OPTI-SCIENCES

PSP32
Peripheral Interface Module

CONTENTS

Introduction:

The Peripheral Interface Module (PIM) allows process control applications using parameters from the PSP32. It can have a mixture of up to 4 Voltage output channels, 4 current loop channels, and 4 dry contact relays. A PIM may be connected to any available port on the PSP32, up to a maximum of 8 PIMs.

There are two types of PIMs available. One has analog and relay contacts (PIM-Analog) the other has two peristaltic pumps and two relay contacts (PIM-Pump). The PIM-Pump is useful for dosing liquids based on a measured parameter.

A PIM operates using a script similar to a standard fluorescence probe. It is classified as a data receiver. Data is used to set a specific output level, toggle a relay state, or control a pump. Each unit can have a number of outputs (analog, relay, or pump) that are called channels. Script commands direct data from a probe to a channel on the PIM. Leaf temperature is an example of data that can be used from a probe. Not all possible parameters are available for use at this time. Modifiers are provided to control scaling and duration of an channel event.

A PIM can receive data from multiple probes and several probes can control a single PIM channel.

DEPLOYMENT:

The included 10m cable is connected to any available port on the PSP32. This connection is for communication and power. The control output connections available will vary by PIM type. Consult the pin-out appendix for connection information. PIMs may be connected live, but it is preferred to connect all system components while the power is off to prevent data errors.

CREATING A PIM SCRIPT USING A TEXT EDITOR:

Scripts can be created using a computer and a simple text editor, or directly on the PSP32. Command lines are plain text entries that are case insensitive and ignore white spaces. Hidden characters other than line feeds and carriage returns should not be present in the text. Make sure the program used to compose the script is set to 'Plain Text'. Most parameter range values are checked, but it is advisable to review the ranges specified with each channel name.

A PIM may have up to 15 command lines. Commands are loaded in the order listed, but run asynchronously. All lines are scanned continuously for events and new probe data. Two commands that act upon the same channel will be executed based on the arrival (or occurrence in the case of time) of new data. If Vout1 is controlled by two different probe leaf temperatures, then the most recent data arrival will be sent to Vout1. This is useful when two probes are running different scripts that take readings at different times.

Comments may be added to a script file and should occupy its own line starting with a '*' character. For example:

```
*This is a valid comment line.

vout1 = sn1100 : tleaf  *This comment will cause an error!
```

The first part of a command line defines the channel number. This is what will be controlled by the probe data. The next part depends on the type of channel (analog, relay, pump, etc.). Analog outputs have a varying range of output, while relays may be either on or off.

SYNTAX FOR VOLTAGE AND CURRENT CHANNEL COMMANDS:

Commands define a relationship between measured parameter and channel. Scaling options may be set to change the standard output range. Voltage sources have a default output of 0 - 5 Volts and current loops from 0 - 24 mA. They take the form of

```
channel name = probe serial number : parameter range min value to max
value
```

If range min & max values are omitted, the default range is used. Note the colon between the serial number and parameter.

For example, to have Voltage on channel 1 track probe serial number 1100 leaf temperature with $10^oC = 0V$ and $30^oC=5V$, use the following script line:

```
Vout1 = sn1100 : tleaf range 10 to 30
```

To use the default range, omit the range option:

```
Vout1 = sn1100 : tleaf
```

This will output 0V at 0^oC and 5V at 50^oC, which is the default range for leaf temperature.

Current channels work the same:

```
loop1 = sn1100 : tleaf range 10 to 30
```

Will have a current loop value of 0mA at 10^oC and 24mA at 30^oC.

While this line:

```
loop1 = sn1100 : tleaf
```

will have a current loop value of 0mA at 0^oC and 24mA at 50^oC.

SYNTAX FOR RELAY CHANNELS:

Relays operate differently as they have only two states On or Off.

Relays may be switched with a value comparison or at a set time.

