-DC controller will first look for a configuration defined by the positions of pin-strap jumpers and then the content of the non-volatile memory to determine the proper device configuration. Functionality of the jumpers is described in the individual product data sheet. The EVB jumper positions are described in the evaluation board data sheet.

Zilker Labs recommends that the evaluation board and the PowerNavigator software be used in a specific order. To ensure that PowerNavigator does not retain any stale data from prior sessions, power should be applied to the board before launching the software. If PowerNavigator is launched without a powered board attached to the PC, an error message will appear asking to connect an evaluation board. Subsequently, the PowerNavigator software should be shut down before turning off the power to the board.

All of the parameters determined by pin-strap configuration can be overwritten via the PowerNavigator with the exception of maximum Output Voltage (V_{OUT}). The set value of V_{OUT} cannot exceed the value determined by the pin-strap or resistor setting by more than 10%. If a user attempts to enter a greater V_{OUT} value through PowerNavigator, the device will not regulate above the pin-strap setting plus 10%. This feature protects the load from inadvertently being powered in excess of its maximum rating. V_{OUT} can be set by PowerNavigator to any value which is lower than the pin-strap defined value. Note that the configuration pins are tri-state; therefore, leaving a pin floating assigns a value to it. For example on the ZL2006, leaving terminals V0 and V1 not connected (floating) means that V_{OUT} is configured to 1.5V.

Writing (and rewriting) of the operating parameters can be executed any time as long as a valid input voltage is applied to the VDD pin of the Digital-DC device. Configuration changes can occur regardless of the state of ENABLE switch and/or whether the input voltage is above or below Input Over-Voltage or Under-Voltage threshold limits defined by controller configuration. Storing a configuration to non-volatile memory (STORE command) does require the device to be disabled.

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1 Main Screen (GROUP MONITOR)

Before moving to descriptions of the specific screens of PowerNavigator, it is worth mentioning that there are several functional "soft buttons" at the main screen of PowerNavigator which are accessible from any screen. Those buttons are found in the upper right corner of the window:

- Screen selection dropdown menu – Provides the option to continuously observe up to three rails simultaneously using the "GROUP MONITOR" mode (shown below) or work with any single rail by choosing "DEVICE CONFIG."
- SW RESTART - Allows the user to restart PowerNavigator without removing power or changing the operational configuration. This button will cause the software to reinitialize and reread the existing device parameters.

PowerNavigator starts in the "GROUP MONITOR" mode by default. This is to allow the user to get a quick view of the power supply system parameters for the first three devices found in the address range 0x20 to 0x2F. While on this screen, the software is said to be in "monitor mode" which means the Digital-DC devices are continually being monitored over the SMBus. This monitor mode is enabled by PowerNavigator by modifying the USER_CONFIG command when the software is launched. Many of the pin configurable parameters and operational conditions can be viewed from this screen.

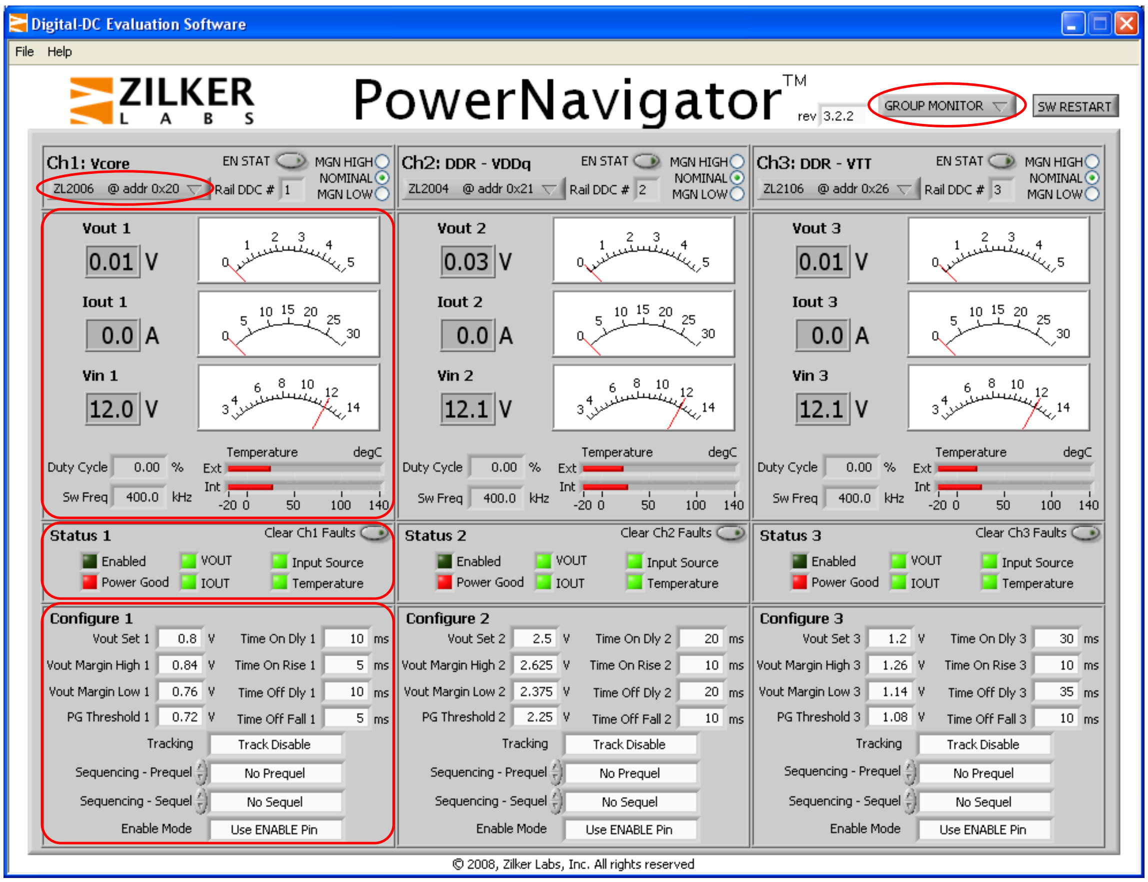

Figure 1. GROUP MONITOR Screen

The “GROUP MONITOR” screen is dedicated to showing basic configuration and monitoring operation of up to three voltage rails simultaneously. When PowerNavigator is invoked, the three Digital-DC controllers with the lowest SMBus addresses will be displayed in the channel sections. If more than three Digital-DC controllers are connected to the common SMBus, the other controllers can be viewed by selecting their address from the pull down menu located at the top of each channel display. When this screen is selected to be displayed, continuous SMBus traffic will occur to continuously update the monitored information. The following interactive regions are displayed in each channel’s section:

1.1 GROUP MONITOR: Region 1

The top of each rail’s display contains a channel description, an address selection drop-down, an enable indicator and a margin selector.

The channel description (i.e. Ch1:<model>) is a copy of the ASCII data stored in the device’s MFR_MODEL field. The MFR_MODEL command can be used to set a relevant description of the device and its rail to make identification more user friendly.

The drop-down menu allows the user to easily switch between any Digital-DC device at their respective addresses. This allows the user to observe and manipulate more than three rails at the same time. PowerNavigator scans the SMBus for Digital-DC devices that are in the hex address range of 0x20 to 0x2F. The devices shown in the drop-down menu are those that were found in an SMBus scan during PowerNavigator startup. The scanned address range can be modified by changing the start and stop address settings in the PowerNavigator.ini file found in the installation directory. Note that setting a scanned address range greater than 16 addresses can cause PowerNavigator to take an excessive amount of time to startup. At any time, this address drop-down menu can be accessed and changed to any device desired.

The enable indicator functions as an enable status light when the rail is configured to operate using the Enable pin mode. The indicator acts as the enable switch when the rail is configured to operate using PMBus enable. The enable indicator light turns bright green when the device is enabled and dark green when it is disabled.

The margin selector is a radio button that indicates the current margin mode of the device. It can be used to margin a rail’s output voltage to its high margin or low margin value when the rail is enabled.

1.2 GROUP MONITOR: Region 2

Basic monitored operating parameters of the converter are displayed in this region. These include the input voltage (READ_VIN), output voltage (READ_VOUT), output current (READ_IOUT), duty cycle, switching frequency, internal controller temperature (READ_TEMPERATURE_1) and the external temperature sensor (READ_TEMPERATURE_2). Note that the external temperature feature is only available on certain devices and must be enabled for monitoring. Refer to the specific device’s data sheet for us of the external temperature feature.

