## Introduction

The ispPAC$^®$-POWR1220AT8 device from Lattice is a full-featured second-generation Power Manager chip. As part of its feature set, this device supports the I^{2}C serial communication specifications. The I^{2}C pins of the device provide a system designer the ability to monitor and control numerous aspects of the Power Manager device and system from a master I^{2}C device, such as reading VMON pins with on-board ADC, setting, clearing, or monitoring input or output pins, and adjusting the Trim DAC settings, just to name a few. A Windows-based utility is provided by Lattice so customers can exercise and observe all the I^{2}C features of the ispPAC-POWR1220AT8 without having to develop code or build hardware. When this utility is combined with PAC-Designer$^®$, a download cable, and an evaluation board (and power supply) all the I^{2}C features can be observed, designs can be developed, and hardware can be verified. This application note provides documentation specifically on the software utility and generally on some of the I^{2}C features of the ispPAC-POWR1220AT8.

This software utility is specifically designed to support the ispPAC-POWR1220AT8 through the I^{2}C port on the Lattice ispPAC-POWR1220AT8 evaluation board. The utility takes advantage of the Lattice ispDOWNLOAD$^®$ cable (parallel port versions only), to communicate the I^{2}C commands for reading and writing both data and instructions. This software is not intended as a generic I^{2}C controller or development tool but a useful utility to exercise and demonstrate the capabilities of the Lattice ispPAC-POWR1220AT8 Power Manager device.

Figure 1. ispPAC-POWR1220AT8 I^{2}C Utility User Interface
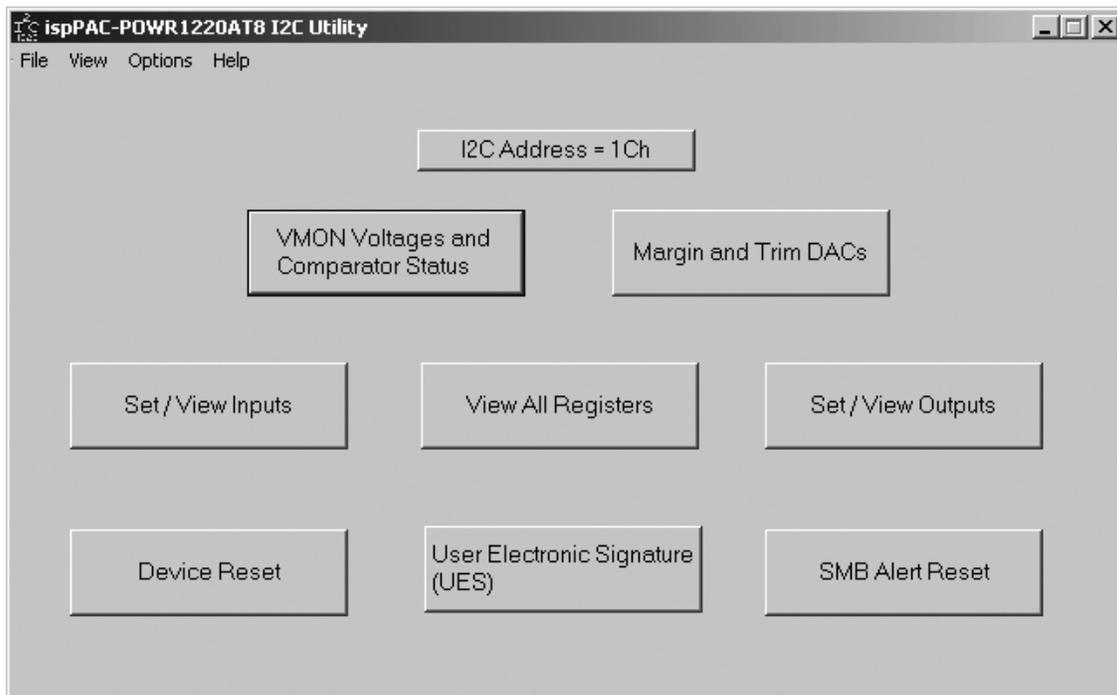

Getting Started

The typical setup shown in Figure 2 includes a PC equipped with a parallel printer port, a Lattice ispDOWNLOAD cable that plugs into that port, power supply, and an ispPAC-POWR1220AT8 evaluation board. The computer should have the latest version of PAC-Designer installed along with the I^{2}C utility. First, PAC-Designer is used to configure and program the ispPAC-POWR1220AT8 with the download cable plugged into the JTAG connector on

the evaluation board. The cable is then moved from the JTAG connector to the I^{2}C connector so the I^{2}C utility can be used.