They may also have a set duration of on/off before returning to their previous state.

relay name on/off for duration if probe serial number : parameter condition

relay name on/off for duration at time

(time always in HH:MM 24 hour format)

RELAY COMMANDS (ABSOLUTE)

For example:

```
relay1 on if sn1100 : ltemp > 25.0
```

will switch the relay on if the leaf temperature at probe serial number 1100 is greater than 25°C. It will not switch the relay off when the temperature falls back below 25°C, another command must be included for this. A small difference between any two On or Off test values should be maintained to prevent the relay from chattering on and off. A sample of a complimentary command would be.

```
relay1 off if sn1100 : ltemp < 23.0
```

This will allow for a 2 degree difference between relay switching. Note that no duration was specified, so the command will switch the relay state indefinitely.

A relay may also be switched on or off at a certain time:

```
relay1 on at 12:05
```

```
relay1 off at 14:10
```

These commands will switch relay1 on at 12:05PM and off again at 2:10:PM. Time of day is supplied from the PSP32 clock. This command is useful for controlling light sources on a timed basis.

RELAY DURATION COMMANDS

There is an additional setting that may be added to a relay command. The duration of the command's action may be set. This allows a relay to be pulsed on/off for a given duration when triggered.

For example, the command

```
relay1 on for 7500 at 12:05
```

will perform the same function as the two line example from above (turn on at 12:05PM and turn off after 2 hours and 5 minutes).

The duration period may range from 1 to 65535 seconds. When omitted, the duration is set to 0, and the relay's state will not change until another command tells it to.

A command that would turn Relay 1 on for 2 minutes if the leaf temperature of probe serial number 1000 exceeded 25°C would look like the following:

```
relay1 on for 120 if sn1000 : ltemp > 25
```

Note: The state of a relay at the end of the duration will be the opposite of the command value regardless of initial conditions.

DURATION COMMANDS VS ABSOLUTE COMMANDS

If multiple command lines are used to control a single relay, the following rules apply:

If a duration is specified, the specified relay will run when triggered until the duration time has elapsed, or a command without a specified duration is triggered.

Relay commands with a specified duration will be ignored until any prior time duration has elapsed.

CHANNEL NAMES:

Voltage outputs: all Voltage outputs have a default range of 0 - 5V

Vout1, Vout2, Vout3, Vout4

Current Loops: all current loops have a range of 0 to 24mA

Iloop1, Iloop2, Iloop3, Iloop4

Relays: all relays can be either on or off

Relay1, Relay2, Relay3, Relay4

Peristaltic Pump:

Pump1, Pump2

AVAILABLE PARAMETERS

There are several different types of probes available for the PSP32 system, below are a listing of the parameters that are available from each. The parameter value is used for setting analog outputs or for logical test events.

PARAMETERS FOR FLUOROMETER PROBE: (TYPE FL-PRB)

Tleaf - leaf temperature, Range 0-50.0 (^{o}C)

PAR - PAR value (5 Min rolling average value), Range 0-2500 (uMoles)

Fvm - Fv/Fm ratio, Range 0-0.999 (no units)

Fvo - Fv/Fo ratio, Range 0-0.999 (no units)

YII - Y(II) ratio (note; omit parenthesis), Range 0-0.999 (no units)

ETR - ETR value, Range 0-399.9 (arbitrary units)

qP - qP ratio, Range 0-0.999 (no units)

qN - qN ratio, Range 0-0.999 (no units)

Fo - minimal dark value, Range 0-3000 (arbitrary units)

Fm - maximal dark value, Range 0-3000 (arbitrary units)

Fs - steady state minimal value, Range 0-3000 (arbitrary units)

Fms - steady state maximum value, Range 0-3000 (arbitrary units)

Fo' - Range 0-3000 (arbitrary units)

NPQ - Range 0-0.999 (no units)

hYNO - Range 0-0.999 (no units)

hYNPQ - Range 0-0.999 (no units)

qL - Range 0-0.999 (no units)

kYNO - Range 0-0.999 (no units)

kYNPQ - Range 0-0.999 (no units)

PARAMETERS FOR CHLOROPHYLL CONTENT PROBE: (TYPE CC-PRB)

raw700 - fluorescence signal @ 700nm, Range 0-3000 (arbitrary units)

raw730 - fluorescence signal @ 730nm, Range 0-3000 (arbitrary units)

ratio - ratio of 700 signal/730 signal, Range 0-3.00 (no units)

chlconc - estimated chlorophyll, Range 50-700 (ug/some volume)

