PS48401 User manual

Version 1.2
October 2015

Liability disclaimer

The product described in this manual is warranted in accordance with the terms as set forward in applicable quotations or purchase orders. Product performance is affected by configuration, application, software control, and other factors. The suitability of this product for a specific application must be determined by the customer and is not warranted by APPLICOS.

APPLICOS shall not be liable for any special, incidental or consequential damage.

Information in this manual is intended to be accurate and reliable. However APPLICOS assumes no responsibility for any errors, which may appear in this document nor does it make any commitment to update the information contained herein.

Preface

This document is intended to aid in the use and understanding of the Applicos PS48401 Programmable Power Supply.

For support please contact:

Applicos
Veldkampseweg 1
8181LN Heerde
The Netherlands

+31 (0)578 696769
pxi-info@applicos.com
www.applicos.com

Table of Contents
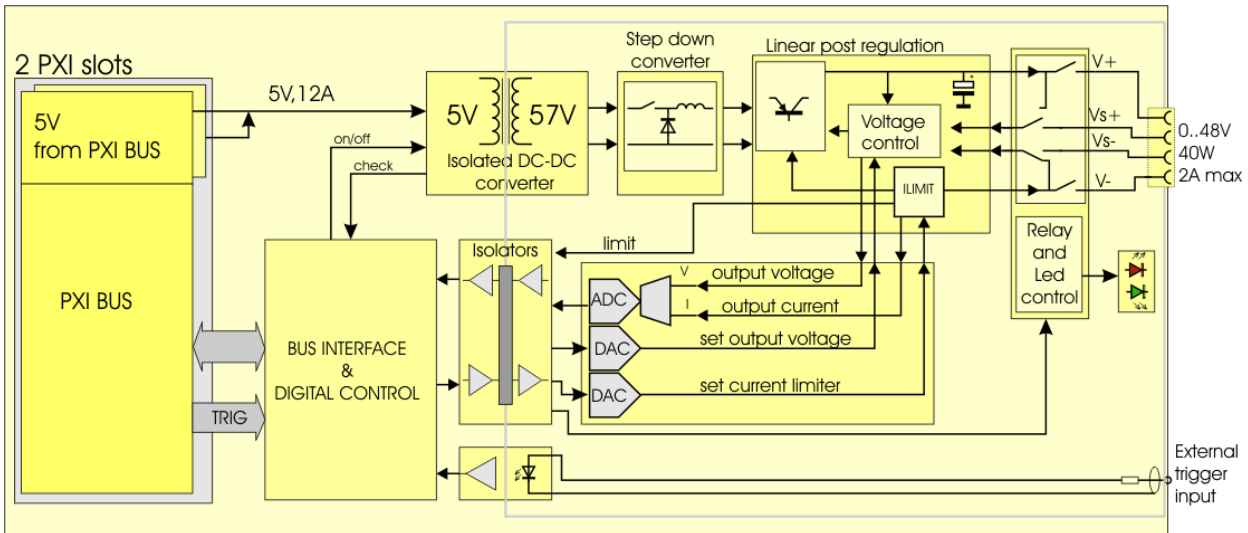
1 Hardware description

1.1 Block diagram

1.2 Description

The PS48401 is a single output programmable power supply which draws its power from two slots of a PXI backplane. The use of 2 backplane connectors minimizes stress on the backplane connectors even under maximum load conditions on the power supply. Power is drawn from the +5V supply and provided to an isolated DC to DC converter (variable) for regulation in a linear regulator stage. The linear regulator minimizes output noise and ripple on the power provided to the user.

Sense lines allow the users to regulate the voltage at a remote point, compensating for voltage drops in the supply wires. The sense wires can be configured to be uncommitted or to automatically connect to the V_{OUT} terminals if they are not connected.

The output voltage and current load can be read back through the internal instrumentation system.

The design is fully isolated from chassis, allowing modules to be added in series for higher voltage applications. Modules can be added in parallel to provide higher output currents with the aid of external supporting hardware.

1.3 Output power

The maximum total output power is limited to 40 Watt. This means that for output voltages above 20V, the maximum output current is linearly reduced to 0.833A at 48V.