Figure 2. Typical Setup
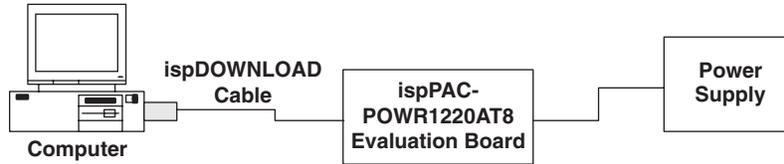
The I^{2}C utility is designed with a simple push-button interface as shown in Figure 1. The buttons are organized to support the various sections of the ispPAC-POWR1220AT8 that can be controlled or monitored by I^{2}C. The first button that one should use is the "I^{2}C Address" button located top and center. This button will open the dialog box shown in Figure 3 so the address that was programmed into the device with PAC-Designer can also be used by the utility to address the device. If the addresses do not match then the device will not respond to the commands and data that are being sent to it.

Figure 3. Setting the Target Device's Address
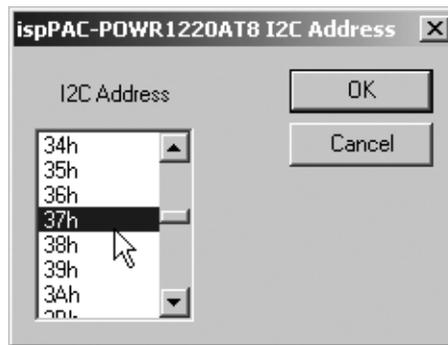
Cable Detect

When any of the other buttons shown in Figure 1 are clicked, the utility will verify both that the download cable is connected to the parallel port and that the cable has power. If either test fails, then the respective message in Figure 4 will be displayed.

Figure 4. Missing Cable and Cable Power Warnings
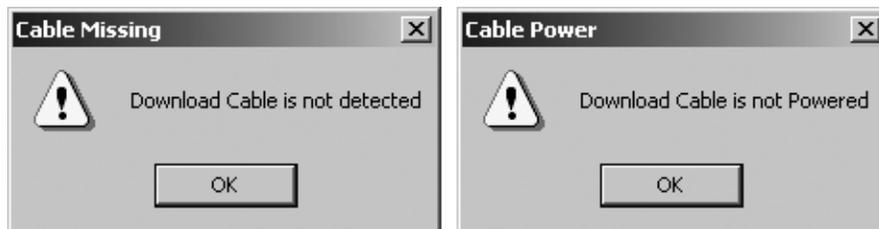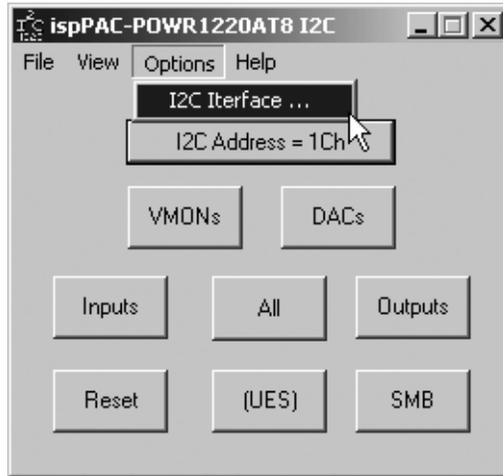
Figure 5. Option Menu is Used to Set the Parallel Port Address

If the cable is indeed attached to the computer, it may be the I²C utility software is set to the wrong port address. To set the parallel printer port address, use the menu "Options -> I²C Interface..." (shown in Figure 5) to open a dialog box that can be used to set the address and test the hardware port. The features of this dialog box are detailed in Figure 6.

Figure 6. Dialog Box Used to Set Port Address and Test Hardware
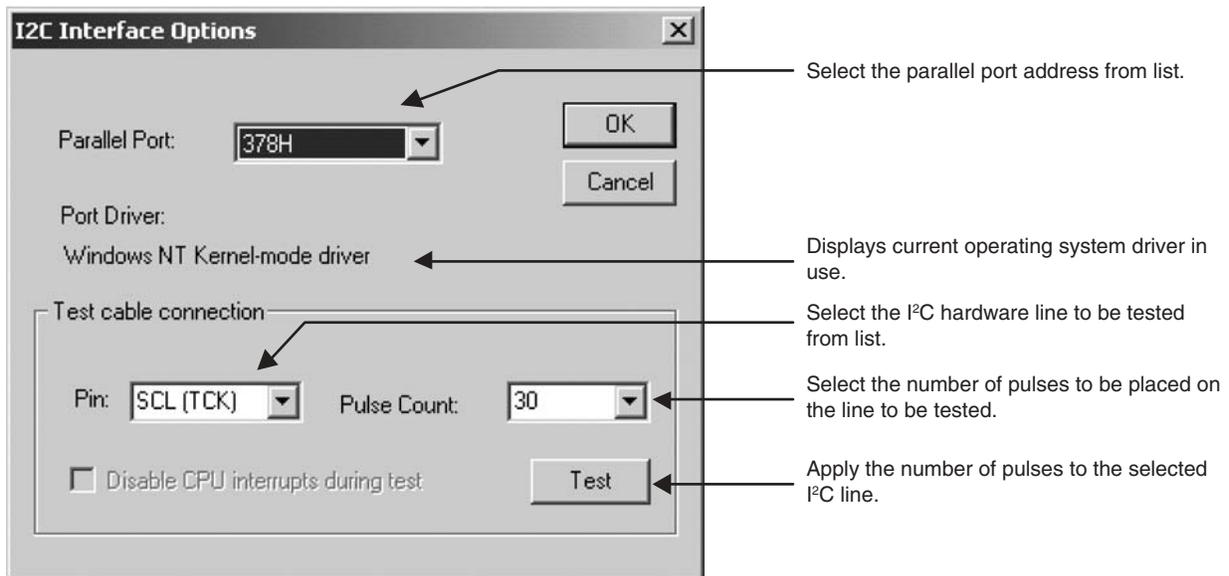
VMON and Comparators