PARAMETERS FOR NDVI PROBE: (TYPE NDV-PRB)

refl450 – relative reflectance signal @ 450nm, Range 0-3.00 (no units)

refl540 - relative reflectance signal @ 540nm, Range 0-3.00 (no units)

refl660 - relative reflectance signal @ 660nm, Range 0-3.00 (no units)

refl720 - relative reflectance signal @ 720nm, Range 0-3.00 (no units)

refl850 - relative reflectance signal @ 850nm, Range 0-3.00 (no units)

NDVI - ratio of (r850-r720)/(r850+r720), Range 0-1.00 (no units)

NDRE- ratio of (r720-r660)/(r720+r660), Range 0-1.00 (no units)

PPR - ratio of (r540-r450)/(r540+r450), Range 0-1.00 (no units)

PARAMETERS FOR ENVIRONMENTAL SENSOR INTERFACE: (TYPE ENV-PRB)

Tamb - ambient Temperature, Range -10.0 to 70.0 (^{o}C)

Hamb - ambient Humidity, Range 2.0-95.0 (%)

PAR - ambient illumination for 400-700nm band, Range 0-5000 (umol/m2s2)

IRill - ambient radiation from 700-1000nm, Range 0-500 (uW/m2)

UVill - ambient radiation from 320-400nm, Range 0-500 (uW/m2)

PM25 - PM2.5 measure of ambient dust, Range 0-1000 (ug/m3)

PARAMETERS FOR ANALOG SENSOR INTERFACE: (TYPE ANA-PRB)

Vin1 - Voltage on channel 1, Range 0-5.000 (Volts)

Vin2 - Voltage on channel 2, Range 0-5.000 (Volts)

Vin3 - Voltage on channel 3, Range 0-5.000 (Volts)

Vin4 - Voltage on channel 4, Range 0-5.000 (Volts)

Vin5 - Voltage on channel 5, Range 0-5.000 (Volts)

Vin6 - Voltage on channel 6, Range 0-5.000 (Volts)

Vin7 - Voltage on channel 7, Range 0-5.000 (Volts)

Vin8 - Voltage on channel 8, Range 0-5.000 (Volts)

ERROR CODES:

If there is a syntax error found in a script, some guidance will be offered in the form of an error code in the message displayed in the PSP32 editor screen. It will aid in correcting the mistake. The message Syntax Error!:# is displayed where # = is the error code.

1   bad channel name

2   bad syntax in probe id (should have format sn####)

3   invalid serial number range (good range 900 - 2560)

4   syntax error in probe/parameter line (i.e. "sn1000 par" is missing a colon)

5   bad parameter name

6   error in range syntax. This can happen if a range parameter is misspelled or incorrectly formatted

7   range format syntax error (should be # to #)

8   specified min out of range

9   specified max out of range

C   invalid conditional choice in relay statement (must be an =, <, or > character)

L   invalid logical choice (other than the 4 relay conditional statements)

T   invalid time parameter in relay statement (must be ##:##, 24hr format)

R   invalid range for relay test

D   invalid duration setting/syntax for relay command

PSP32 SOFTWARE CHANGES TO ACCOMMODATE PIMS

PIMs are supported by the PSP32 with the release of version 1.02 application software. While most screens remained unchanged, features needed for PIM control were added to the following screens.

TEST RUN SCREEN:
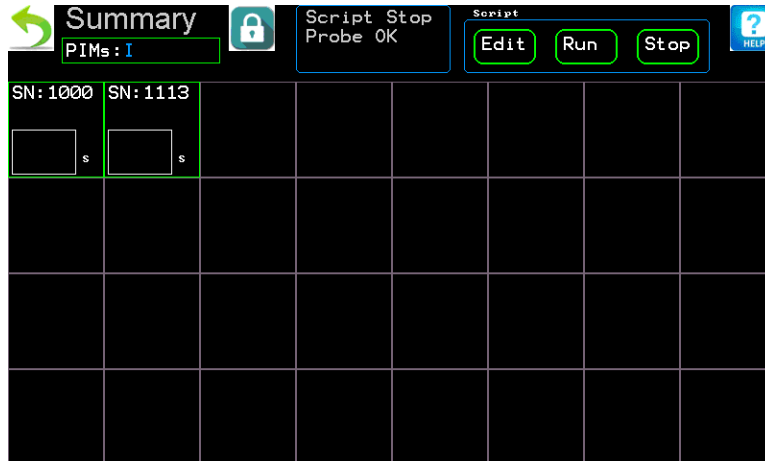
The controls in the 'Script' box now also control matching PIM functions. A PIM script can be edited by selecting **Edit** and choosing **PIM** as the target. A list of PIMs present will guide the user to the desired PIM to edit. Similar functions exist for the **Run** and **Stop**. PIMs may accept data from many probes. PIMs and probes may be started and stopped independently of one another. It is important to ensure that probes and PIMs are installed and running to provide a complete data path between the two. PIMs are controlled from this screen only and do not have a global 'Run' or 'Stop' option at this time.