1.3 GROUP MONITOR: Region 3 (Status)

This region displays the status of the device’s operation and if there are any faults. As an example, the Power Good fault on the device displayed in Ch1 is red since it is not enabled. This section will also indicate if output or input voltages, output current, or temperature has deviated beyond their respective fault limits. More details regarding fault status is described in the PMBus: Monitor and Status window and PMBus: Fault Limits sections of this document. Use the PMBus: Monitor and Status tab to capture a fault status and have the ability to manually clear the fault status. Refer to AN2033 and the PMBus Specification part II for fault definitions.

1.4 GROUP MONITOR: Region 4 (Configure)

The configuration settings in this region of the screen are used to configure certain parameters of the power supply operation. In this area, the tracking, sequencing, delay start, ramp times, under-voltage level, margin voltages and V_{OUT} are configured. This screen displays the power rails from a system perspective; therefore, changing V_{OUT} in this screen will automatically change V_{OUT}, UV and OV thresholds, Margin High/Low and Power Good thresholds.

The Tracking drop-down button is used to select 100% or 50% voltage tracking. When two EVBs are connected together, the EVB on the left is the tracked device and the EVB on the right is the tracking device. Note that all devices within a current share rail must be set to the same tracking setting.

The Sequencing drop-down buttons configure the devices for event based sequencing. The drop-down provides selection of the Rail ID of a different rail in the system. The prequel Rail ID is the rail that should turn on prior to the observed rail turns on during the start up sequence. The sequel Rail ID is the rail that should turn on after to the observed rail turns on. The opposite is true for the prequel and sequel definitions during the turn off sequence.

The Enable mode drop-down button selects the option to use the toggle switch on the EVB (EN pin) or the PMBus as the source of the enable signal. Note that all devices within a current share rail must be set to the same enable mode setting.

Ensure that any configuration changes made to a device that is a member of a current share rail is applied to all devices within a current share rail. The current share rail may not have the desired operation if configuration settings are not consistent amongst all devices within a current share rail.

2 Device Configuration Screen (DEVICE CONFIG)

To reach this screen, click on the GROUP MONITOR button and select DEVICE CONFIG. Once in this mode, the user has the ability to select a specific device to configure by selecting its address with the pull down on the upper right. The user can then choose between the Configure Device, File I/O and PMBus Commands tabs. Note that this screen only accesses the SMBus when there is a tab change, device selection change or command value change. The USER_CONFIG value that was read when PowerNavigator was launched is replaced into the device when the DEVICE CONFIG page is selected. (i.e. when the DEVICE CONFIG page is selected and each time a tab is selected within the DEVICE CONFIG page, the parameters are read from the selected device to refresh the values on that tab's screen. Otherwise there is no continuous SMBus access while viewing the DEVICE CONFIG screen.)

2.1 Configure Device Tab

See Figure 2. The Configure Device tab provides access to the general power conversion and power management settings.

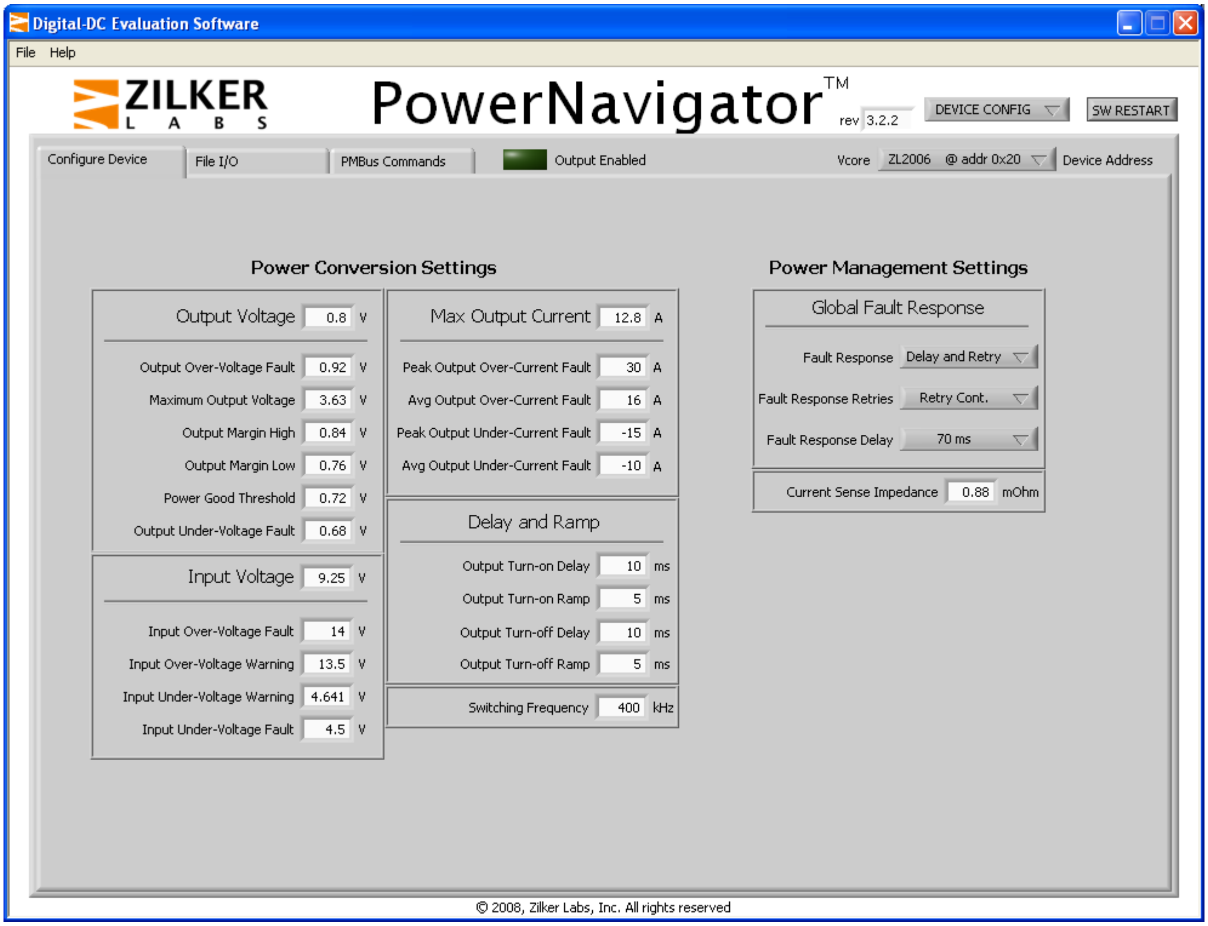

Figure 2. DEVICE CONFIG screen: Configure Device tab

Note: Modifying Output Voltage (V_{OUT}) will proportionally change the other six parameters below which are associated with it. Fault thresholds and responses also are entered here. Global Fault Response settings set all fault response routines to the same mode. The Digital-DC device can be configured to shutdown, ignore or conditionally react to faults. In the conditional mode, the user can configure how long to ignore a fault or how many times the device retries before shutting down completely. Fault Response format and settings are covered in detail in

PMBus: Fault Limits section.

2.2 File I/O Tab

See Figure 3. Use the File I/O tab to store or load a configuration file.