The "VMON Voltages and Comparator Status" button will initiate conversation between the software and the evaluation board that consists of a minimum of 192 bytes of commands and data. A series of I²C commands will be sent to both MUX each of the 12 VMON inputs to the ADC of the ispPAC-POWR122AT8 and to start a conversion. Then a series of commands will be sent to check the status of the ADC. Another series of I²C commands will be sent to obtain the ADC results and still another series of commands will be issued to read the status of each of the VMON comparators. All the results are conveniently displayed in the summary dialog box that is shown in Figure 7. Note the ADC readings are converted to volts for the display. If the "Read" button is activated, the complete series of I²C commands will be repeated and the display will be updated. This provides a quasi real-time display of each of the 12 VMON inputs in one convenient dialog.

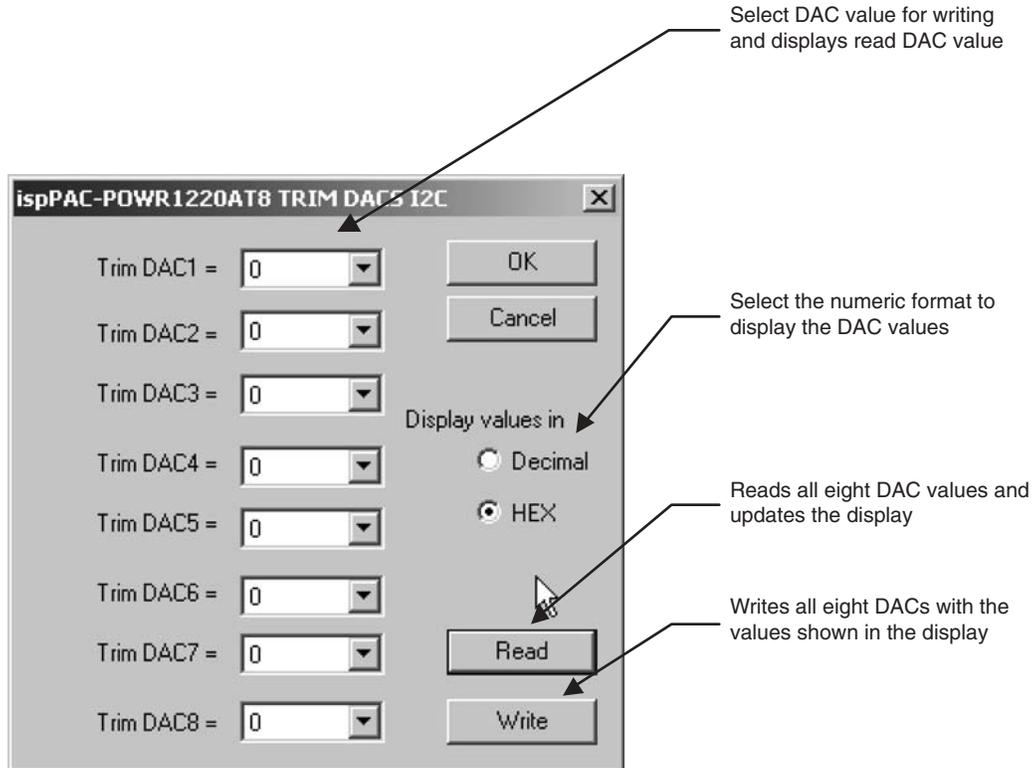*Figure 7. VMON Dialog Box Displays the Pin Voltage and the Comparator Outputs*

Voltage at the VMON pin.

