

PROGRAMMING MANUAL - PLS SERIES

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1 OPERATING MODE

PLS will operate in one of eight modes:

1.0.1 Local

In Local mode, the user controls PLS via the front panel. While in Local mode the user can achieve nearly full capability via the SCPI command interface, EXCEPT for setting operational voltage and current setpoints and activating the output. The SCPI command to deactivate the output will be executed. While in Local mode, the Analog Voltage and Analog Current inputs are ignored.

1.0.2 Remote

In Remote mode, full capability is available over the SCPI command interface. The front panel Voltage and Current rotary controls are disabled and the Enable button is recognized only to enter Setup or to deactivate the output. The Analog Voltage and Analog Current inputs on the Interface board are ignored.

1.0.3 Remote with Lock

Remote with Lock mode is identical to Remote mode, except all front panel capability is disabled. (That is, the Enable button cannot be used either to enter Setup or to deactivate the output.) As in Remote mode, the Analog Voltage and Analog Current inputs on the Interface board are ignored.

1.0.4 Analog Voltage Control

In Analog Voltage Control mode, the output voltage setpoint is provided by the Analog Voltage input to the Interface board. (The current setpoint is set to the most recent Local mode setpoint and cannot be changed.) Limited SCPI command capability is provided. The front panel Voltage and Current rotary controls are disabled and the Output On/Off button is recognized only to enter Setup or to activate/deactivate the output.

1.0.5 Analog Current Control

In Analog Current Control mode, the output current setpoint is provided by the Analog Current input to the Interface board. (The voltage setpoint is set to the most recent Local mode setpoint and cannot be changed.) Limited SCPI command capability is provided. The front panel Voltage and Current rotary controls are disabled and the Output On/Off button is recognized only to enter Setup or to activate/deactivate the output.

1.0.6 Analog Dual Control

In Analog Dual Control mode, the output current setpoint is provided by the Analog Current input to the Interface board and the output voltage setpoint is provided by the Analog Voltage input to the Interface board. Limited SCPI command capability is provided. The front panel Voltage and Current rotary controls are disabled and the Output On/Off button is recognized only to enter Setup or to activate/deactivate the output. Note that in both OFF and ON states, the screen displays the current mode in the upper right corner.

1.0.7 Parallel Mode

In parallel mode the analog output is activated and this output is proportional to the output current of the power supply. When this output voltage is fed to one or more analog inputs of other supplies and the analog inputs of those supplies are set for Analog Current Control the supplies will share current equally.

1.0.8 Series Mode

In series mode the analog output is activated and this output is proportional to the output voltage of the power supply. When this output voltage is fed to one or more analog inputs of other supplies and the analog inputs of those supplies are set for Analog Voltage Control the supplies will match output voltages.

1.0.9 Mode Transitions Commanded from Front Panel

You can enter all modes except Remote with Lock from the front panel.

- Press and hold the Output On/Off button for 5 seconds to enter Setup. Release the Output on/off button and the Control Source selection screen will appear.
- Press the Output On/Off button again. The Select Control Source (Mode) screen will appear, with the current mode displayed (for example, LOCAL).
- Turn either rotary control CW or CCW to select the desired mode and press Output On/Off to select it.
- From the Control Source selection screen, turn either rotary control CW to display the Exit option. Press the Output On/Off button again.
- The Save Config? screen is displayed, with the Yes option. If the newly selected mode is to be stored to non-volatile memory, press Output On/Off. However, if the newly selected mode is desired only temporarily and can be lost when primary power is removed, turn either rotary control CCW to display the No option. Then press the Output On/Off button.

Selecting the No option will not cancel the selection – it will just not store the selection to non-volatile memory. To discard the new selection, the user must return to the Control Source option and re-select the original mode.

1.0.10 Mode Transitions Commanded via Remote SCPI Command

You can enter all modes including Remote with Lock via the SCPI command interface.