The maximum output current for any output voltage is $\frac{P_{max}}{V}$ (where P_{max} is the maximum output power and V is the ouput voltage) or 2.0 A, whichever is smaller.
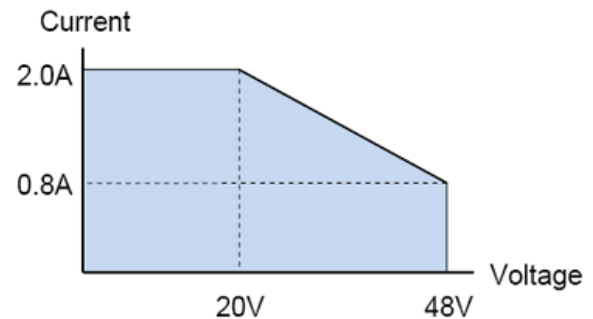
1.4 Front panel description
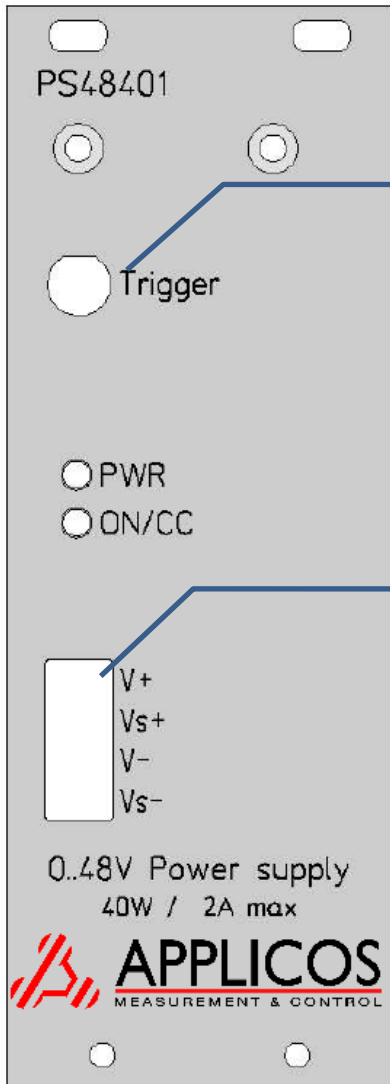
Male SMB coaxial connector (jack). Mates with female SMB (plug)

PTR Messtechnik type STLZ1550/4G/3.81-H-GREEN. Mates with PTR Messtechnik AKZ1550/4-3.81-xxx

PWR LED:

Off – Internal +56V power supply is disabled.
Green – Internal +56V power supply is enabled.

ON/CC LEDs:

Off – Output disconnected
Green – Output connected
Green+RED – Connected, Current clamp active

2   Software description

2.1   Installed components

The PS4840x software package is a combined installer for both the PS48401 and PS48402. It includes the following components:

- LabVIEW drivers including an application example
- LabWindows/CVI drivers (compiled binary + source code)
- .NET driver wrapper (compiled binary + C# source code)
- Soft Front panel
- Driver documentation
- User manual

This supports a wide range of development environments.

For both the LabVIEW and the native Windows driver, VISA driver V4.1 or higher should be installed.

2.2   Soft Front Panel

The Soft Front Panel application shown below provides basic functionality for operating the PS48401 module.
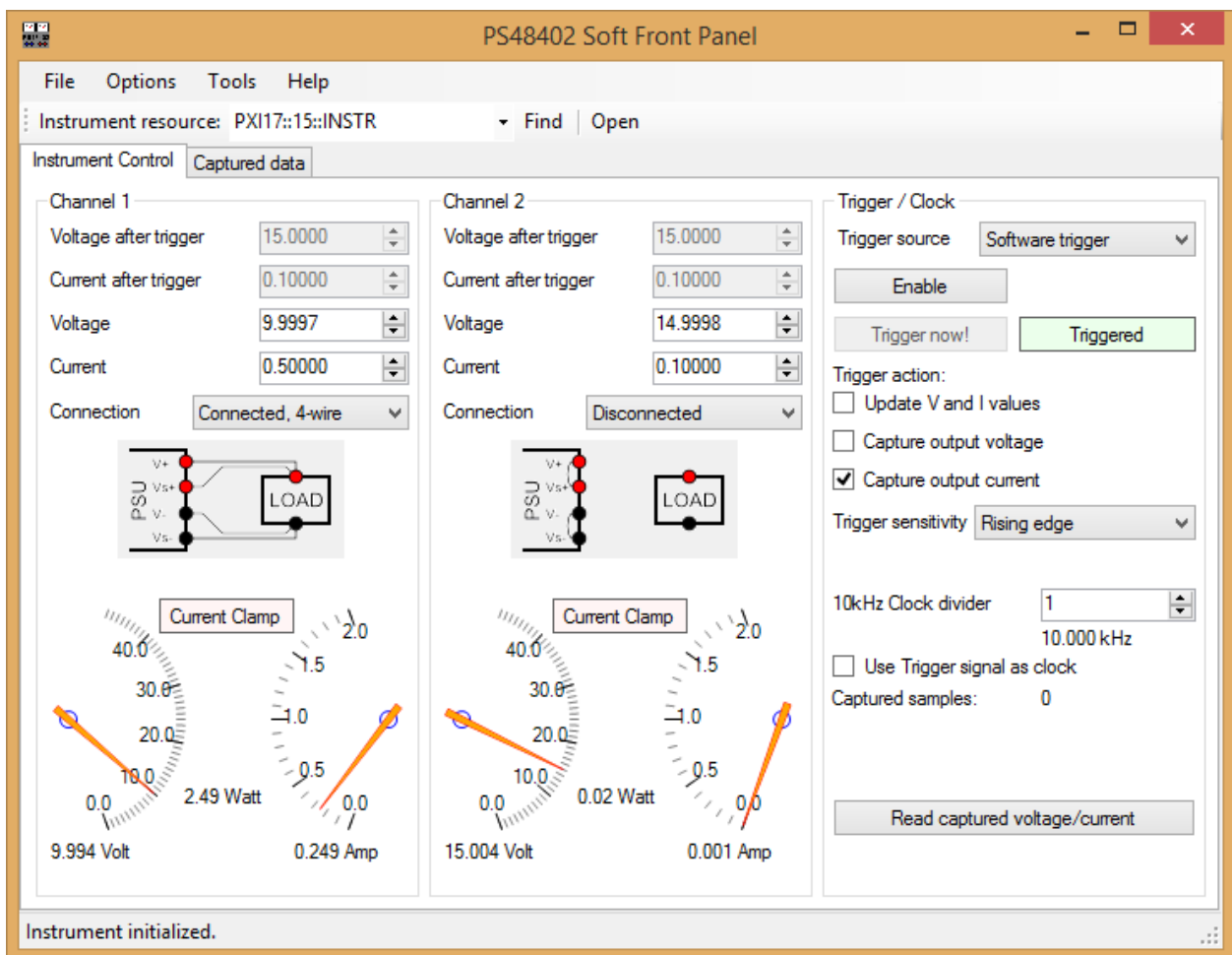
2.2.1 Getting started