Status of the VMON comparators
(input to the PLD).
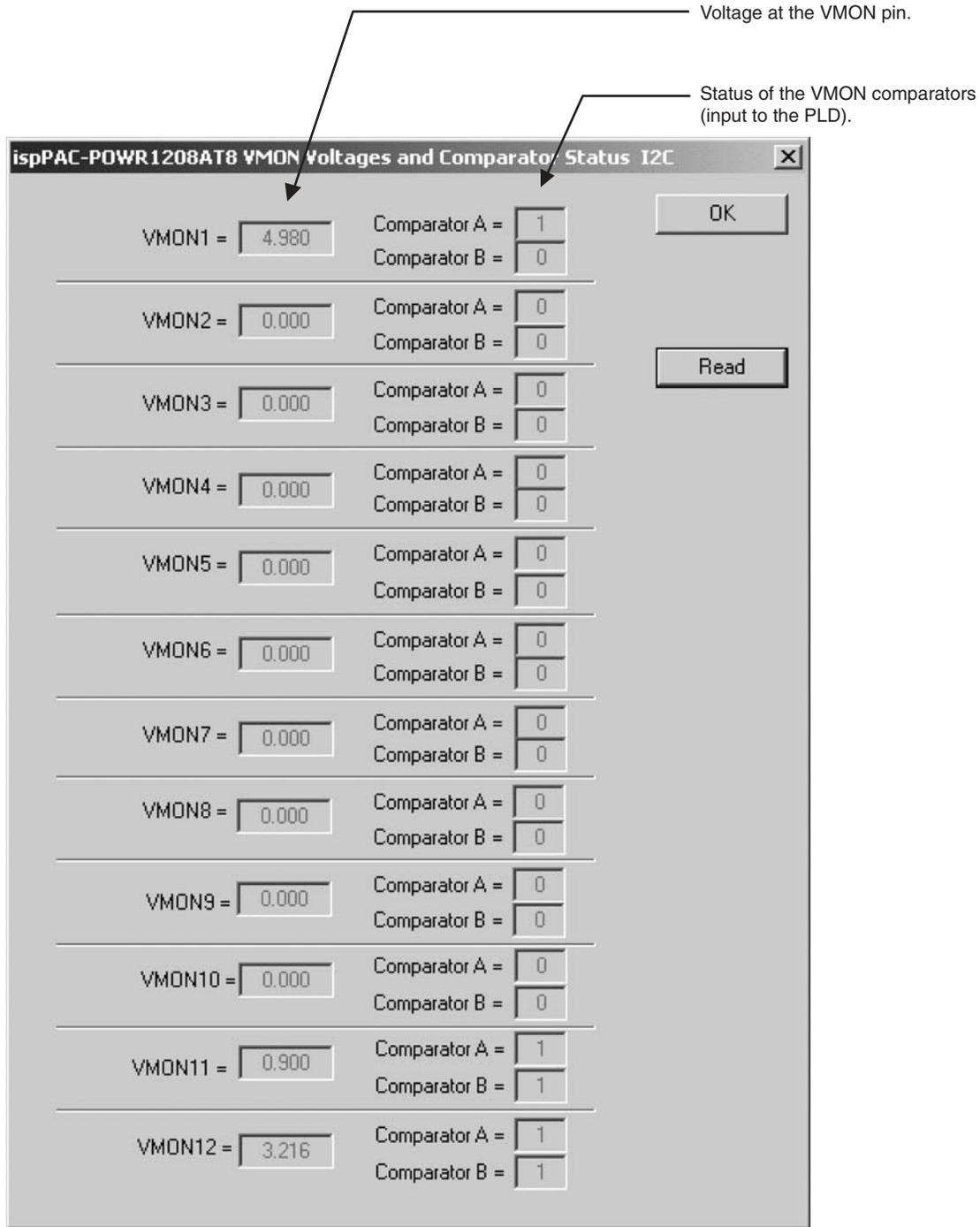
DACs

When the "Margin and Trim DACs" button in Figure 1 is pressed, a series of I^{2}C commands will be sent to the evaluation board to read the current value of each of the eight Trim DACs. The results are summarized in the dialog box shown in Figure 8. The 8-bit DAC values can be displayed in HEX or decimal but not volts. The values displayed are signed 8-bit numbers because 80H represents a DAC output of bipolar zero. The absolute output voltage at the Trim pin depends upon the offset value which is set by JTAG programming and is not accessible via I^{2}C. To change

one or more DAC values, simply select the new settings and click on the "Write" button. This button will write all eight DAC values with a single click. Similarly, a click on the "Read" button will re-read all eight DACs.

*Figure 8. DAC Dialog Box is Used to Read and Write DAC Values*

Select DAC value for writing and displays read DAC value

Select the numeric format to display the DAC values

Reads all eight DAC values and updates the display

Writes all eight DACs with the values shown in the display

Inputs

The "Set / View Inputs" button in Figure 1 will send the I^{2}C commands to read two input registers. One register is the I^{2}C input register, which is both readable and writable, while the other register is the actual input to the PLD. Notice in Figure 9 there is a MUX between these two registers. The MUX is set when the ispPAC-POWR1220AT8 is programmed to select between a physical input pin or the I^{2}C input register. Since this MUX is controlled by the configuration memory, its setting cannot be determined from I^{2}C.

The dialog box shown in Figure 9 lists the contents of both registers side by side. Read and write buttons are provided to change the I^{2}C input register values and provide real-time display respectively. Note that for input IN1 the I^{2}C register is not writable. This is because the MUX for IN1 is designed to switch between a JTAG writable register and the physical input pin. This provides sequencer control via JTAG as well as I^{2}C but, the details of that architecture is described in the ispPAC-POWR1220AT8 data sheet.