SYSTem:MODE:LOCAl	For Local mode
SYSTem:MODE:REMOte	For Remote mode
SYSTem:MODE:RWLock	For Remote with Lock mode
SYSTem:MODE VOLTage	For Analog Voltage Control mode
SYSTem:MODE:CURRent	For Analog Current Control mode
SYSTem:MODE:DUAL	For Analog Dual Control mode

Selecting any of the three Analog modes, you will additionally need to select scaling for the appropriate channel, Analog Voltage, Analog Current, or both. This is done with:

SYSTem:MODE:AScale <VOLT|CURR>,<3|5|10> Set analog channel scaling level

SYSTem:AOUTput:MODE <DISabled|PARAllel|SERies> For parallel/series operation. No scaling is available for the analog output

1.1 LOCAL MODE

In Local Mode, you will control PLS primarily using the front panel controls. However, many SCPI commands are still available – only setting of setpoints and activating the output are disallowed.

When the output is OFF, the set of available commands is:

VOLTage:PROTect <value>	Set voltage protection level (volts)
VOLTage:PROTect?	Query voltage protection level (volts)
CURRent:PROTect <value>	Set current protection level (amps)
CURRent:PROTect?	Query current protection level (amps)
POWer:PROTect <value>	Set power protection level (watts)
POWer:PROTect?	Query power protection level (watts)
OUTPut:AUTO <ON OFF>	Enable/disable the Auto-Start feature
OUTPut:AUTO?	Query present Auto-Start state
SYSTem:CONFIguration:SAVE	Save configuration data to non-volatile memory

When the output is ON, the set of available commands is:

OUTPut?	Query output state
OUTPut OFF	Deactivate output
MEASure:VOLTage?	Measure and return output voltage (volts)
MEASure:CURRent?	Measure and return output current (amps)

Regardless of the output state, you can query Status and Error registers, as described in Section 6.0.

1.2 REMOTE MODE

In Remote Mode, you will control PLS using SCPI commands. You will also have limited control available via the front panel

1.2.1 SCPI Commands

In the following list of available SCPI commands:

OUTPut <ON OFF>	Activate/deactivate output
OUTPut?	Query activation state
VOLTage <value MIN MAX>	Set voltage setpoint (value in volts)
VOLTage?	Query voltage setpoint (volts)
CURRent <value MIN MAX>	Set current setpoint (value in amps)
CURRent?	Query current setpoint (amps)
POWer <value MIN MAX >	Set power setpoint (value in watts)
POWer?	Query current setpoint (watts)
MEASure:VOLTage?	Measure and return output voltage (volts)
MEASure:CURRent?	Measure and return output current (amps)
VOLTage:PROTect <value>	Set voltage protection level (volts)
VOLTage:PROTect?	Query voltage protection level (volts)
CURRent:PROTect <value>	Set current protection level (amps)
CURRent:PROTect?	Query current protection level (amps)
POWer:PROTect <value>	Set power protection level (watts)
POWer:PROTect?	Query power protection level (watts)
OUTPut:AUTOstart <ON OFF>	Enable/disable the Auto-Start feature
OUTPut:AUTOstart?	Query present Auto-Start state
SYSTem:CONFIguration:SAVE	Save configuration data to non-volatile memory

1.2.2 Front Panel Commands

When in Remote Mode, you will have limited control from the front panel. Specifically, the Output On/Off button is available to deactivate the output when the output is ON or to enter System Setup to switch to a different Operating Mode when the output is OFF.

1.2.3 Additional Capabilities

When the output is OFF, you can switch operating modes, as described in Section 1.0.

When the output is OFF, you can configure Remote Sense, as described in Section 2.0.

When the output is OFF, you can execute unit Calibration, as described in Section 3.0.

When the output is ON, you will be able to execute only those commands which disable the output, measure the output voltage and current, and set the voltage or current setpoint. Regardless of the output state, you can query Status and Error registers, as described in Section 6.0.

1.3 REMOTE WITH LOCK MODE

Remote with Lock Mode is identical to Remote Mode, except you will have no control available from the front panel (i.e., it is locked).

Remote with Lock Mode (which cannot be exited from the Front Panel) will not be stored in non-volatile memory. An attempt to do so will replace it with Remote Mode (which can be exited from the Front Panel).

1.4 ANALOG VOLTAGE CONTROL MODE

1.4.1 Voltage Setpoint

When the unit is in Analog Voltage Control Mode, the Analog Voltage channel supplies the Voltage Setpoint.