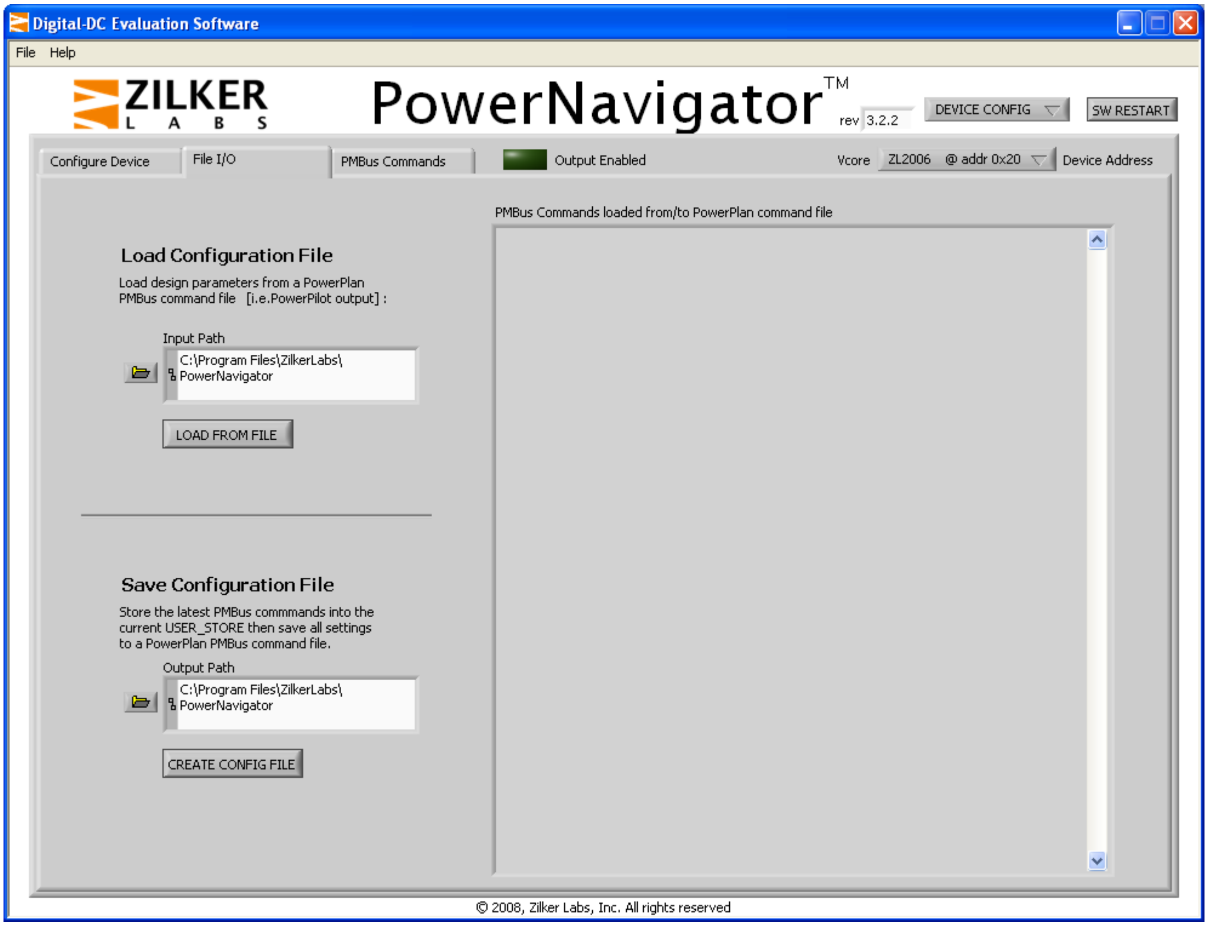

Figure 3. DEVICE CONFIG screen: File I/O tab

When loading or saving a configuration file, the text of that file will be displayed in the large text box. When loading a configuration file, browse to the location of the file using the folder button then click the “LOAD FROM FILE” button. When saving a configuration file, browse to the desired location of the configuration file and click the “SAVE TO FILE” button.

PowerNavigator enables the user to configure the device with any of the PMBus commands without ever writing code for the device. The configuration file is a tab-delimited text file that contains the PMBus commands. For more information on the PMBus command set refer to Application Note 33.

2.3 PMBus Commands Tab

The PMBus Commands tab allows the user to access and optimize any PMBus command that is implemented in the device under evaluation. The user is given the ability to adjust individual parameters to optimize controller operation and a specific power train. All PMBus commands are presented in the same syntax as defined in the PMBus specification (refer to AN2033 for PMBus command use). There are sub-tabs within the PMBus Commands tab. The first sub-tab is shown in Figure 4.

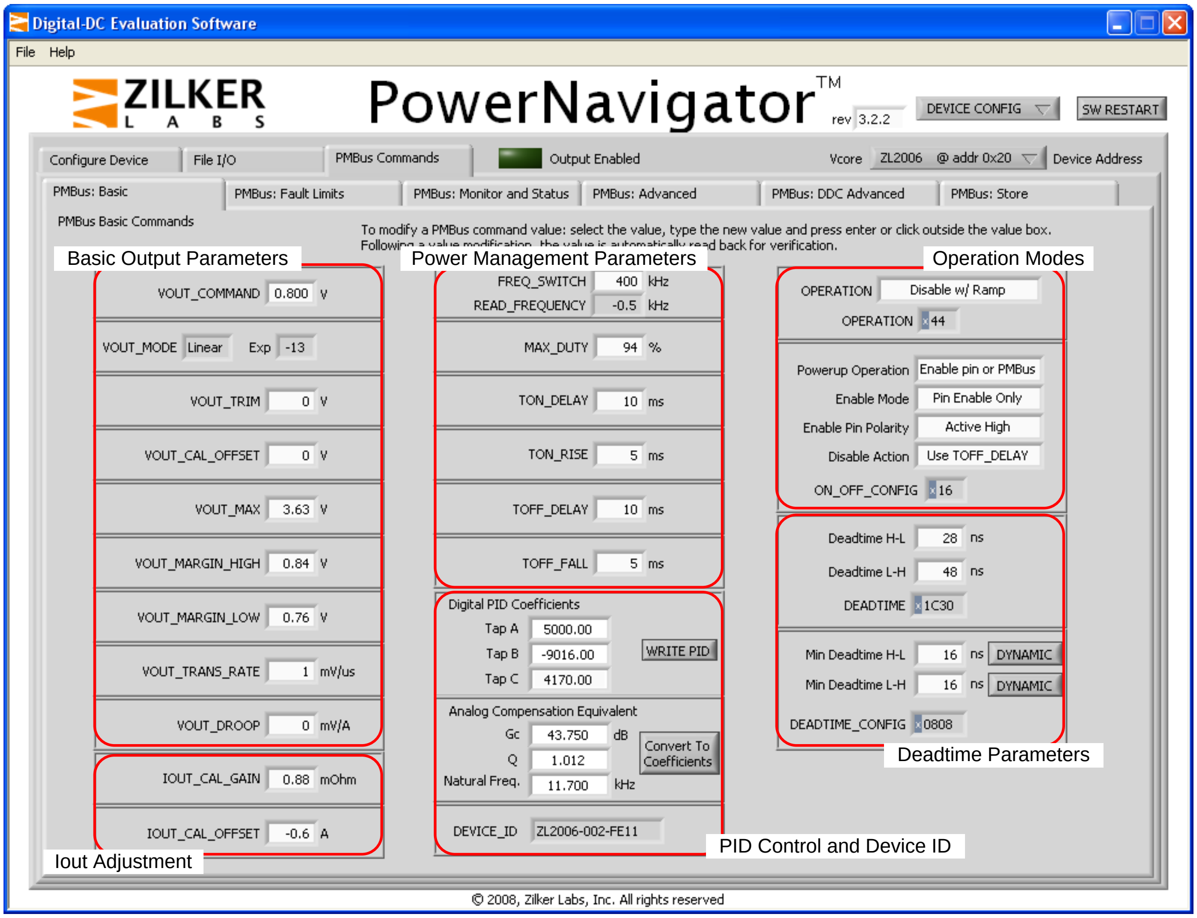

Figure 4. PMBus: Basic

2.3.1 PMBus: Basic

This tab enables the review and manipulation all of the basic PMBus operational parameters of a single Digital-DC device. This tab consists of several areas.

Unlike the GROUP MONITOR page and Configure Device tab, *parameters changed through the PMBus: Basic tab are changed individually, regardless of their relation to other parameters*. For example, if VOUT_COMMAND is modified, the corresponding VOUT fault thresholds and margin levels may not be valid. If the new VOUT_COMMAND is stored, the device will recalculate the parameters relative to VOUT unless a given parameter value is also stored. Using this tab of PowerNavigator along with the PMBus: Fault Limits and PMBus: Advanced tab allows the user to configure the Digital-DC device to meet specific system requirements.

2.3.1.1 Basic Output Parameters

This section includes basic output set-up parameters starting with the output voltage programmed value. Calibration and scaling of voltage and current sense signals, adjustment of output voltage droop and parameters related to output transitions such as start-up, shut-down and margin adjustments are all individually adjusted in this section.