Figure 9. Inputs Dialog Box is Used to Read and Write the Logic Inputs
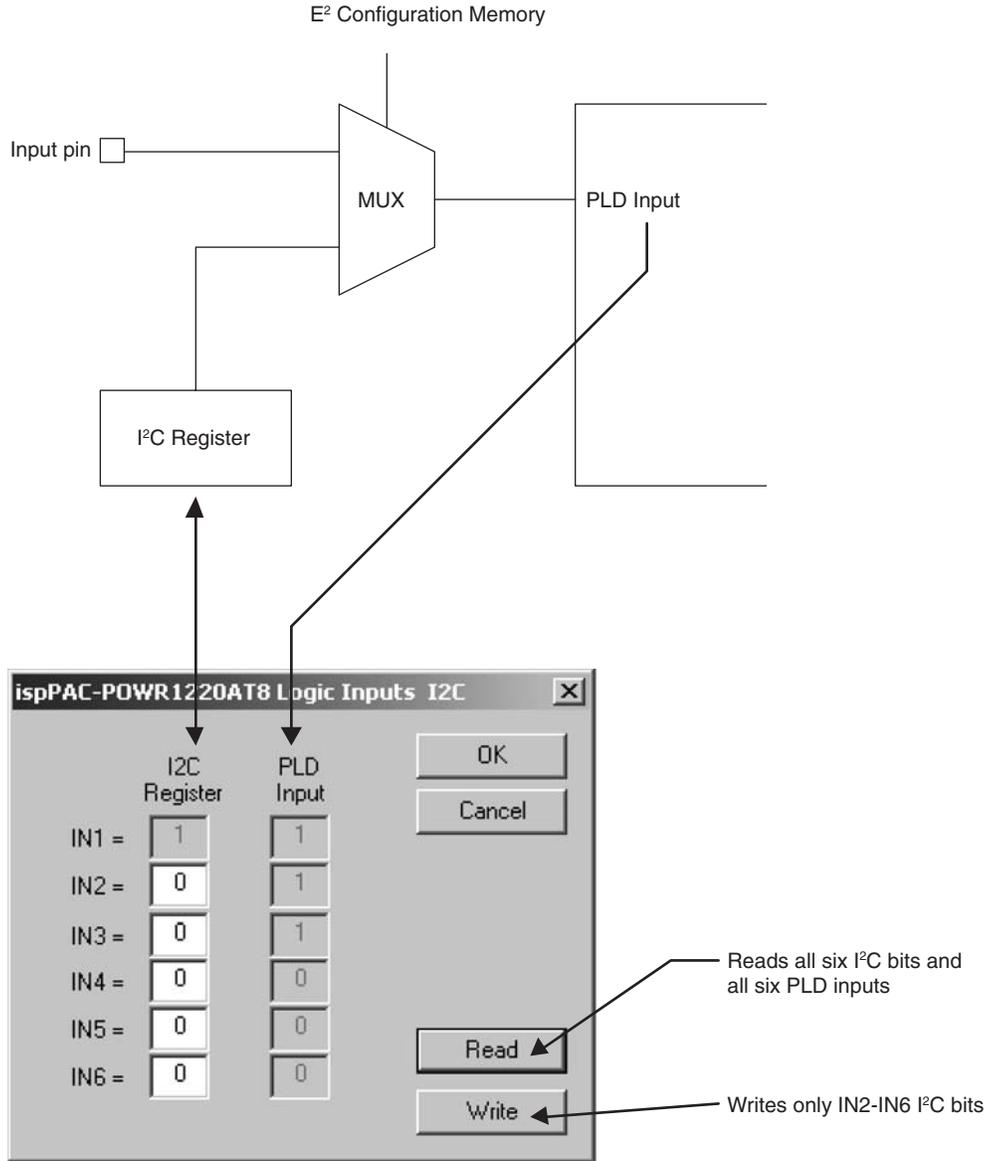
Outputs

The "Set / View Outputs" button in Figure 1 will send a series of I²C commands to read the status of both the I²C output register and the physical pin. The results are presented in two columns as shown in Figure 10. Like the inputs, the outputs of the ispPAC-POWR1220AT8 are very flexible. Each of the 20 output pins can be controlled by either the customized logic within the PLD or from I²C commands. The MUX shown in Figure 10 is set at the time the ispPAC-POWR1220AT8 is programmed. Read and write buttons are provided to support control of the outputs and display updates respectably.