1.4.1.1 Scaling

You can select 3 volt, 5 volt, or 10 volt scaling for the analog voltage input. This is the value which represents the maximum model-specific voltage. For example, if you have the 400V 2.5A model and have selected the 10V scaling, then 10 volts applied across the Analog Voltage channel will result in a 400 volt setpoint. For the same scaling, 5 volts applied across the Analog Voltage channel will result in a 200 volt setpoint.

If Analog Voltage Control Mode is entered via the front panel, you will be asked to select which scaling you want. You may also select scaling with the SCPI command:
`SYSTem:MODE:ASCale VOLT,<3|5|10>`

1.4.2 Current Setpoint

The Current Setpoint is the last current value set when in Local Mode, and once in Analog Voltage Control Mode, cannot be changed either from the front panel or by a SCPI command.

1.4.3 Activating/Deactivating the Output

You can activate or deactivate the output either from the front panel Output on/off button or by the SCPI command:

`OUTPut <ON|OFF>` Activate/deactivate output

1.4.4 Remote Queries

When the output is ON, you may query the output current and voltage, as well as the output state and voltage and current setpoints using the commands:

MEASure:VOLTage?	Measure and return output voltage (volts)
MEASure:CURRent?	Measure and return output current (amps)
OUTPut?	Query output state
VOLTage?	Query voltage setpoint (volts)
CURRent?	Query current setpoint (amps)
POWer?	Query power setpoint (watts)

Voltage is returned in volts, current in amperes, and power in watts. The output state is either ON or OFF.

1.4.5 Additional SCPI Commands

Regardless of the output state, you can query Status and Error registers, as described in Section 6.0.

1.4.6 Additional Capabilities

When the output is OFF, you can switch operating modes, as described in Section 1.0.

When the output is ON, you will be able to execute only those commands which activate and deactivate the output and measure the output voltage and current.

1.5 ANALOG CURRENT CONTROL MODE

1.5.1 Current Setpoint

When the unit is in Analog Current Control Mode, the Analog Current channel supplies the Current Setpoint.

1.5.1.1 Scaling

You can select 3 volt, 5 volt, or 10 volt scaling for the analog current input. This is the value which represents the maximum model-specific current. For example, if you have the 400V 2.5A model and have selected the 10V scaling, then 10 volts applied across the Analog Current channel will result in a 2.5 amp setpoint. For the same scaling, 5 volts applied across the Analog Current channel will result in a 0.750 amp setpoint.

If Analog Current Control Mode is entered via the front panel, you will be asked to select which scaling you want. You may also select scaling with the SCPI command:

```
SYSTem:MODE:AScale CURRent,<3|5|10>
```

1.5.2 Voltage Setpoint

The Voltage Setpoint is the last voltage value set when in Local Mode, and once in Analog Current Control Mode, cannot be changed either from the front panel or by a SCPI command.

1.5.3 Activating/deactivating the output

You can activate or deactivate the output either from the front panel Output On/Off button or by the SCPI command:

```
OUTPut <ON|OFF>                    Activate/deactivate output
```

1.5.4 Remote Queries

When the output is ON, you may query the output current and voltage, as well as the output state and voltage and current setpoints using the commands:

MEASure:VOLTage?	Measure and return output voltage (volts)
MEASure:CURRent?	Measure and return output current (amps)
OUTPut?	Query output state
VOLTage?	Query voltage setpoint (volts)
CURRent?	Query current setpoint (amps)
POWer?	Query power setpoint (watts)

Voltage is returned in volts, current in amperes, and power in watts. The output state is either ON or OFF.

1.5.5 Additional SCPI Commands

Regardless of the output state, you can query Status and Error registers, as described in Section 6.0.

1.5.6 Additional Capabilities

When the output is OFF, you can switch operating modes, as described in Section 1.0.

When the output is ON, you will be able to execute only those commands which activate and deactivate the output and measure the output voltage and current.

1.6 ANALOG DUAL CONTROL MODE

1.6.1 Voltage Setpoint

When the unit is in Analog Dual Control Mode, the Analog Voltage channel supplies the Voltage Setpoint.

1.6.1.1 Analog Input Scaling

You can select 3 volt, 5 volt, or 10 volt scaling for the analog voltage input. This is the value which represents the maximum model-specific voltage. For example, if you have the 400V 2.5A model and have selected the 10V scaling, then 10 volts applied across the Analog Voltage channel will result in a 400 volt setpoint. For the same scaling, 5 volts applied across the Analog Voltage channel will result in a 200 volt setpoint.