2.3.1.2 I_{OUT} Adjustment

Performance of the Digital-DC device can be optimized for variances in power train components. As an example, when using $R_{DS(ON)}$ for current sense, there are several parameters available to adjust for variations in a current sense element and power train parasitics. IOUT_CAL_GAIN represents equivalent impedance of the current sense element at 25°C ambient and therefore can be considered a slope coefficient (gain) of the output current measured as a function of the voltage drop across current sense. IOUT_CAL_OFFSET allows compensation of offset error in the current sensing loop.

The two IOUT_CAL parameters allow consistent current measurements using the parasitic impedance of power train components. The parameters are used to help correct for wide variations in the current measurement loop normally associated with production tolerances in $R_{DS(ON)}$ of power MOSFETs or DCR of an output inductor. This approach helps to achieve a higher efficiency and a lower cost with little compromise in current sensing performance. Additional details on different current sensing schemes and their selection are available in AN2015 *Current Protection and Measurement* application note.

2.3.1.3 Calculating Current Sense Parameters

This example uses a module with maximum rated output current of 20A:

1. Connect USB and power to the evaluation board.
2. Launch PowerNavigator. Note that the controller must be disabled to accept a change in the IOUT_CAL_GAIN parameter.
3. Click on the GROUP MONITOR drop-down menu and select DEVICE CONFIG.
4. Click on the PMBus commands tab. At the bottom left side of the new page (labeled PMBus Basic) is located the IOUT_CAL_GAIN and IOUT_CAL_OFFSET parameters.
5. Set the offset to 0. For the scale, enter the estimated impedance value found in the sense elements data sheet ($R_{DS(ON)}$ for FET or DCR for inductor).
6. Click on the PMBus: Advanced tab. Type AC (FET sense element) or A6 (Inductor sense element) into the TEMPCO_CONFIG property. See AN2033 for more details about TEMPCO_CONFIG.
7. Go back to the main menu by clicking on the DEVICE CONFIG drop-down menu and changing it to GROUP MONITOR.
8. Now turn the converter ON by switching the enable switch on the EVB to ENABLE.
9. Apply the maximum rated load to the power train, which is 20 A in this case. Record the value shown in "I_{OUT} 1" at GROUP MONITOR page. This is data point P1. In this example it is 26.2 A. Note that it is advisable to wait a few seconds to allow the readout to stabilize before recording the point. The I_{OUT} fault might be activated at this point since the scale value is significantly smaller than it should be. Correct this by increasing the fault limits. See application notes AN2033 for more details.
10. Apply half the maximum rated load (10 A in this case). Record the value shown in "I_{OUT} 1" at GROUP MONITOR: page. This will be data point P2 and in this example it is 12.2 A. P1 and P2 do not have to be maximum and half load, but they should represent the desired operational range. Note that it is not advised to use data points below 25% of rated maximum currents,

11. For better results repeat steps 9 and 10 and average the acquired values.
12. Calculate the scale correction factor:

$$c = \frac{P2 - P1}{Load\_at\_P2 - Load\_at\_P1}$$

$$c = \frac{12.2A - 26.2A}{10A - 20A}$$

$$c = 1.40$$

13. Turn the device OFF and go back to the PMBus Commands tab. Multiply the scale used before (2.91 in this case) by the c value. For this example the new scale factor is equal to 4.07. Enter the new scale into the IOUT_CAL_GAIN parameter.
14. Return to the GROUP MONITOR page and turn the system back ON with the same load that was used to make P2, in this case 10 A.
15. Note by how much the system needs to be corrected. In this example the value indicated by I_{OUT} 1 is 9.3 A, so the offset needs to be -0.7 A.
16. Enter this value into the IOUT_CAL_OFFSET parameter in the PMBus Commands window.
17. Fine tuning of the results may be required based on the application. For the example shown above fine tuning changed the values of the scale factor to 3.95, yet the offset stayed the same.
18. At this point the user should save the settings by clicking on STORE_USER_ALL or on STORE_DEFAULT_ALL (depends on application) in the PMBus: Store tab.

2.3.1.4 PID Controls and Device ID

The PID and Device ID fields are in the lower half of the middle section of the PMBus: Basic tab. The PID coefficients are for setting the feedback loop response. Optimization of a feedback control loop of a Digital-DC device can be achieved through the selection of an appropriate set of PID coefficients. Note that the integral gain of the PID filter is calculated by adding all of the taps together. This gain must at least be greater than 0 for the controller to regulate. A detailed process of selecting these coefficients is described in AN2035 *Compensation Using CompZL*.

Below the PID controls is the Device ID which identifies which Digital-DC device you are looking at. It will give you the complete part number including silicon and firmware revision information.

2.3.1.5 Enable & Disable Conditions

The configuration for how the device will be enabled and disabled is on the upper right side of the PMBus: Basic tab. The options are to use the bus or enable pin for turning the controller on and off. Additional functionality is given for the polarity of the enable pin as well as for disable signal response.

2.3.1.6 Dead Time Control Parameters

The adjustments for the Dead Time intervals during transitions between High Side and Low Side switches are in the bottom right area of this page. These numbers are only used when Dynamic Dead Time optimization algorithm is disabled (Frozen). This section allows the user to individually disable the Dead Time optimization algorithm for either High-to-Low or Low-to-High transitions, as well as adjust the minimum Dead Time when this algorithm is enabled. The minimum dead time interval can be adjusted in increments of 4 nS. Refer to device data sheets for specific dead time parameter features.

2.3.2 PMBus: Fault Limits

To ensure proper protection of the load and converter itself in case of abnormal conditions, the fault limits and responses have to be set. The Configure Device section is used to set a global reaction for all faults. In the PMBus: Fault Limits tab, the user is able to set the individual warning and fault levels as well as the action to be taken when a specific fault occurs. The screen is shown in Figure 5:

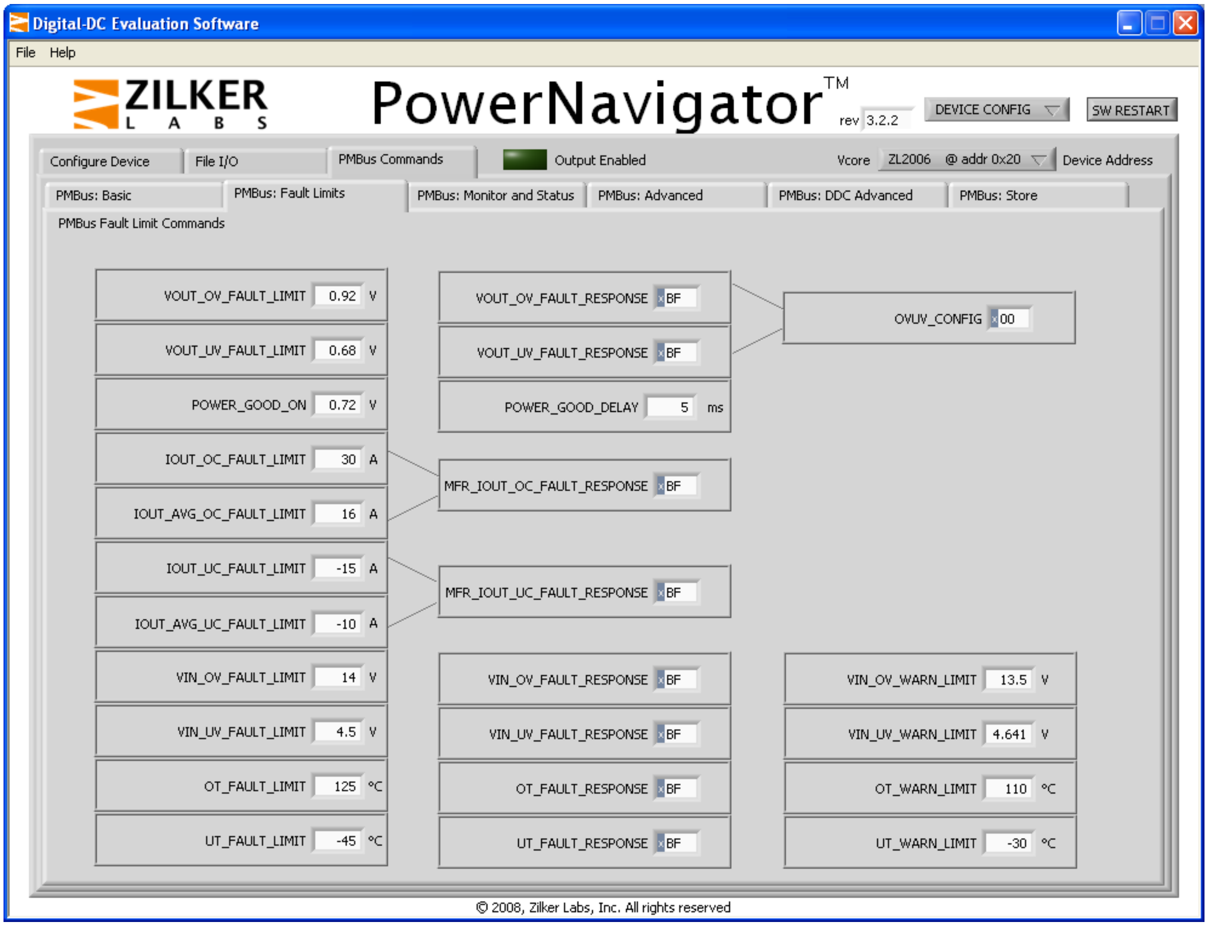

Figure 5. PMBus: Fault Limit

Configuration parameters on the Fault Limit page can be divided into three subgroups:

2.3.2.1 Fault and Alarm Threshold Limits

Some parameters, such as output voltage (V_{OUT}), can have two sets of thresholds. One set is V_{OUT} under voltage (UV) and over voltage (OV) fault limits, and the other is a combination of warning thresholds for the same parameters. Warnings are used as early alarm signals and can only be utilized when a Digital-DC device is connected to a system host via I^2C/SMBus. The device does not activate any response sequence when warning thresholds are exceeded other than generating a warning on the I^2C/SMBus. Crossing the fault thresholds trigger a configurable fault response sequence, which is described in the following section.

2.3.2.2 Fault Response

Unlike analog solutions where external filters have to be deployed to avoid accidental fault protection activation due to noise or other disturbances, the Digital-DC solution implements precise delays in response when the fault signal is generated. This will eliminate any false triggers or shutdown of the supply for transients or noise. It also gives control over how the converter reacts to the detected and confirmed fault conditions. Options include ignoring or delaying a fault condition response, determining whether the converter should try to restart its operation after a fault response was activated and also how many retries are allowed before a complete shut-down, should a fault condition persist. Besides adding flexibility to a design, this approach permits the user to deploy different settings during Production Test and Design Verification, therefore potentially simplifying and shortening those procedures.

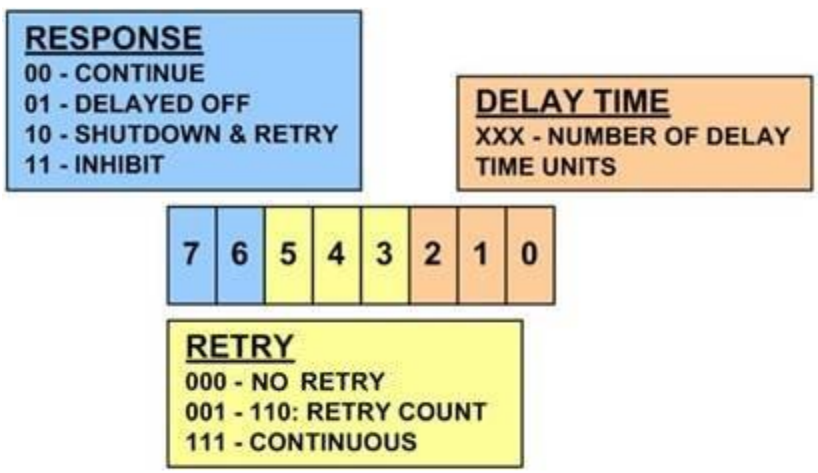

Figure 6.Fault Response Command Format

2.3.2.3 VOUT_OV_FLT_RESPONSE

This field defines the type of response to output voltages in excess of the OV limit detected at the SENSE input of the Digtial-DC device, the time interval between consecutive retries, and the number of retries before a shut-down if failure persists (0xBF is a default value of this command, which can be expressed as 1011 1111 in binary code). Per the command format described in Figure 6, this would translate into the following response sequence when an output OV event is detected: Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries. Refer to the PMBus Specification part II for a detailed description of the format.

2.3.2.4 VOUT_UV_FLT_RESPONSE

This field defines the type of response to output voltages below the UV limit detected at the SENSE input of the Digital-DC device, the time interval between consecutive retries, and the number of retries before a shut-down if failure persists (0xBF is a default value of this command, which can be expressed as 1011 1111 in binary code). Per the command format described in Figure 6, this would be translated into following action when an output UV event is detected: Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries. Refer to AN2033 for a detailed description of the format.

2.3.2.5 MFG_IOUT_UC_FLT_RESPONSE

This field defines the delay in responding to output currents in excess of the UC limits required to trigger a UC response and also the type of response to an UC event (Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries are factory defaults). Refer to AN2033 for a detailed description of the format.

2.3.2.6 MFG_IOUT_OC_FLT_RESPONSE

This field defines the delay in responding to output currents in excess of the OC limits required to trigger an OC response and also the type of response to an OC event (Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries are factory defaults). Refer to AN2033 for a detailed description of the format.

2.3.2.7 VIN_OV_FAULT_RESPONSE

This field defines the delay in responding to input voltages in excess of the OV limit detected at the V_{DD} input of a Digital-DC device required to trigger a VIN_OV_FAULT response and also the type of response to an input OV event (Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries are factory defaults). Refer to AN2033 for a detailed description of the format.

2.3.2.8 VIN_UV_FAULT_RESPONSE

This field defines the delay in responding to input voltages below the threshold of input the UV limit detected at the V_{DD} input of a Digital-DC device required to trigger a VIN_UV_FAULT response and also the type of response to an input UV event (Shut-down and retry, Continuous Retry, delay time of 70 ms (seven 10 ms time units) between retries are factory defaults). Refer to AN2033 for a detailed description of the format.

2.3.2.9 OVUV_Config and Warning Limits

This column shows configuration parameters for response to over- and under- voltage conditions. It also provides space for determining the Warning Limits for Input Voltage and Temperature Configuration parameters included on this page.

2.3.2.10 OVUV_CONFIG

This field is a single byte field that defines the two following parameters for Output Voltage Over- or Under-Voltage fault detection and response:

- Number of consecutive output voltage samples (taken every 4 µs) violating OV or UV limits ignored before triggering OV or UV response;
- Whether the Low Side switching device is set to the “ON” state after an OV response is triggered.

The default value is 0x80 which can be expressed as 1000 0000 in binary code and translated into following response:

- Declare an OV or a UV fault after one violation (lower three bits value N is set to 0, violation count is N+1)
- Turn on a lower switch upon fault (highest bit is set to 1)

Refer to AN2033 for format definition.

2.3.3 PMBus: Monitor and Status

The PMBus: Monitor and Status tab gives a view of what is happening with the supply at any given time. This tab is refreshed by clicking the “READ ALL” button. Note that the “READ_xxx” commands may return invalid values when the device is disabled (8.0 for VOUT and -0.5 for others). This is normal and expected when the device is in the low power mode, not in the monitor mode, as set by USER_CONFIG command.