Figure 10. Outputs Dialog Box is Used to Read and Write the Output Registers
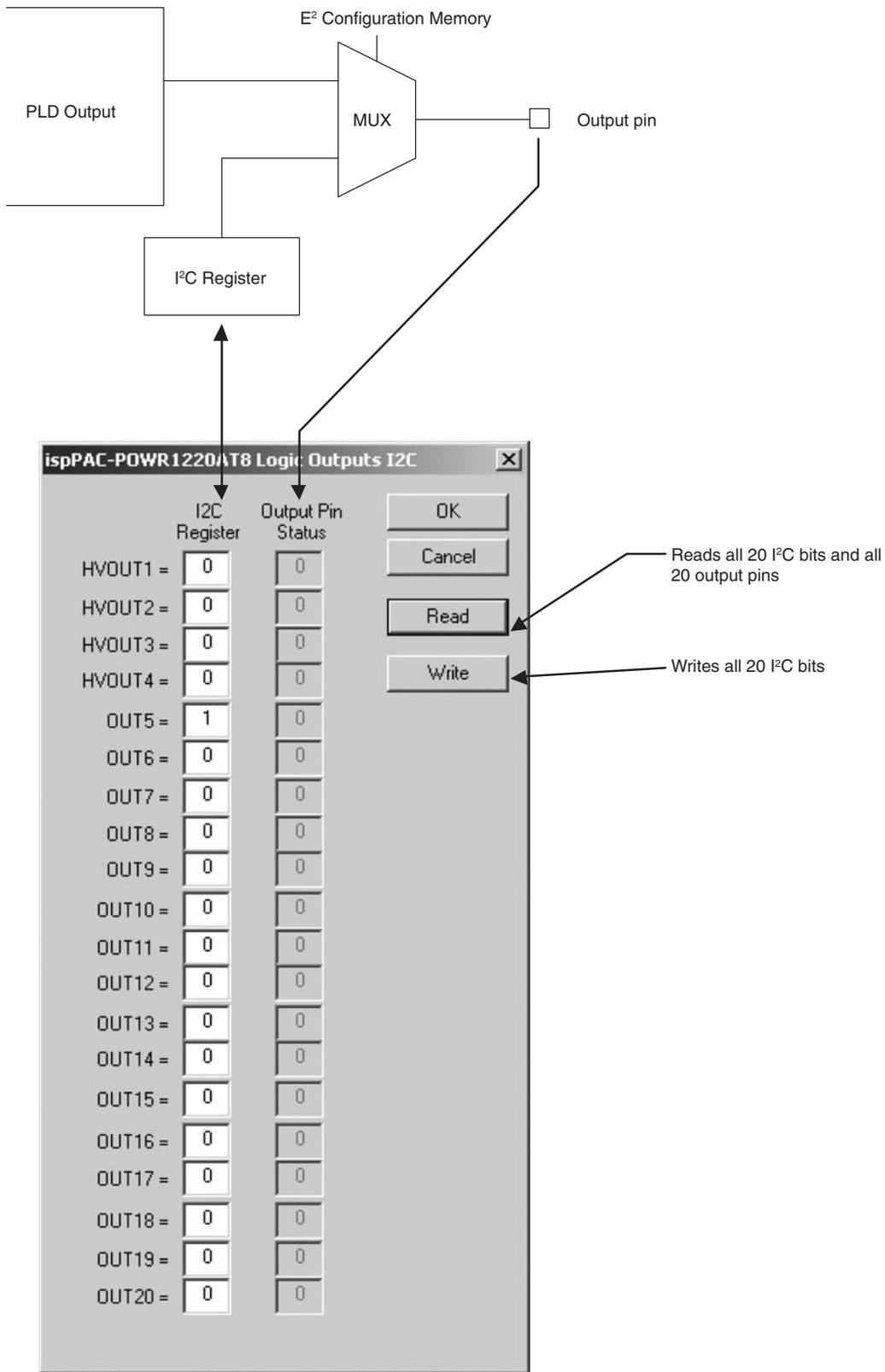
View All

The "View All Registers" button in Figure 1 is used to read and display every single I^{2}C register in the ispPAC-POWR1220AT8. The dialog box in Figure 11 displays the I^{2}C register address, name and value in a list that can be customized by the user. To remove a register from the list, select it with the mouse and click on the "Hide" button. This allows one to show only the registers of interest, which can be useful when debugging. Just click on the "Show" button to restore the list to showing all the registers. The "Read" and "Write" buttons in the "Selected Register" box only apply to the currently selected I^{2}C register while the "Read" and "Write" buttons in the "All Registers" box apply to all the I^{2}C registers in the currently viewable list. If a selected register is a read-only register, then the "Write" button will be disabled. If the selected register is a read-write register, then a prompt will appear at the top and the "Write" button will be enabled. The "Read" and "Write" buttons in the "Selected Register" box can be used to capture individual commands and data with an oscilloscope. To edit the value of the selected I^{2}C register, simply double-click on it and the edit dialog in Figure 12 will be provided.