If Analog Voltage Control Mode is entered via the front panel, you will be asked to select which scaling you want. You may also select scaling with the SCPI command: `SYSTem:MODE:AScale VOLTage,<3|5|10>`

1.6.2 Current Setpoint

When the unit is in Analog Dual Control Mode, the Analog Current channel supplies the Current Setpoint.

1.6.2.1 Analog Input Scaling

You can select 3 volt, 5 volt, or 10 volt scaling for the analog current input. This is the value which represents the maximum model-specific current. For example, if you have the 400V 2.5A model and have selected the 10V scaling, then 10 volts applied across the Analog Current channel will result in a 2.5 amp setpoint. For the same scaling, 5 volts applied across the Analog Current channel will result in a 0.750 amp setpoint.

If Analog Current Control Mode is entered via the front panel, you will be asked to select which scaling you want. You may also select scaling with the SCPI command: `SYSTem:MODE:AScale CURR <3|5|10>`

1.6.3 Activating/deactivating the output

You can activate or deactivate the output either from the front panel Output On/Off button or by the SCPI command:

`OUTPut <ON|OFF>` Activate/deactivate output

1.6.4 Remote Queries

When the output is ON, you may query the output current and voltage, as well as the output state and voltage and current setpoints using the commands:

<code>MEASure:VOLTage?</code>	Measure and return output voltage (volts)
<code>MEASure:CURRent?</code>	Measure and return output current (amps)
<code>OUTPut?</code>	Query output state
<code>VOLTage?</code>	Query voltage setpoint (volts)
<code>CURRent?</code>	Query current setpoint (amps)
<code>POWer?</code>	Query power setpoint (watts)

Voltage is returned in volts, current in amperes, and power in watts. The output state is either ON or OFF.

1.6.5 Additional SCPI Commands

Regardless of the output state, you can query Status and Error registers, as described in Section 6.0.

1.6.6 Additional Capabilities

When the output is OFF, you can switch operating modes, as described in Section 1.0.

When the output is ON, you will be able to execute only those commands which activate and deactivate the output and measure the output voltage and current.

2 REMOTE SENSE CONFIGURATION

2.0.1 You can enable or disable the PLS Remote Sense capability and set the lead resistance with the following SCPI commands.

RSENSE	Enable/disable Remote Sense
RSENSE?	Return Remote Sense state
RSENSE:RESistance	Set the remote sense resistance
RSENSE:RESistance?	Return the remote sense resistance

2.0.2 In addition, you can command PLS to calculate the lead resistance by executing the following sequence:

1. Short leads which connect to the load at the load.
2. Execute the command to enable Remote Sense
RSENse ON
3. Execute the command to calculate lead resistance.
RSENse:RESistance:CALCulate <current> Initiates calculation

The <current> value is the current, in amperes, at which the lead resistance is to be calculated and will normally be toward the high end of your application.

If the specified current is greater than the maximum allowed for the PLS model you are using, you will trigger the error: -222, "Data out of range"

4. Execute the command to query the remote sense calculation state.
RSENse:RESistance:CALCulate?

If the calculation is still taking place, PLS will report: CALCULATING

When the calculation is complete, PLS will report: COMPLETE

If the calculated resistance is too large for practical application of remote sensing, PLS will return the error: 181, "Resistance too large"

3 CALIBRATION

You can calibrate PLS over the SCPI command interface. To do so you must execute a series of steps while opening and shorting the output. These steps may be performed via the front panel or via SCPI commands. A calibrated high-accuracy digital multimeter (DMM) and a high accuracy shunt is required to perform calibration.

The sequence of commands is listed below. The sequence must be run to completion. If it is aborted early either by cycling power or exiting Calibration Mode, you must restart the command sequence from the beginning.