To initialize communication with the PS48401 hardware, the instrument must be opened. Make sure the instrument resource field is set to the PS48401 unit you want to use.

Instrument resource description

Find instruments

Open driver session

PS48402 Soft Front Panel

File   Options   Tools   Help

Instrument resource: PXI17::15::INSTR   ▾   Find | Open

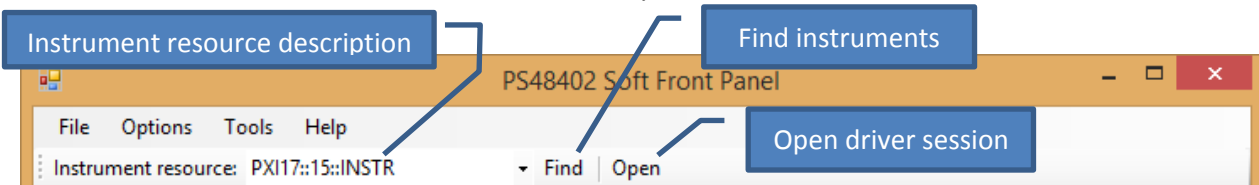You can also let the software search for available PS48401 units in your system, by clicking the "Find" button.

When the correct instrument resource is set, you initialize the driver session by clicking the "Open" button.

2.2.2 Channel settings

The Soft Front Panel has a section for each channel.

For each channel you can set the following settings:

- Voltage – The currently programmed output voltage.
- Current – The currently programmed output current.
- Connection – The currently programmed output connection mode. (Disconnect, 2-wire connection, 4-wire connection)
- Voltage after trigger – The voltage that will be the output voltage after a trigger event. (Only available when "Update V and I values" is enabled, see section 2.2.3)
- Current after trigger – The current that will be the output current after a trigger event. (Only available when "Update V and I values" is enabled, see section 2.2.3)
- Additionally, there are two indicators that show the readback value of the output current and the output voltage. Further, the calculated output power is shown and the current clamp status is displayed (red when active).
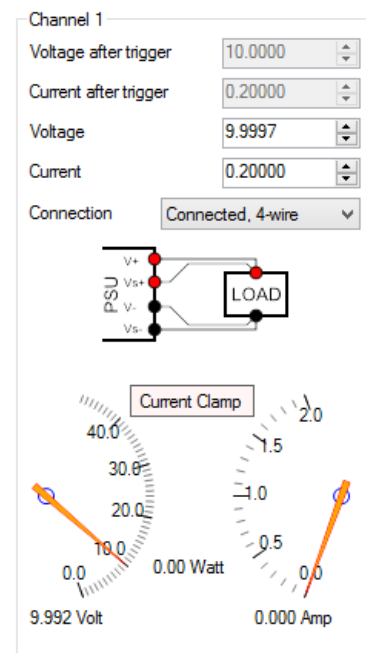
The software updates the output state immediately after setting a new value.

2.2.3 Trigger-based actions

The PS48401 can perform actions on a triggered basis. Available actions are:

- Update output voltage **and** current
- Capture output voltage **or** output current, using the build-in transient recorder.

These two actions can be set independently from each other.

As trigger source, there are a number of available options:

- Front
- Software
- PXI trigger 0..7
- PXI Star trigger

The triggering circuit can be configured to respond on a rising edge or on a falling edge.

To perform a triggered action, the software must be set in a mode that makes the instrument sensitive for triggering. This is done by clicking the
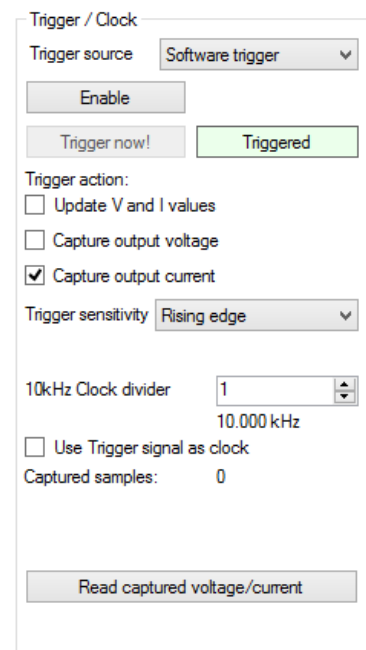
"Enable" button. This disables the controls and the readback for the channels, and the instrument now waits for a trigger event.