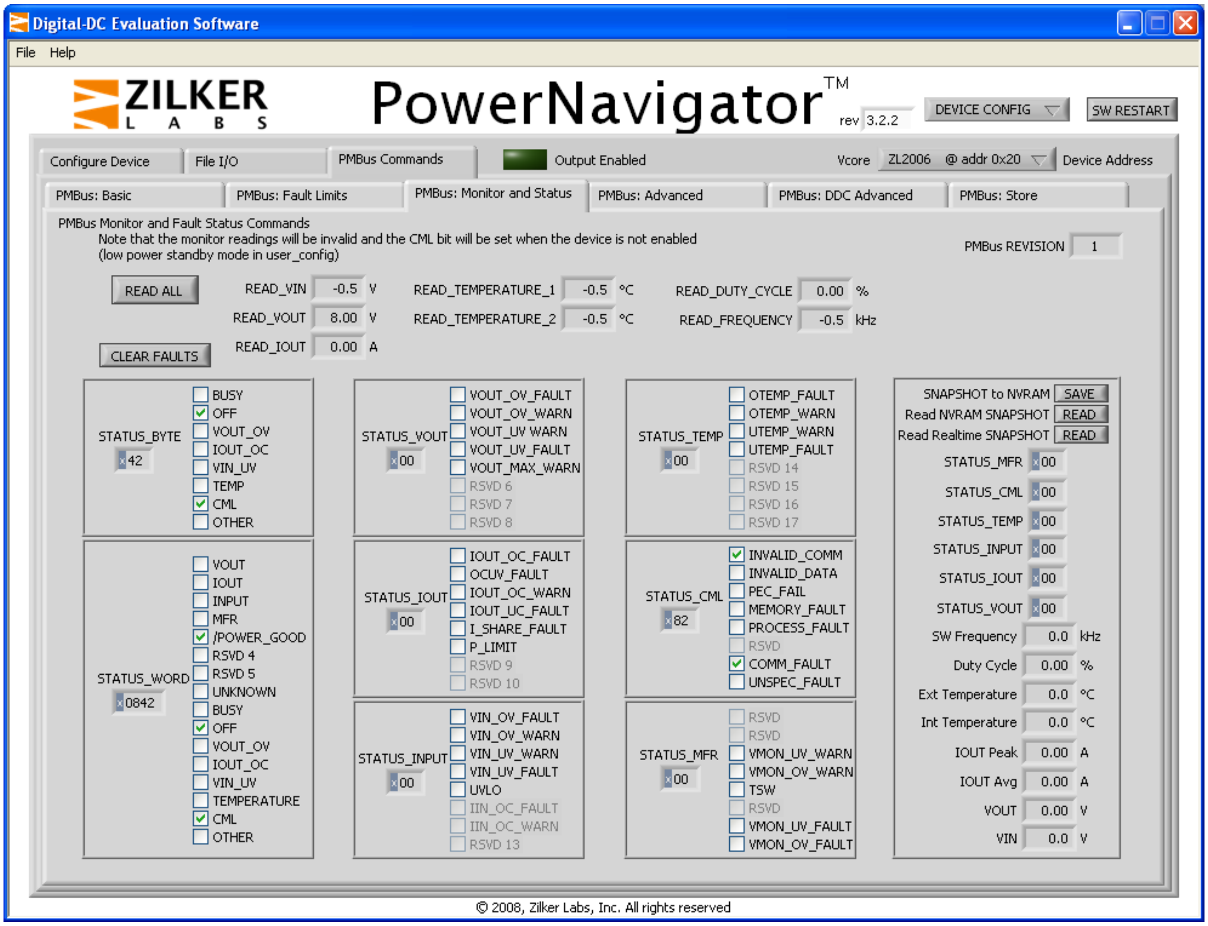

Figure 7. PMBus: Monitor and Status

As long as V_{IN} is within the Digital-DC device’s operating limits, all faults will be stored. Fault and Warning information persist until the CLEAR_FAULTS command is issued or power is cycled. This remains true regardless of whether or not the controller is Enabled or if V_{IN} is above or below the configured Input Voltage fault threshold limits.

In most cases, seeing all the activated faults signals allows the user to analyze the root cause of a problem. For example, when an output over-voltage occurs, it will cause VOUT_OV_FAULT and simple analysis will determine the root cause of the problem. Should a more complicated situation arise, such as during the design verification stage, individual fault protection responses can be disabled from the PMBus: Fault Limits tab allowing a detailed analysis of the problem.

The content is divided according to the type of fault signal and determined by the PMBus communication protocol structure. This tab allows monitoring of all fault signals generated by the Digital-DC device. Remember: once a fault signal is generated, it will stay in the memory for the duration of operation unless the Fault Register is cleared or the controller’s input voltage, V_{DD}, is cycled. If only currently active fault signals are desired to be shown, the Clear Faults button should be clicked.

2.3.4 PMBus: Advanced

Another tab that demonstrates the capabilities of the Digital-DC solution is the PMBus: Advanced screen, as seen below.

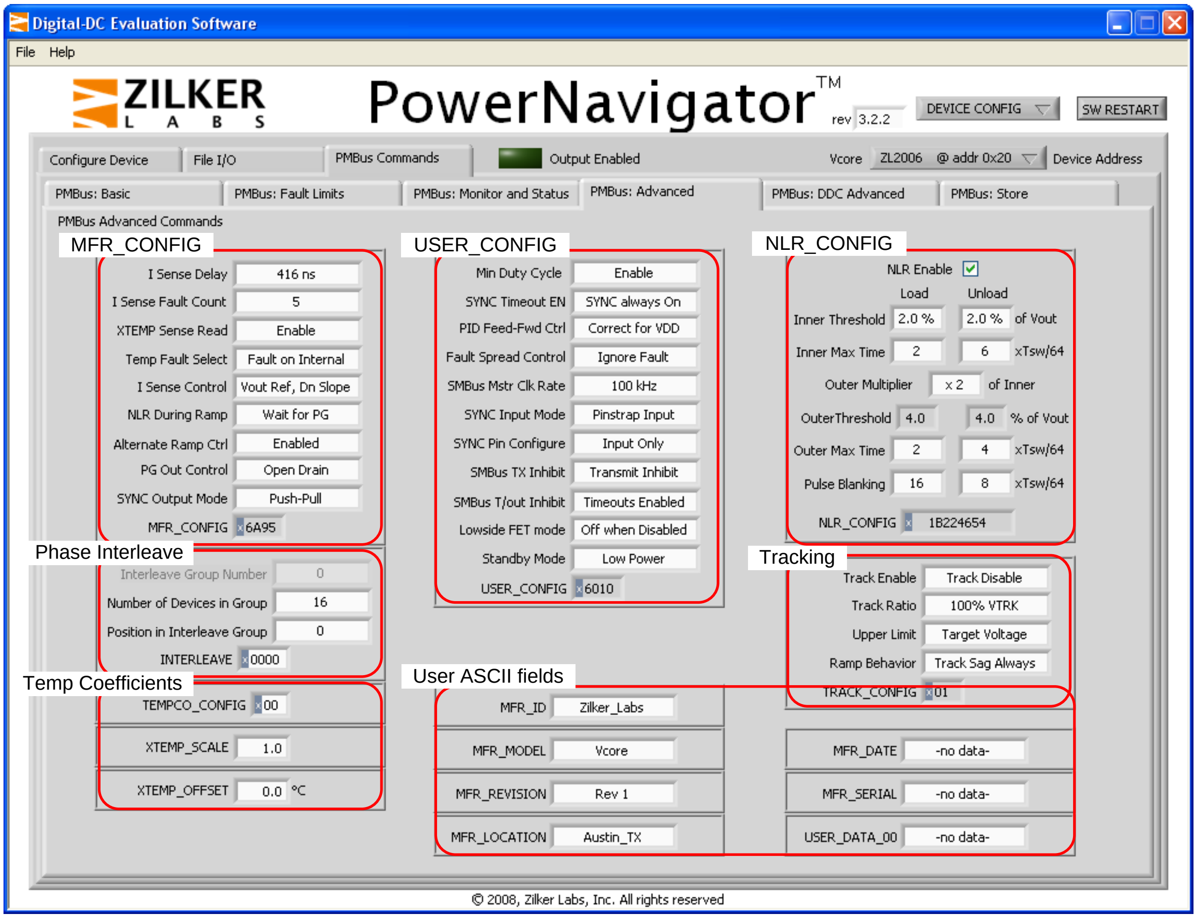

Figure 8. PMBus: Advanced

The PMBus: Advanced screen is separated into seven segments:

2.3.4.1 MFR_CONFIG

Selection and configuration of different methods of output current sense, external temperature sensing and the format of both Power Good and Sync Out pins are all addressed in this screen. The I Sense Delay parameter allows control of the blanking time between switching the top or bottom FET, allowing the filtering out of noise associated with turning those devices on and off from the current sense circuit. The I Sense Fault Count, in turn, allows a specified number of consecutive current measurements in excess of Over- or Under-Current fault limits to be ignored in order to avoid protection triggering during brief transient events. For more detailed description of each of these parameters, please refer to AN2033.

2.3.4.2 USER_CONFIG

This command specifies how the device will propagate its status to the other supplies on the bus and react to other supplies conditions. The low side FET mode and Standby Mode are also set here. Refer to AN2033 for a more extensive explanation of each of these parameters.