3.0.1 Calibration Sequence

- 1 Remove any load from the output terminals and apply the DMM leads to the output terminals. Set the output voltage to a low value (recommend 10% of the rated output voltage) and enable the output. Record the low voltage setpoint.
- 2 Use the DMM to record the actual output voltage of the supply. Record the low voltage measured.
- 3 Set the output voltage to a high value (recommend 90% of the rated output voltage). Record the high voltage setpoint.
- 4 Use the DMM to record the actual output voltage of the supply. Record the high voltage measured.
- 5 Command PLS to perform the voltage calibration based on the recorded values:
CALibration:CALCulate:VOLTage <low voltage setpoint>,<low voltage measured>,<high voltage setpoint>,<high voltage measured> All voltages must be in Volts.
- 6 Disable the output. Let it bleed down to near 0V. Connect the shunt to the output terminals and apply the DMM leads to the shunt terminals. Set the output current to a low value (recommend 10% of the rated output current) and enable the output. Record the low current setpoint.
- 7 Use the DMM to record the actual output current of the supply. This may involve dividing a measured voltage by the known shunt resistance. Record the low current measured.
- 8 Set the output current to a high value (recommend 90% of the rated output current). Record the high current setpoint.
- 9 Use the DMM to record the actual output current of the supply. Record the high current measured. This may involve dividing a measured voltage by the known shunt resistance.
- 10 Command PLS to perform the current calibration based on the recorded values:
CALibration:CALCulate:CURRent <low current setpoint>,<low current measured>,<high current setpoint>,<high current measured> All current must be in Amperes.

4 SELF-TEST

PLS executes Self-Test as part of its power-up sequence. In addition, you may exercise a number of Self-Test options with the following SCPI commands:

*TST?	Execute Self-Test and return the results.
TEST:SELFtest[:EXECute]	same as above
TEST:QUERy?	Return most recent Self-Test results without executing.
TEST:SELFtest:CLE	Clear Self-Test results

5 MISCELLANEOUS COMMANDS

PLS recognizes a number of miscellaneous SCPI commands.

- 5.0.1 *CLS
*CLS clears the Event registers of the Questionable Status, Operation Status, Temperature Status, and Hardware Status Register structures, in addition to the Error/Event Queue.
- 5.0.2 *IDN?
*IDN? returns the identification string for this unit. The string will contain, separated by commas: 1) the company name, Versatile Power; 2) the model; 3) the serial numbers of the main and interface boards; and 4) the software revision number for the main and interface board processors. For example, a 100V 10A model may, in response to *IDN?, return: "Versatile Power,Bench 100-10 XR,031418032001,1.00.0051/1.00.1361"
- 5.0.3 *RST
*RST executes a soft reset of the system. The output is deactivated, all error Conditions are cleared (however, error Events are not), and the unit is returned to its Output Off state. The operating mode is not changed.
- 5.0.4 SYSTem:PROMpt <ON|OFF>
If you are interacting directly with PLS and would like to have a prompt, SYSTem:PROMpt enables (ON) or disables (OFF) the SCPI prompt. The prompt is OFF by default. The prompt is a newline (0x0A) character.

6 STATUS AND ERRORS

6.0.1 Architecture

Figure 1 shows the Overall Status Architecture. Each section will then be discussed in greater detail.