A status box has been added for PIM units (upper left). Each PIM will appear as the letter I,R,or F for Idle, Running, or Faulted. Tapping on the box will bring up the PIM status screen. The status screen shows current values for all PIM's channels. Idle PIMs will have their values listed as null values. Faulted PIM's will have an error message. The values shown are updated in real time with the arrival of relevant probe data. An example of the PIM status screen is shown below.
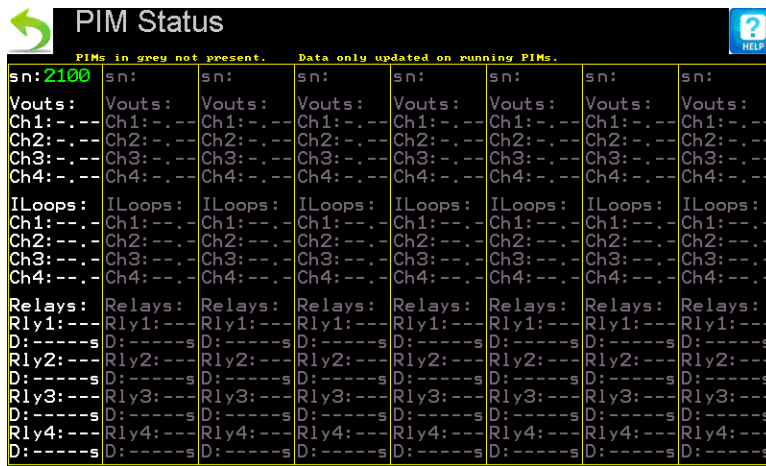
In this example, only one PIM , serial number 2100, is installed on the system, and it is in the Idle state. A PIM-Pump will have a unique set of channel data values.

SCRIPT EDITOR:
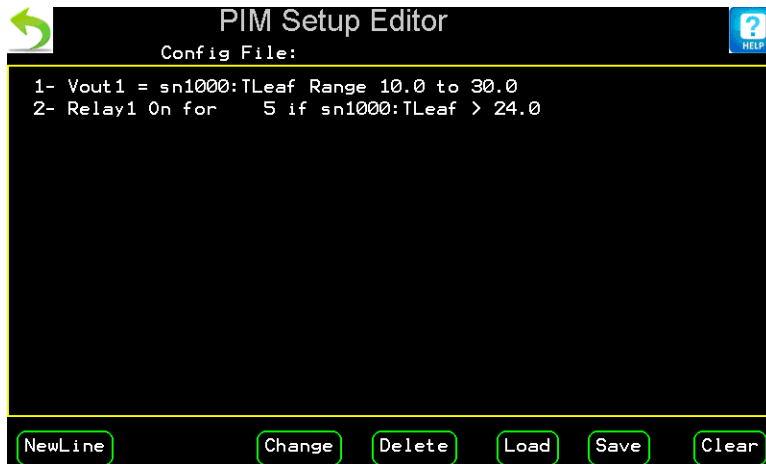
The PIM script editor is very similar to the probe editor. Basic operation is the same as that explained in the PSP manual. As the scripts are different, new list options are available. The script on each PIM is separately managed.

Change will replace the selected line. The other edit buttons function as noted in the probe script editor documentation.