If the trigger source is set to "Software trigger", the "Trigger" button becomes active. A click on this button will cause the instrument to trigger.

If the instrument is set up to capture the output voltage or current on a trigger, the transient recorder stores up to 16384 samples per channel in its internal memory. If "Use Trigger signal as clock" is checked, every sample is taken when a trigger is detected. Otherwise, the internal sample clock is used to time the storage of the samples. The internal sample clock source has a base frequency of 10kHz, but can be divided down to 5kHz, 3.3kHz, 2.5kHz, etc. by setting the clock divider to 2, 3, 4, etc.. Maximum value is 16384.

The "Captured samples:" field shows how many samples are stored. When the counter is at its maximum, the software automatically returns to its normal state (re-enabling the channel controls and the readback loop). The normal state can also be forced earlier by clicking the "Disable" button.
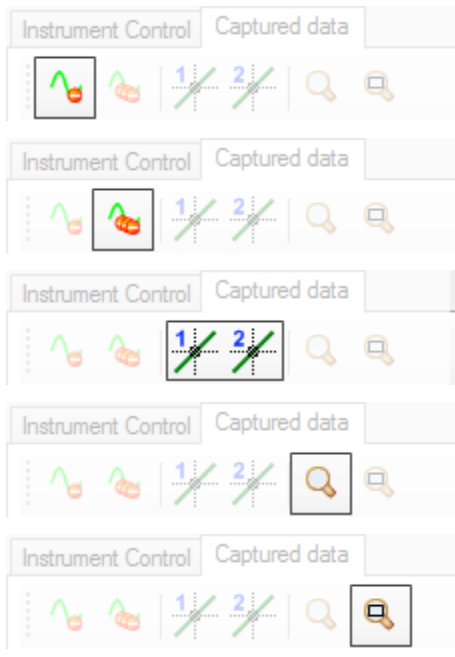
2.2.4 Analyzing captured current/voltage

When the built-in transient recorder has been used to record voltage or current measurements, the results can be read by clicking the "Read I/V" button at the bottom of the "Trigger/Clock" section. This reads all captured samples of both channels. The focus is switched to the "Captured Data" tab page (shown below), and for each channel a trace is added to the graph.
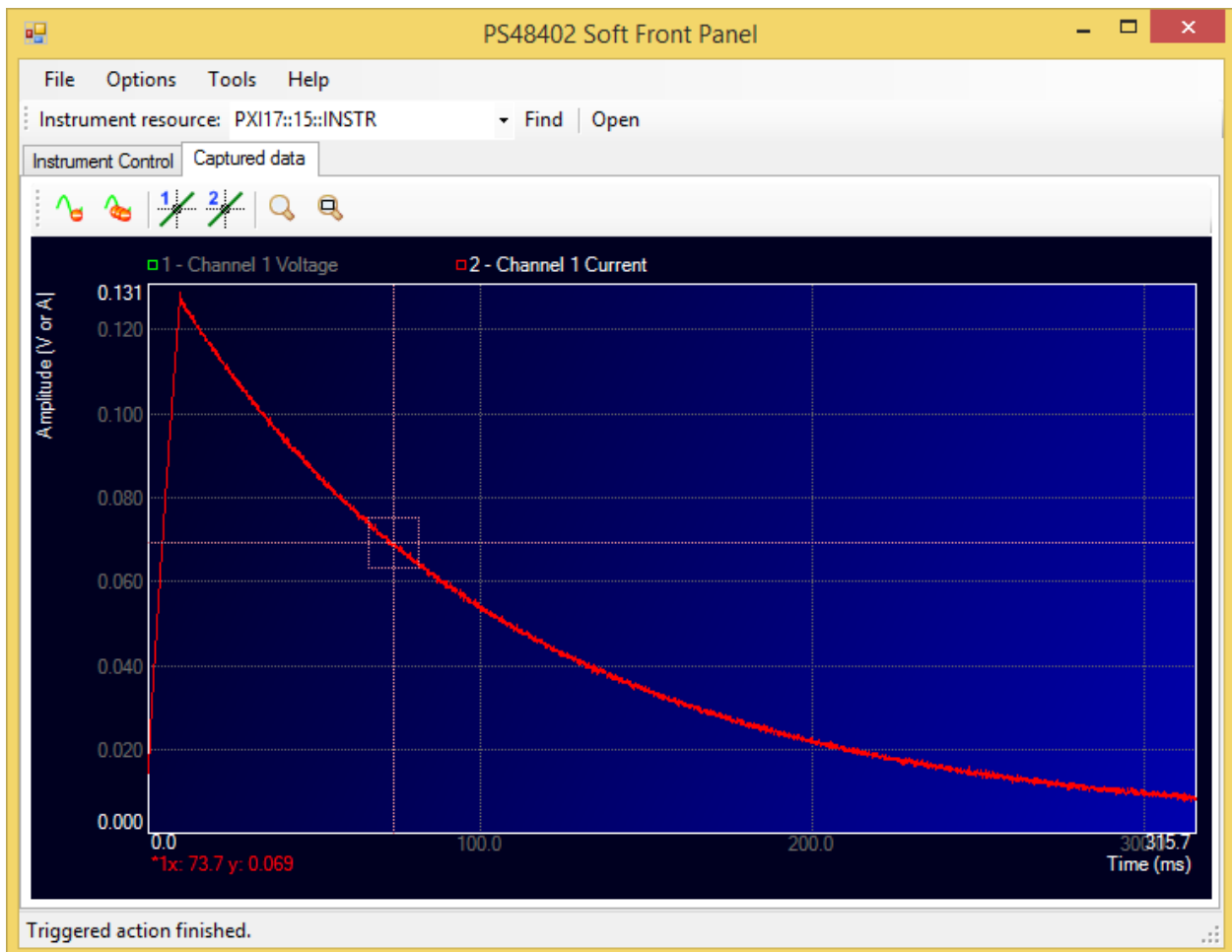
You can select a trace by clicking on the corresponding label in the graph's legend (above the graph).