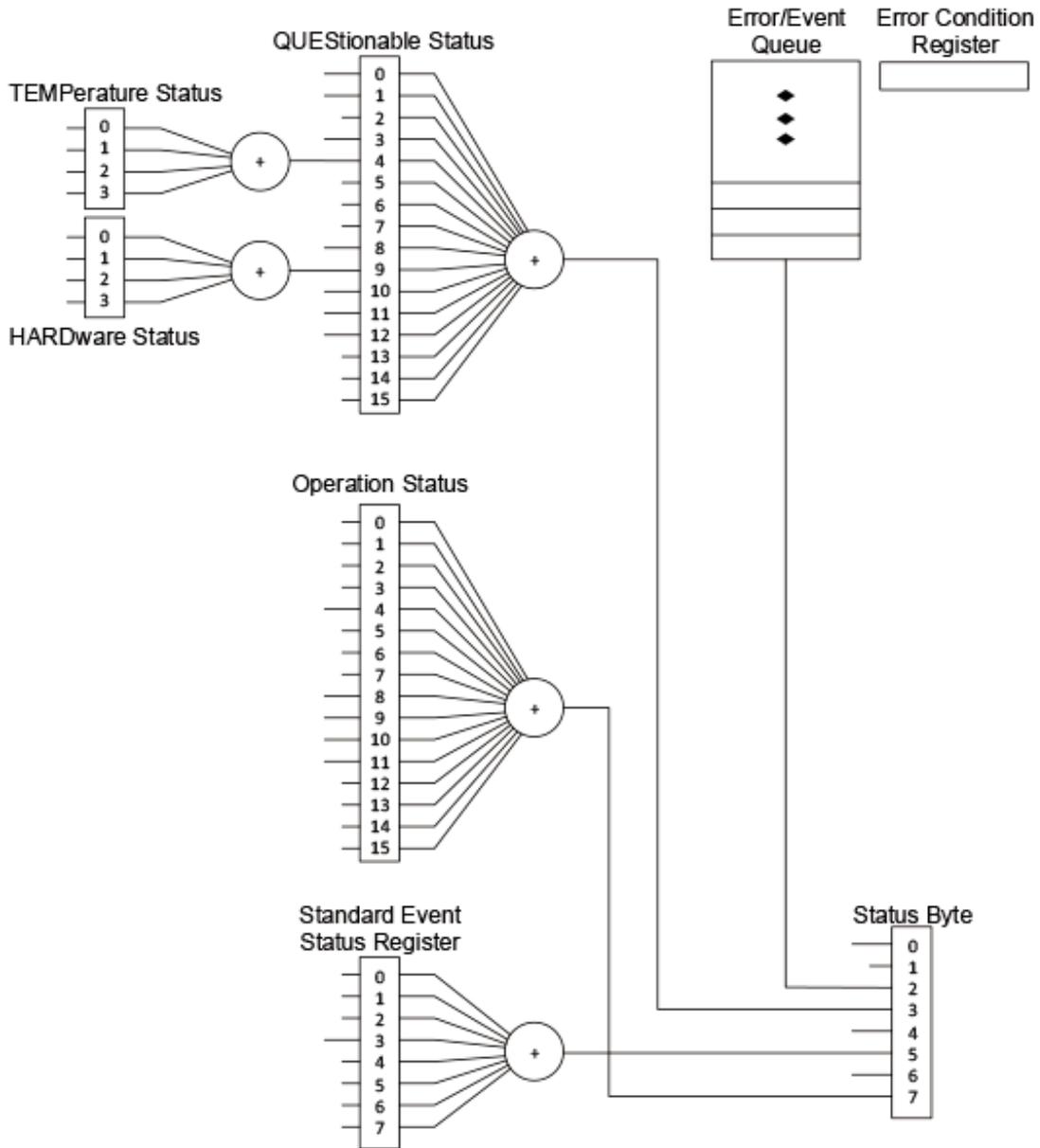


Figure 1. Overall Status Architecture

Questionable Status Register

Figure 2 shows the Questionable Status Register.