DIAGNOSTICS SCREEN:
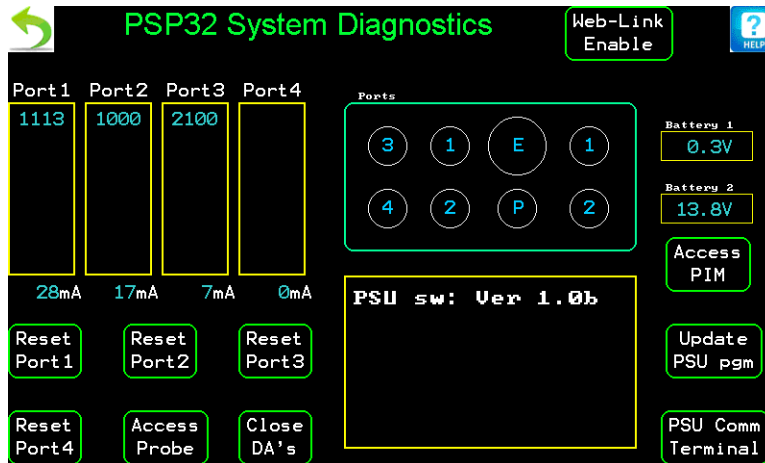
A new button will appear with the addition of PIM units. **Access PIM** (center right), when clicked will display a list of available PIMs, allowing access to a specific unit by serial number. Selecting a unit will bring up the following screen.

CHANNEL DIAGNOSTIC SCREEN:
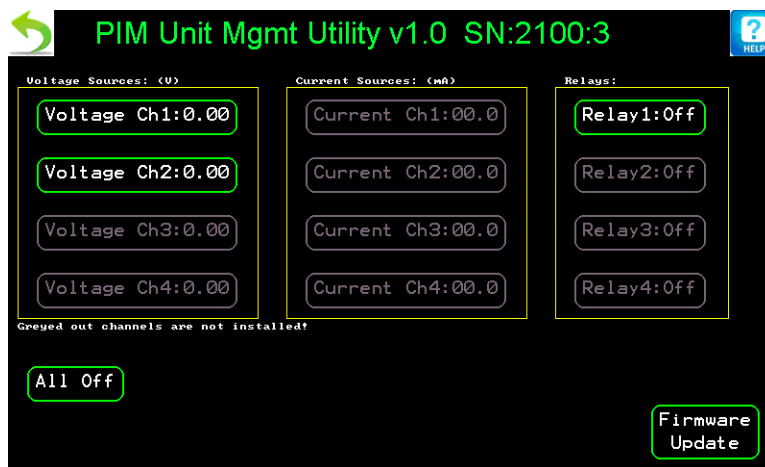
This screen allows for the control of each PIM channel for setup and testing. Channel output and relay status can be changed by tapping the relevant button. Exiting the diagnostic screen will switch all channels to their idle/off state. There is also a button to update the firmware in the PIM. This feature should only be used if directed by service personnel.

WEB INTERFACE:

Version 1.02 introduces some additions to the web control feature. An additional description line has been added to each connected device, identifying its type. All command scripts still reference a device by serial number for selection.

Clicking on **2100 PIM-Ana** from the above list will display the PIM status page.

This page shows the current value of all PIM channels and the loaded script file. No settings can be changed from this page. PIM scripts are changed using the same method employed for probes (test management).

PIM operation and scripting may be managed remotely on the Test Management page shown below.

Multiple selection of devices is limited to identical device types. This prevents a probe and a PIM from being selected at the same time. The **Select Device Set** button may be used to highlight all members of the currently selected type. If a probe is selected and there are 5 probes and 2 PIMs installed, clicking this button would select the remaining 4 probes and no PIMs. The script text box works identically to the previous version. It does not make any distinction between probe or PIM scripts, so make sure the proper one is selected for the selected device type. Trying to send a script meant for one type to another will eventually result in an error message.