Figure 11. View All Dialog Can Be Customized to Display Registers of Interest
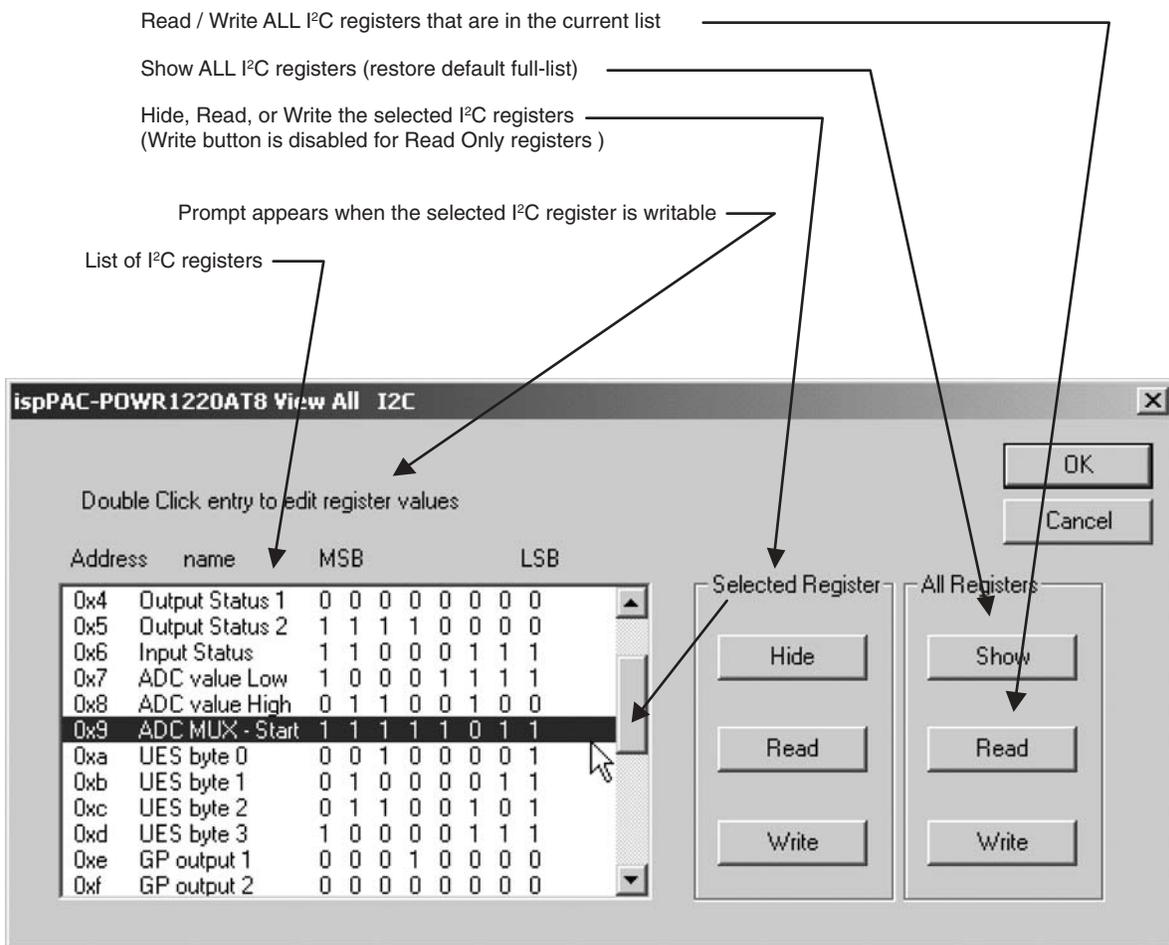
The title of the dialog box in Figure 12 holds the name of the I^{2}C register whose value is to be edited. The value can be selected from a list and the list can be displayed in binary, Hex, or decimal. To discard changes, click the "Cancel" button; otherwise the "OK" button will return to the "View All" dialog with the new value displayed in the I^{2}C register list. The new value will not be sent to the evaluation board until either of the "Write" buttons are activated.

Figure 12. Edit Dialog Supports Changing Register Values
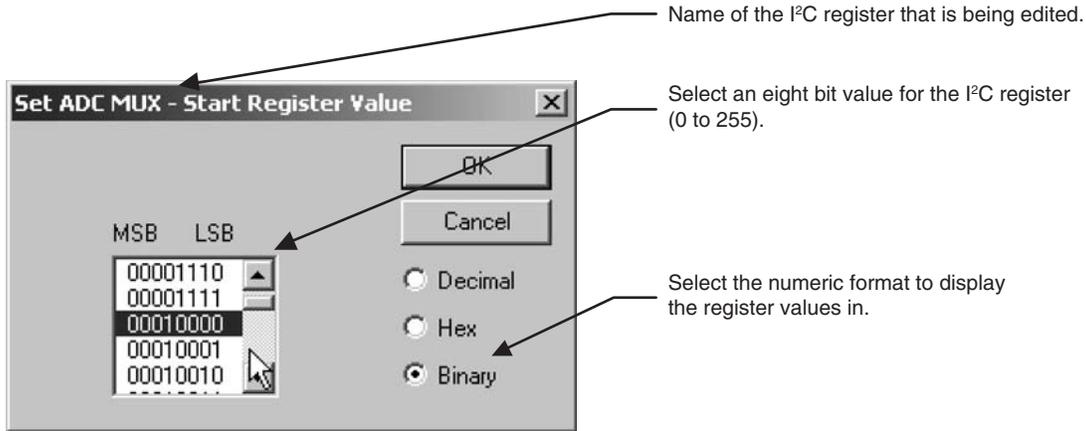
UES

The "User Electronic Signature (UES)" button in Figure 1 will read the four read-only I²C registers that mirror the 32-bit UES bits. The UES bits can be programmed via JTAG when the device is configured but, can be read via I²C. The dialog box in Figure 13 displays the UES bits in order and in three selectable formats; binary, Hex, or decimal.