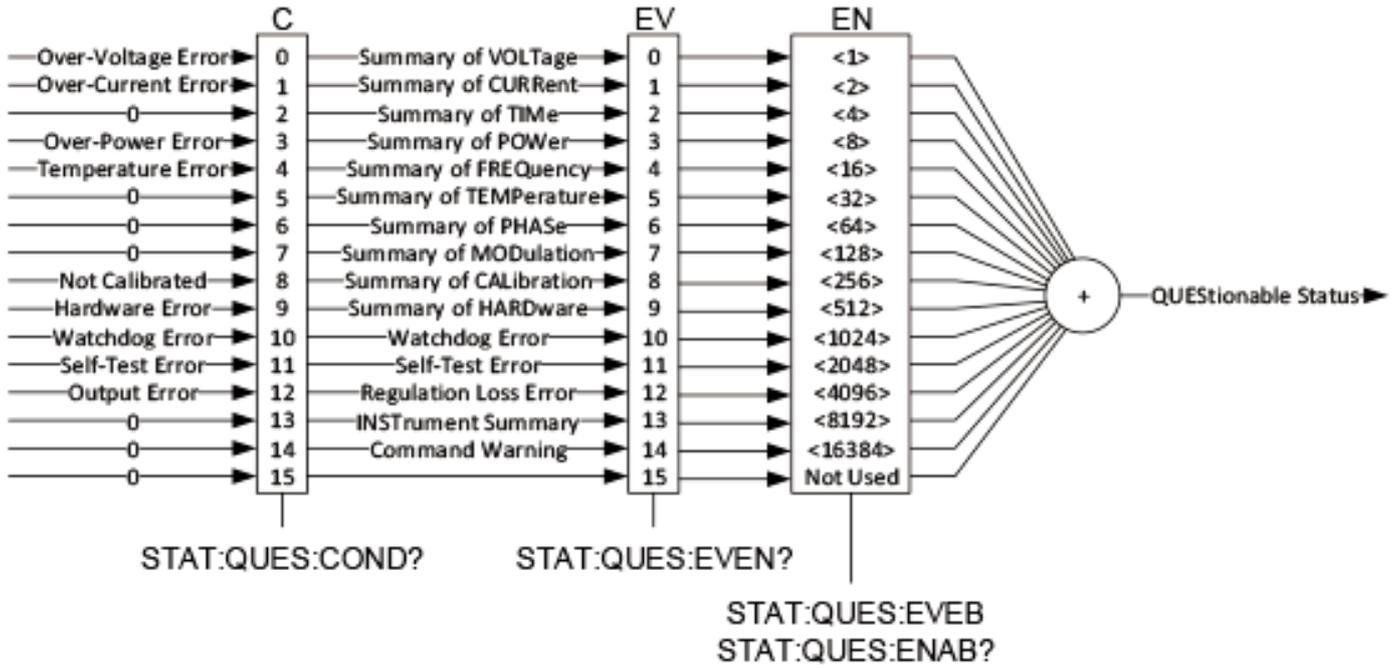


Figure 2. Questionable Status Register

The Questionable Status Register takes the standard SCPI structure. The seven individual condition inputs are:

- 6.0.1.1 Over-Voltage Error. When activated, the unit has exceeded the Over-Voltage Protection limit.
- 6.0.1.2 Over-Current Error. When activated, the unit has exceeded the Over-Current Protection limit.
- 6.0.1.3 Over-Power Error. When activated, the unit has exceeded the Over-Power Protection limit.
- 6.0.1.4 Not Calibrated. The unit is not calibrated.
- 6.0.1.5 Watchdog Error. A watchdog timeout has occurred and the processor has restarted itself.
- 6.0.1.6 Self-Test Error. A self-test error has occurred. Self-test is run automatically at power-up and can additionally be commanded remotely.

6.0.1.7 Output Error

Regulation of the output has been lost.

6.0.1.8 SCPI Access

Access to the Questionable Status Register is via the following commands:

STATus:QUEStionable[:EVENT]?	Rtn Event register
STATus:QUEStionable:CONDition?	Rtn Condition register
STATus:QUEStionable:ENABle <value>	Set Enable register
STATus:QUEStionable:ENABle?	Rtn Enable register

6.0.2 Questionable Status Fan-Out Registers

In addition, there are two fan-out structures feeding the Temperature Error and Hardware Error inputs.

6.0.2.1 Temperature Status Register

Figure 3 shows the Temperature Status Register. It also takes the standard SCPI structure.

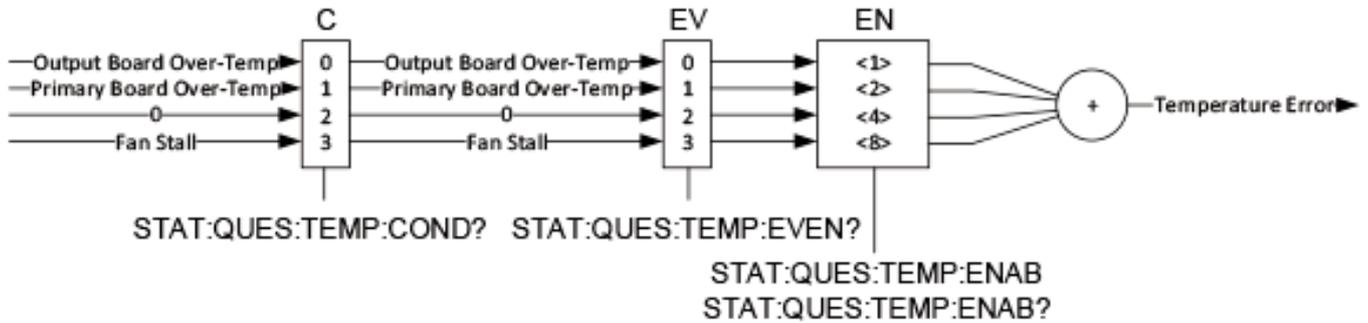


Figure 3. Temperature Status Register

The Temperature Status Register two individual condition inputs are:

- 6.0.2.1.1 Output Board Over-Temperature. The output board temperature surpasses its allowed operating limit.
- 6.0.2.1.2 Primary Board Over-Temperature. The primary board temperature surpasses its allowed operating limit.
- 6.0.2.1.3 Fan Stall. The cooling fan is non-operative.