2.3.4.3 Phase Interleave

The INTERLEAVE command is to set phase spreading (phase offset) between different converters by defining groups to which a device being configured belongs, number of phases in the group and device's relative position in the group. If, for example, number 0142 is entered into the INTERLEAVE box, this means that the device being configured belongs to a group with ID 1, there are total of four phases in this group, which corresponds to a phase shift step between phases of 90^{o} calculated by dividing 360 by total number of phases in the group (number of converters in the group can be larger than number of phases), while digit 2 means that phase of the device being configured is shifted two positions relatively to a first device with no phase shift which will have value of 0140 in its corresponding INTERLEAVE box The specific format for INTERLEAVE is described in AN2033.

2.3.4.4 Tracking / Sequencing

This section is used for setting power management functions for group operation. Its content also can be adjusted in a simplified way using the GROUP MONITOR tab.

SEQUENCE allows the DDC Rail ID to be set for both a prequel and sequel device relative to this device when used in a sequence. The device will enable its output (using the configured delay time) when either its EN or Operation Enable State is set and the PREQUEL device has issued a Power Good event on the DDC bus. The data field is a two-byte value. The most-significant byte contains the DDC Rail ID of the prequel (preceeding) device. The least-significant byte contains the DDC Rail ID of the sequel device. Note that only DDC Rail ID values of 1 – 31 are valid for the SEQUENCE command. A value of zero in either byte defines this device to be the beginning or the end of a sequence. For a complete description of this command, refer to AN2033.

The TRACK_CONFIG command serves for setting parameters related to the tracking mode of operation. The ratio, limits and reaction while tracking are configured here. Utilizing this function greatly reduces the problems associated with power supplies in DDR2 and similar applications. This PMBus command is described in more detail in AN2033.

2.3.4.5 Temperature Coefficients

The TEMPCO_CONFIG variable configures the correction factor and temperature measurement source when performing temperature coefficient correction for current sense. The temperature sensor source is selected as well as the correction factor. Format of this parameter can be found in AN2033.

The XTEMP_SCALE and XTEMP_OFFSET commands allow the user to calibrate external temperature readings (TEMPERATURE_2) for external temperature sensors other than the default 2N3904.

2.3.4.6 User ASCII Fields

This is a set of ASCII commands that the user can enter information pertaining to the individual needs. The sum total of characters plus one byte per command cannot exceed 128 characters. To configure these fields, refer to AN2033.

2.3.4.7 NLR_CONFIG

The NLR function allows bypassing of the normal feedback loop during Output or Input transients. This makes the controller function with a very high equivalent bandwidth, similar to that of a Hysteretic Mode controller, for short time intervals. Its operation is described in detail in AN2032 *NLR Configuration*.

2.3.5 PMBus: DDC Advanced

The PMBus: DDC Advanced contains commands included in Digital-DC products that utilize the DDC bus. The screen is shown below:

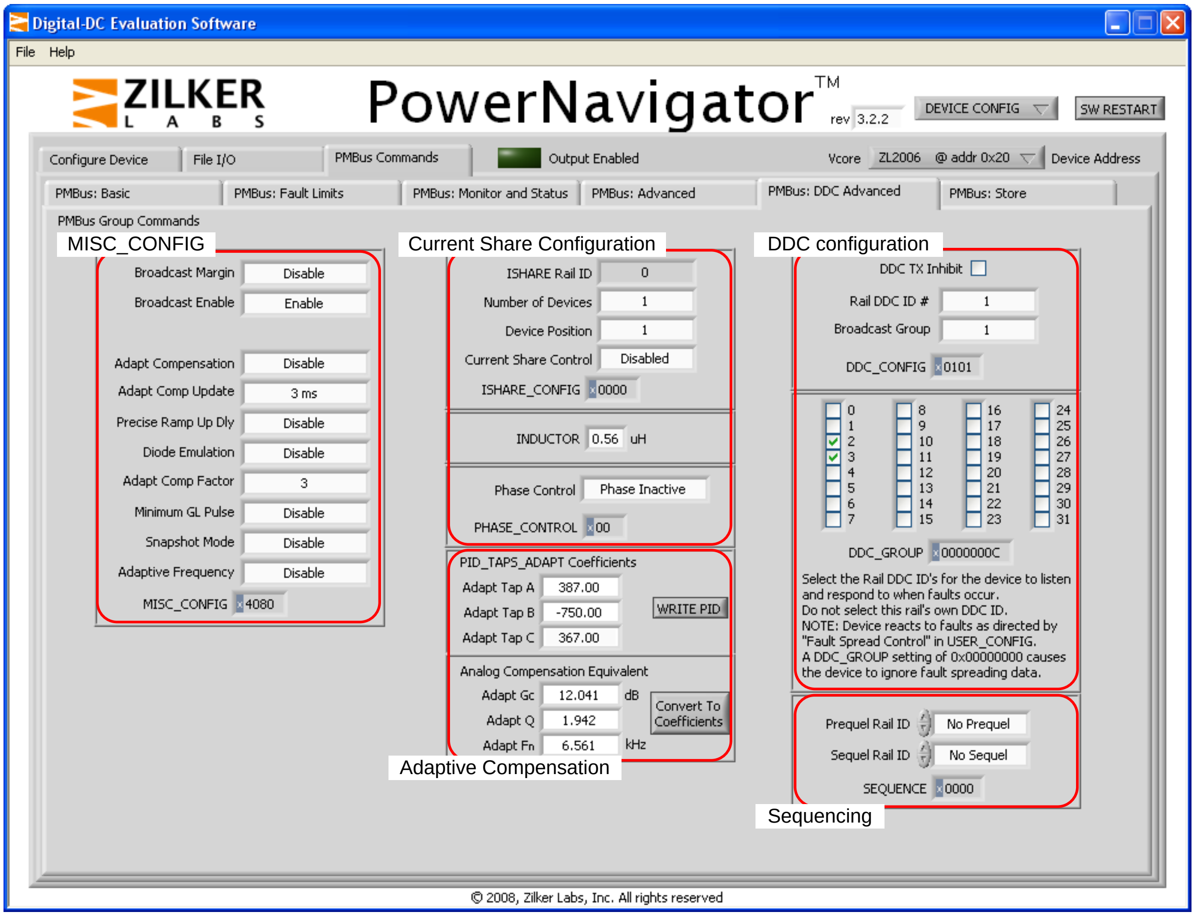

Figure 9. PMBus: DDC Advanced

2.3.5.1 MISC_CONFIG

The fields in this command control various adaptive and broadcast functions in the Digital-DC device. Format of this parameter can be found in AN2033.

2.3.5.2 Current Share Configuration

The fields in these commands are used to configure a device for current share operation. Note that ISHARE Rail ID field is read only and will be set equal to the assigned Rail DDC ID found in the DDC Configuration section. Refer to AN2034 for a description of the current share configuration.

Adaptive Compensation

The parameters in these fields set the compensation PID coefficients for the adaptive compensation algorithm. Refer to AN2035 for more detail on compensation.

2.3.5.3 DDC Configuration

The DDC_CONFIG and DDC_GROUP commands configure the device to use the inter-device DDC bus. Assign the device's system power supply rail number to the Rail DDC ID in the DDC_CONFIG command. Also use this command to assign a broadcast response group to the device (broadcast enable or margin function). The DDC_GROUP command is used to set the rail ID's of other members of a set of power supply rails that this device should listen to for fault spreading response. Refer to AN2033 for a detailed description of these PMBus commands.

2.3.6 PMBus: Store

The PMBus: Store tab allows the user to store and restore configurations within a device's memory. The screen is shown below.