Figure 13. UES Bits Can Be Read With I²C
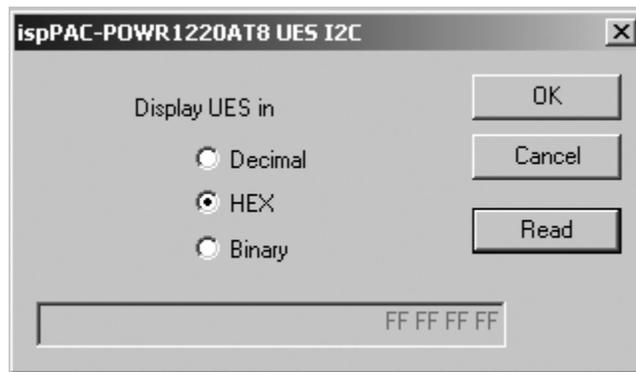
Device Reset

The "Device Reset" button in Figure 1 can be used to reset the ispPAC-POWR1220AT8. Sending this I²C command is equivalent to asserting the physical RESET pin of the device. After the command is sent, the dialog box shown in Figure 14 is displayed to confirm the situation.

*Figure 14. Confirmation the Reset Command was Sent*

SMB Alert Reset

The "SMB Alert Reset" button in Figure 1 can be used to reset an SMB Alert condition (OUT5) of the ispPAC-POWR1220AT8. This button sends the SMB Alert Response Address down the I²C wires and not the I²C address. An SMB compliant device, like the ispPAC-POWR1220AT8, will respond with its own I²C address. Thus a processor will know which device issued the alert. If the device address that is read back matches the I²C address the dialog box in Figure 15 will be shown; otherwise, if the address does not match, the dialog box in Figure 16 will be shown.

*Figure 15. Device Responded with Correct Address, SMB Alert is Reset*

Figure 16. Device Address Did Not Match, SMB Alert Not Reset
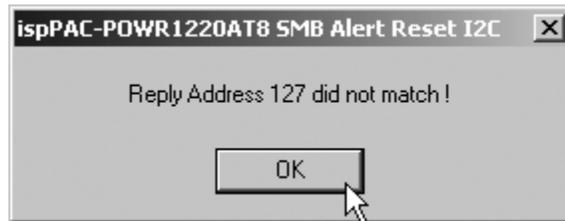
Smaller Footprint

The View menu provides a way to switch from the large interface shown in Figure 1 or the smaller interface shown in Figure 17. The larger interface has more text on the buttons and is easier to learn how to use, while the smaller interface in Figure 17 summarizes the button functions and takes up less space on a computer desktop. Thus, the smaller interface is designed to be used in conjunction with PAC-Designer or other software when an engineer wishes to have both applications visible at the same time.

Figure 17. View Menu is Used to Select from Large or Small Interface
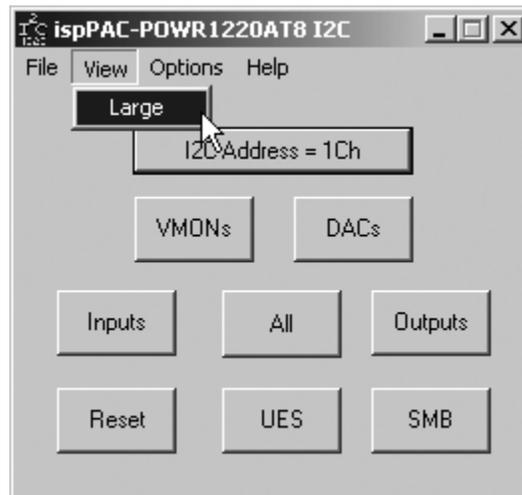
Summary

The I^{2}C software utility is very useful for verifying hardware designs centered around the ispPAC-POWR1220AT8 Power Manager device. Also, this utility can be used for learning, demonstrating, and testing the I^{2}C features of the ispPAC-POWR1220AT8. This Power Manager tool has been designed to be very user friendly and easy to use. This software utility can be used to demonstrate and verify the I^{2}C features of the device without having to develop custom software and it makes use of the same download cable used by PAC-Designer. The buttons and dialogs are organized to group together I^{2}C commands that are functionally similar to provide a convenient interface. This software utility is packaged with PAC-Designer (version 4.0 and greater) so that engineers can easily evaluate the features of the ispPAC-POWR1220AT8 with only a download cable, evaluation board, and small power supply. In addition to evaluation, this utility can also be used to verify hardware designs. Using an oscilloscope, one can capture commands and data to compare waveforms and debug systems in development. This utility is only one of many that Lattice offers in an effort to provide valuable support tools for its sophisticated programmable devices.

Related Literature

• ispPAC-POWR1220AT8 Data Sheet

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