Above the graph a toolbar is visible, allowing performing some actions on the graph:

Remove the currently selected trace from the graph.

Remove all traces from the graph.

Enable/disable cursor 1 or 2 on the selected trace.

Toggle zoom mode.

Reset zoom to fit all traces on the graph.

The graph's cursors can be moved with the keyboard arrow keys, or by dragging them with the mouse.

When a cursor is enabled, the exact cursor position is shown below the graph.

2.2.5 Options menu

In the "Options" menu, some application options are available:

- Disconnect before close – When checked, the instrument's outputs are disconnected when the software is closed.
- Prevent hot-switching – When checked, the software prevents the occurrence of hot-switching by bringing the output voltage to zero before switching the output connection. See section 3.2 to find out what hot-switching is, and why this should be prevented.
- Display connected load resistance – Show the calculated load resistance on the front panel.
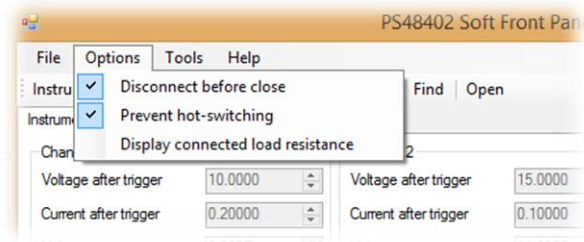
2.2.6 Tools menu

The "Tools" menu contains some useful software-tools:

- Calibration report – Show a calibration report (see section **Error! Reference source not found.** for more information)
- Calibration wizard – Start the calibration wizard (see section **Error! Reference source not found.** for more information)
- Diagnostics, Memory Test – Perform a memory read/write test on the capture memory.
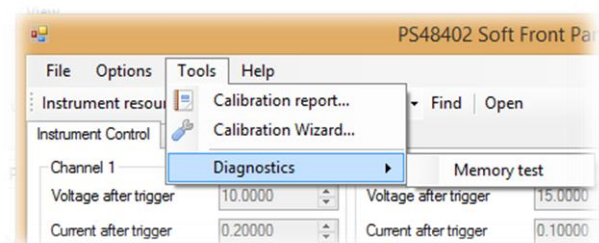
2.3   Sources and binaries

At installation, the driver binaries, sources, documentation, etc. are copied to the installation location.

The default installation location is:

[VPNPPATH]\WinNT\ps4840x

Where [VPNPPATH] is the VXI*plug&play* default installation path, read from the registry key:

HKLM\SOFTWARE\VXIPNP_Alliance\VXIPNP\CurrentVersion\VXIPNPPATH

If this key is not available the directory is:

Program Files\Applicos\ps4840x

The user can change the installation directory during the installation process.

2.4   Driver documentation

The driver functions documentation files are accessible from the start menu.

Native driver functions:

ps48401.chm (compiled HTML Help) and ps48401.txt (plain text file)

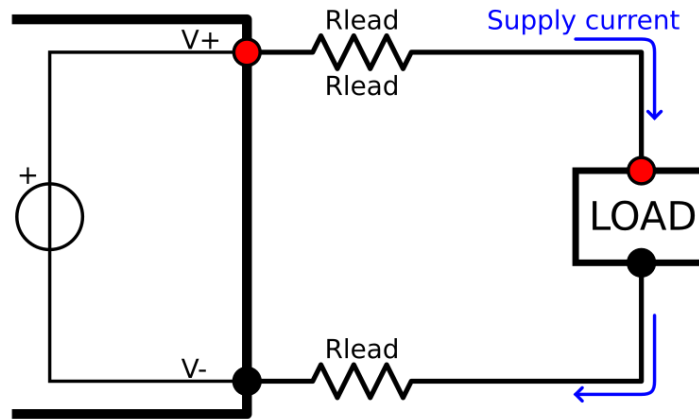**C#/.NET driver wrapper functions**:

PS4840x_Driver_Documentation.chm

3 Measurement concepts

3.1 Two-wire vs. four-wire connection

The diagram below shows a Power Supply unit with a typical 2-wire connection to the load.