Similar changes have been made to the 'Web Link' feature in the diagnostics page:
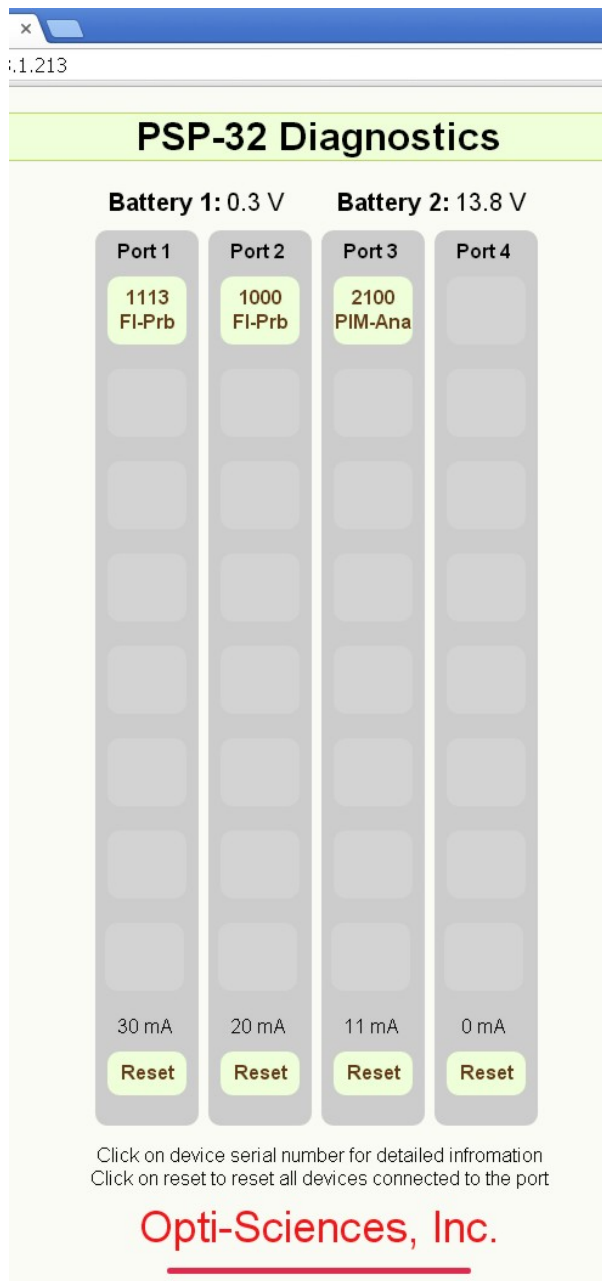
This view shows which port the device is connected to (vertical columns). Selecting **2100 PIM-Ana** will display the following page.

Peripheral Interface Module Diagnostics

Serial Number: 2100

Voltage output		Current loop	
Channel 1:	V	Channel 1:	mA
Channel 2:	V	Channel 2:	mA
Channel 3:	V	Channel 3:	mA
Channel 4:	V	Channel 4:	mA

Relay control

Relay 1: Off
Relay 2: Off
Relay 3: Off
Relay 4: Off

Press enter in box to accept value.

Home

Opti-Sciences, Inc.

Each of the PIM's channel values may be changed from this page to aid in setup and troubleshooting. Channel Voltages and currents may be entered into the respective boxes and relay states may be toggled. All PIM channels will revert to their idle state upon exiting the 'Web Link' mode. Altering values in this screen will have no effect on the script loaded into the PIM.

SPECIFICATIONS:

ANALOG UNIT:

VOLTAGE OUTPUT:

Number: 4 channels

Range: 0-5VDC 10mA max load current

Resolution: 10 bits

Galvanic isolation from PSP32: 500VDC

All four outputs share a common ground (isolated from the PSP32).

CURRENT LOOP:

Number: 4 channels

Range: 0-24mA with 24V compliance (does not source current)

Resolution: 10 bits

Galvanic isolation from PSP32: 500VDC

Each channel is separately isolated.

RELAYS:

Number: 4 channels

Contact ratings: 2A, 125VAC max load

Galvanic isolation from PSP32: 500VDC

CONNECTIONS:

VOut 1-4 are accessible via a 5 terminal removable barrier strip (5 outputs and a common ground).

Each ILoop output has its own 2 terminal removable barrier strip.

Each Relay connection has its own 3 terminal removable barrier strip (common, normally open, normally closed).

PUMP UNIT:

PUMPS:

Number: 2 units

Peristaltic pump

Flow rate: adjustable with 0-100mL/Min flow rate

Duration control variable

1/8" ID tubing connections

RELAYS:

Number: 2 channels

Contact ratings: 2A 125VAC max load

Galvanic isolation from PSP32: 500VDC

Each Relay connection has its own 3 terminal removable barrier strip (common, normally open, normally closed).