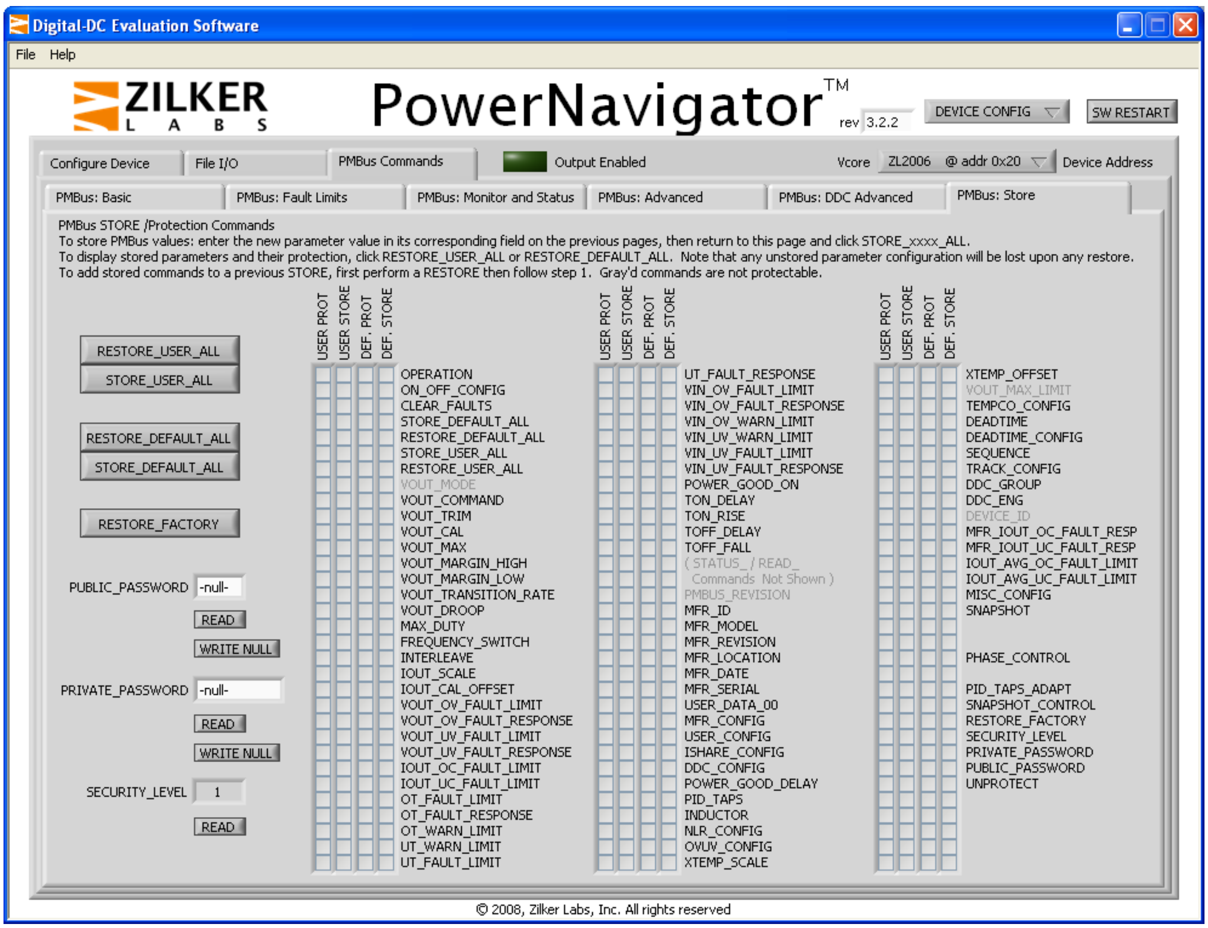

Figure 10. PMBus: Store

The Digital-DC device has nonvolatile memory to store configured parameters. The device reads the stored configuration parameters each time that it is powered up. Refer to the device data sheet for the description on how the device uses its configuration at power up. The PMBus: Store tab shows the user which specific parameters are saved in a given store upon performing a restore.

For example, start with a device that is originally configured to output 3.3V via the pin-straps (jumpers) on the evaluation board. Change the output to 1.5V on either the Configure Device or GROUP MONITOR page. The "STORE_USER_ALL" and the "RESTORE_USER_ALL" operations can then be performed. When complete, there are check marks on the fields associated with commands required to implement the change of the Output Voltage value and the related parameters, which are automatically adjusted when Output voltage value are replaced on these pages.

It is important to remember that all changes made to a configuration through PMBus, either via PowerNavigator or other means, will be lost after powering the controller down unless they are written into nonvolatile memory of the Digital-DC device.

This storage procedure can be executed after the changes are applied to the device by clicking on the STORE_USER_ALL or STORE_DEFAULT_ALL soft buttons on the PMBus: Store tab of PowerNavigator. Since the "USER" register has the highest level in the storage hierarchy, upon cycling the input power, parameters stored in the "USER" register are loaded into the device as the operating configuration.

Specific configurations stored in non-volatile memory in "USER" or "DEFAULT" registers can always be recalled by clicking on RESTORE button of the respective register on the PMBus: Store tab. Entire configuration may also be loaded into the device memory from a configuration text file using LOAD FROM FILE command at the File I/O screen.

3 PowerNavigator Revision History

PowerNavigator Change log

app3.2.2:
made XTEMP_SCALE unitless
corrected fault response writes from Config Device page
removed xtemp bits for ZL2105 view
changed fault response labels from ..FLT.. to ..FAULT..
added Rail DDC # to Group Monitor page
added USER_DATA_00 (ASCII input field) to advanced page
added DDC rail number indicator to group config page (front panel)
added release revision indicator to screen
added "CML fault" comment to status page

app3.2.1 :
added READ_FREQUENCY next to FREQUENCY_SWITCH command
created pop-up for tracking/toff delay time
inhibited sequencing if tracking on Group Config page
removed SEQUENCE for ZL2005, ZL2105 on GROUP_CONFIG page
moved SEQUENCE command to DDC page
added scroll buttons for SEQUENCE
added CLEAR_FAULT button on GROUP_CONFIG front panel (sticky faults)
limited DEADTIME settings to -10 to +60
fixed DEVICE_CONFIG page had issue with "Max Current" entry did not translate to command writes
fixed Vout UV/OV fault limit set issue on PMBus: Fault Limit page (VOUT_COMMAND stale issue)
added pop up after EXT_TEMP enable or disable action

app3_2_0 :
added ZL2106
added FD (FSC device) capability
INTERLEAVE breakout updates fixed, disabled Interleave Group Number
forced 'PID to analog' to use fresh values form device on refresh
added SEQUENCE enable MSB
fixed Password lengths
added Max_IOUT and VIN calculations to Device Configure tab
added Min Duty Cycle enable bit
added clear check marks on STORE page when address change done

app3_1_3 :
Adaptive Compensation Factor values
add support for ZL2005-2
Ton Rise readbacks
VOUT_TRIM and VOUT_CAL_OFFSET negative value readbacks

app3_1_2 :
Adaptive Comp Update - only one bit
Iout Ripple selection
Added PID_TAPS_ADAPT
Fixed front panel - Ton rise
Fixed TEMPCO_CONFIG writes
Changed PMBUS: Group Config tab to PMBus: DDC Advanced
Fixed SEQUENCE command

app3_1_1 :
Replaced all PMBus accesses with ZL_PMBus2.vi (major)
viTech still exist in ConfigGen.vi

app3_0_2 :
fixed issue of creating config files on the ZL2006

app3_0_1 :
fixed bug with reading PMBus:Basic values on tab switch,
done by reverting to previous method of reading

app3_0_0 :
added installer build

4 References

[1] AN2011 – Component Selection, Zilker Labs, Inc..

[2] AN2015 – ZL2005 Current Sensing Techniques, Zilker Labs, Inc.

[3] AN2032 – NLR configuration in Digital-DC products, Zilker Labs, Inc.

[4] AN2033 – PMBus Command Set, Zilker Labs, Inc.

[5] AN2034 – Current Sharing with DDC Products

[6] AN2035 – Compensation Using CompZL, Zilker Labs, Inc.

[7] ZL2006 Data Sheet, Zilker Labs, Inc.

[8] ZL2004 Data Sheet, Zilker Labs, Inc.

5 Revision History

Date	Apnote Rev	Power Navigator Rev. #	
6 June 2008		1.0	Initial release
23 June 2008		2.0	Changed descriptions to match 3.2.0 of PowerNavigator which includes the DDC bus and devices ZL2004 and ZL2006
November 2008		3.2.1	Added screen shots to 3.2.1 Added PowerNavigator change log
December 2008		3.2.2	Added screen shots to 3.2.2 Updated PowerNavigator change log
May 2009	AN2026.0	3.2.2	Assigned file number AN2026 to app note as this will be the first release with an Intersil file number. Replaced header and footer with Intersil header and footer. Updated disclaimer information to read “Intersil and it’s subsidiaries including Zilker Labs, Inc.” No changes to datasheet content.
October 2013	AN2026.1	3.2.2	Added note to page 1: “This User’s Guide is for PowerNavigator™ Version 3. Refer to PowerNavigator™ 5 User’s Guide when using PowerNavigator™ Version 5.” Updated logo’s throughout to Intersil. Updated copyright area bottom of page 1 Updated last page disclaimer to standard Intersil apnote disclaimer.