The load draws a certain amount of current from the source. Resistance in the connection wires (R_{Lead}) cause a voltage drop when current flows through it. Depending on the magnitude of the resistance and the current, this may lead to significant errors. If, for instance, the resistance of a single lead is 10 milliOhm, the total lead resistance in the V+ and the V- wire is 20mOhm. According to Ohm's law $U = I * R$, when drawing 2 Amp from the power supply unit, this will lead cause a voltage drop of (*2 * 0.010) Ω * 2.000 A = **0.040 V**. Depending on your application this might be a problem.

The solution is to connect remote sensing wires, as shown below:
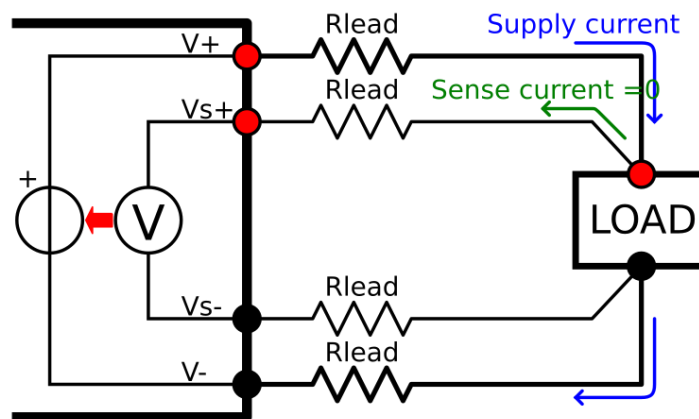
The sense lines are connected to as close to the load as possible. The sensing lines will also have a certain amount of resistance, but since the voltage measurement is high impedance, hardly any current will flow through the sense lines. Therefore the lead resistance will cause nearly no voltage drop, allowing for an accurate measuring of the voltage on the point of load. Using a closed loop voltage regulation, the output voltage is automatically increased until the sensed voltage matches the programmed voltage.

The PS48401 PXI Programmable Power Supply is equipped with sense line connections. **Please note that in 4-wire mode, sense lines should never be left floating,** because that would greatly influence the output voltage. When the test setup does not accommodate remote sense lines, choose the 2-wire connection mode. This will connect the sense lines to the force lines internally.

3.2 Hot switching (and why this should be prevented!)

Hot Switching is a term used to describe when a relay changes state while carrying a signal.

When a relay is connected or disconnected with a voltage across the contacts, arcs may arise. This greatly reduces the contact's life, as it heats and erodes the contacts.

The PS48401 uses relays to connect/disconnect the output lines from the card. Therefore it is sensitive for hot-switching.

To prevent hot-switching, make sure the voltage on both sides of the relay will be equal when the relay is in the open-state. Usually it is easiest to set this to 0 Volt.

Example sequence to connect the PS48401:

1. Program the output voltage to 0 Volt (assuming the load is un-powered, and at 0 Volt).
2. Wait for the output voltage to be settled.
3. Connect the output.
4. Wait for the relays to be settled.
5. Program the output voltage and current to the desired values.

Example sequence to disconnect the PS48401:

1. Program the output voltage to 0 Volt (assuming the load will be at 0 Volt when un-powered).
2. Wait for the output voltage to be settled.
3. Disconnect the output.

3.3 Increasing current by putting multiple Power Supplies in parallel

When the required output current is higher than what the power source can supply, multiple power supplies can be put in parallel to share the requested output current sourcing. However, care must be taken not to damage the power supply in the process.

When both outputs are not sourcing exactly the same voltage, the power supply with the lowest output voltage will start sinking current from the power supply with the higher output voltage. The PS48401 is intended for 1-quadrant operation (positive voltages, sourcing current only), but there is a small current sink that helps discharging the output capacitors when the output voltage is changed down. This circuit however does not make it a real 2-quadrant power supply, as it cannot handle a continuous current.

So care must be taken to prevent the lower-output-voltage power supply from sinking current. The recommended way is to use a Schottkey diode in series with each '+' output. A Schottkey diode typically has a low voltage drop, and this drop can be compensated by connecting the sense lines after the diodes. A diode with sufficient current rating should be selected.
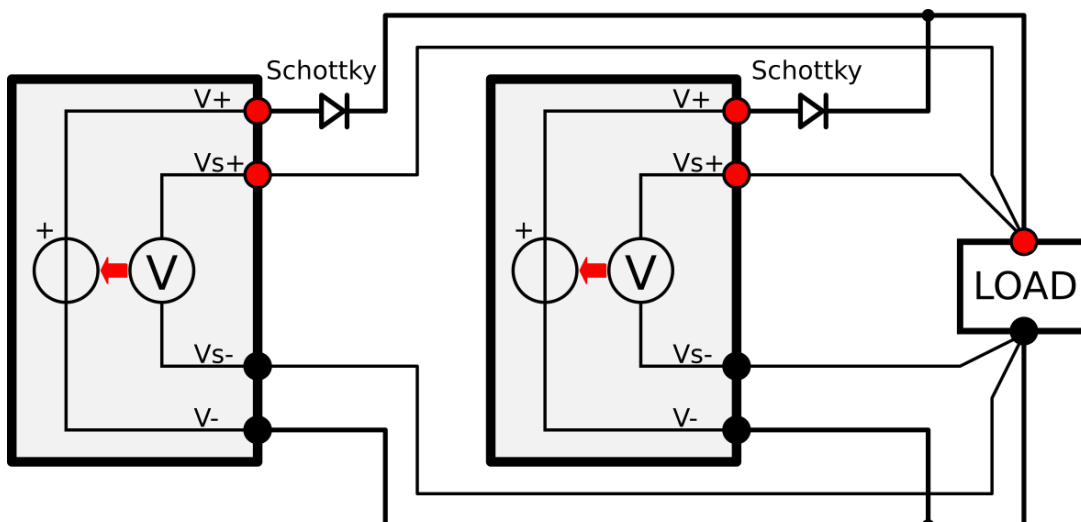
3.4 Increasing output voltage or creating a bipolar supply by putting Power Supplies in series

When the required output voltage is higher than what the power source can supply, multiple power supply channels can be put in series to increase the total output voltage. This can be seen in the left diagram below.

When a bipolar power supply is required, the wiring is very similar, except that the connection putting the two channels in series is becoming the GND net. This can be seen in the right diagram below.
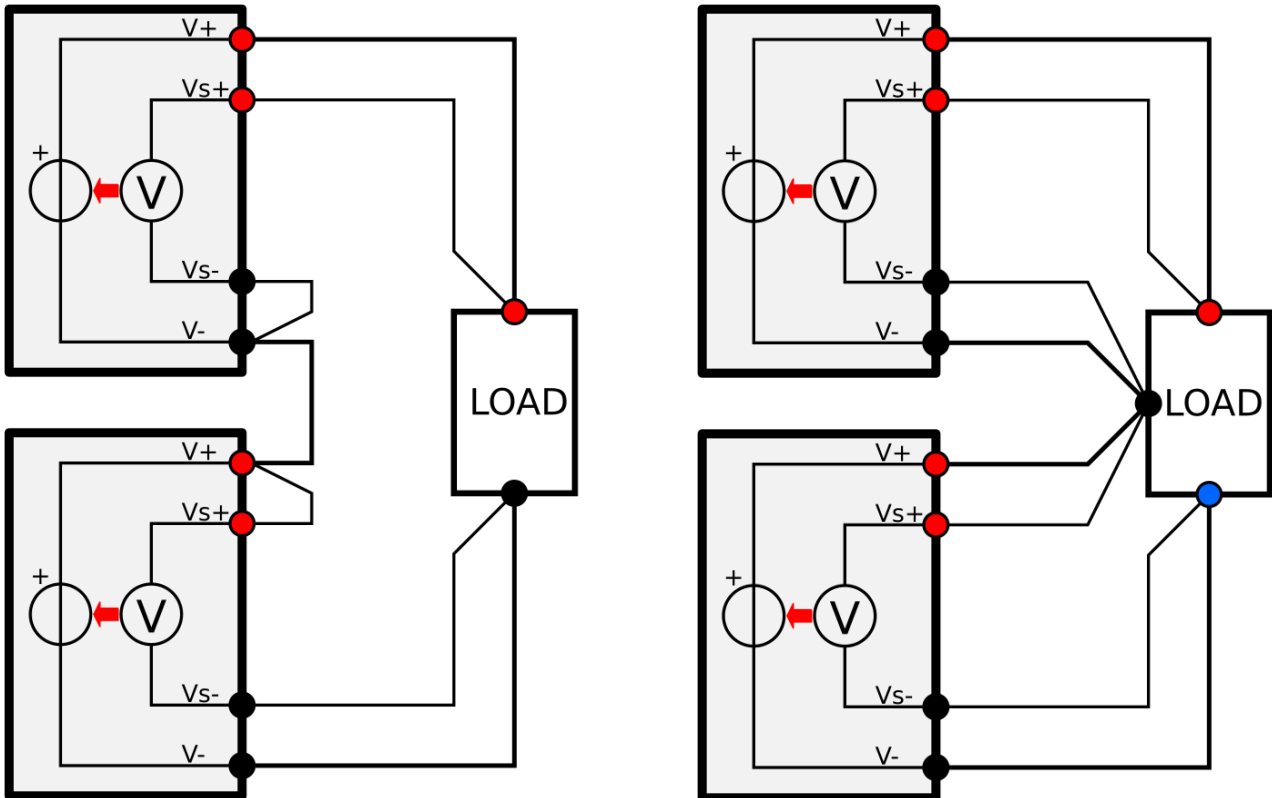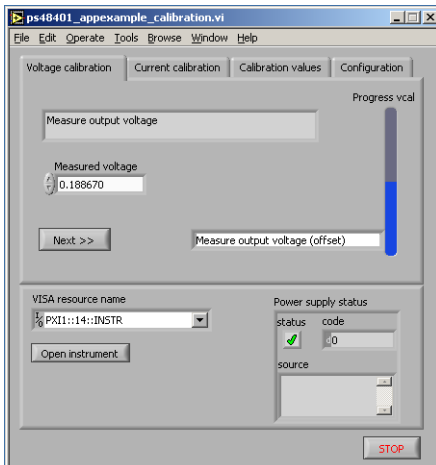
4 Calibration

The LabVIEW calibration application example can be used to perform calibration of the instrument.

Load the PS48401 calibration application example VI, select the correct PXI slot address and open the instrument.

4.1 Voltage calibration

Calibration starts with voltage calibration. The output voltage DAC and the voltage measurement ADC are calibrated.

Select the "Voltage calibration" tab and connect the voltmeter to output. Then click "Start".

Remember to connect the sense lines with the corresponding force lines.

Enter the measured voltages, two voltages in total:

First voltage reading: minimum 180 mV, maximum 200 mV.
Second voltage reading: minimum is 45.62 V, max is 46.54V.

After a successful Voltage calibration, the found calibration values are stored automatically in the module EEPROM.

4.2 Current calibration

After voltage calibration is completed, select the "Current Calibration" tab. The current limiter and current measurement are calibrated.
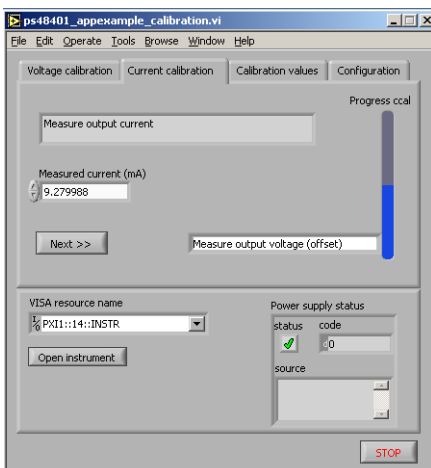
During the Current calibration, an Ampere meter should short-circuit the output, to measure output current. At the first calibration step, the Ampere meter should have a minimum shunt resistance of approximately 10 ohms. When this constraint is not met, add a series resistor.

Then Click "start" and enter the currents measured with the ampere meter during this calibration procedure.

During the second current reading, the 10 ohms series resistor should be removed. Otherwise the1.5 ampere current will not be reached.

Please note that the front panel LED should light red during the current measurement. *This indicates that the current limiter is active.*

First current reading: minimum 8 mA, maximum 12 mA.
Second current reading: minimum is 1.49 A, max is 1.55 A.

After a successful Current calibration, the found calibration values are stored automatically in the module EEPROM.

5 Technical Specifications

Output

Output Voltage	0 to 48 V
Voltage setting resolution	0.74 mV
Voltage setting accuracy	± 0.2 % of programmed value ± 25 mV
Load regulation	0.1 % of programmed value + 5 mV (10 to 90 % load change)
Output current	0 to 2 A (Above 20 V: Linear de-rating to 0.8A (40 W max. total power))
Maximum output power	40 Watt
Current limit resolution	35 µA
Current limit accuracy	0.5 % of programmed value ±10 mA
Sense line regulation area	0.5 V (sum of both sense lines)
Output ripple (typical)	1.5 mV$_{RMS}$, 6 mV$_{PP}$ (Full load, BW = DC – 1 MHz)
Rise time:	1 V/ms (typical at full load)

Readback

Voltage Read back resolution	0.74 mV
Voltage Read back accuracy	±0.1 % of reading ± 10 mV
Current read back resolution	35 µA
Current read back accuracy	±0.2 % of reading ± 5 mA

Triggering

Trigger sources	Software trigger, Front trigger, PXI0..7, PXI Star
Front trigger input	Floating opto-coupler input (220 Ω in series with a diode)
Front Trigger level	4.0 V – 12 V (approx. 10 mA – 50 mA)
Minimum trigger pulse low / high time	20 µs
Trigger actions	Update output voltage/current, Capture output voltage/current, Update + Capture output voltage/current

Capturing measurements

Capture Memory Depth	16384 samples
Maximum capture clock frequency	10 kHz
Internal capture clock divider	1 .. 16384 (generates 10kHz .. 0.6 Hz capture clock)
Capture clock sources	Internal sample clock, Trigger source

Operating limits

Voltage to chassis (any pin)	60 VDC (safety limit, design breakdown voltage > 250VDC)
Insulation resistance	> 100 MΩ
Backplane 5V under-voltage lockout	4.65 V
Backplane 12V under-voltage lockout	11.3 V
Operating temperature	0°C to 50°C

6 Document history

Version	Date	Editor	Changes
0.1	December 2012	JvdV	Initial draft.
0.2	March 2013	JvdV	Fixed description of trigger behavior in 2.2.3. Added section 1.3 about maximum output power.
0.3	April 2013	JB	Extended current calibration section
0.4	June 2013	JvdV	Added front connector description.
0.5	July 2013	JvW	Added select instrument location, chapter 2.2
1.0	January 2015	JvdV	Added chapter 3: "Measurement concepts" Updated SFP description to match SFP version 2 Updated chapter 2.1: "Installed components" Split "Driver documentation" to "2.3 Sources and binaries" and "2.4 Driver documentation". Added support contact information to "Preface".
1.1	September 2015	JvdV	Added chapter 3.3: "Increasing current by putting multiple Power Supplies in parallel". Fixed document revision reference missing in page footer. Fixed bug in illustrations on chapter 3.1
1.2	October 2015	JvdV	Added chapter 3.4: "Increasing output voltage or creating a bipolar supply by putting Power Supplies in series".