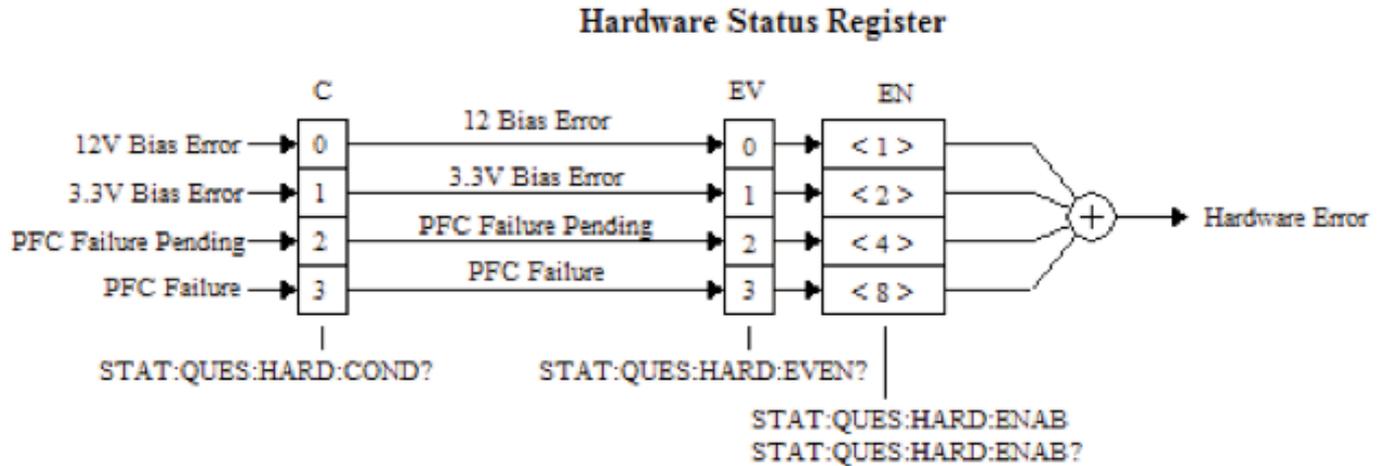
6.0.2.1.4 SCPI Access

Access to the Temperature Status Register is via the following commands:

STATus:QUEStionable:TEMPerature[:EVENT]?	Rtn Event register
STATus:QUEStionable:TEMPerature:CONDition?	Rtn Condition register
STATus:QUEStionable:TEMPerature:ENABLe <value>	Set Enable register
STATus:QUEStionable:TEMPerature:ENABLe?	Rtn Enable register

6.0.2.2 Hardware Status Register

Figure 4 shows the Temperature Status Register. It also takes the standard SCPI structure.



The Hardware Status Register four individual condition inputs are:

6.0.2.2.1 12V Bias Error. The internal 12V bias is either too low or too high for valid operation.

6.0.2.2.2 3.3V Bias Error. The internal 3.3V bias is either too low or too high for valid operation.

6.0.2.2.3 PFC Failure Pending. The unit's PFC supply has either failed or primary power has been removed.

6.0.2.2.4 PFC Failure. The unit's PFC supply has failed.

6.0.2.2.5 SCPI Access

Access to the Temperature Status Register is via the following commands:

<code>STATus:QUESTIONable:HARDware[:EVENT]?</code>	Rtn Event register
<code>STATus:QUESTIONable:HARDware:CONDition?</code>	Rtn Condition register
<code>STATus:QUESTIONable:HARDware:ENABLE <value></code>	Set Enable register
<code>STATus:QUESTIONable:HARDware:ENABLE?</code>	Rtn Enable register

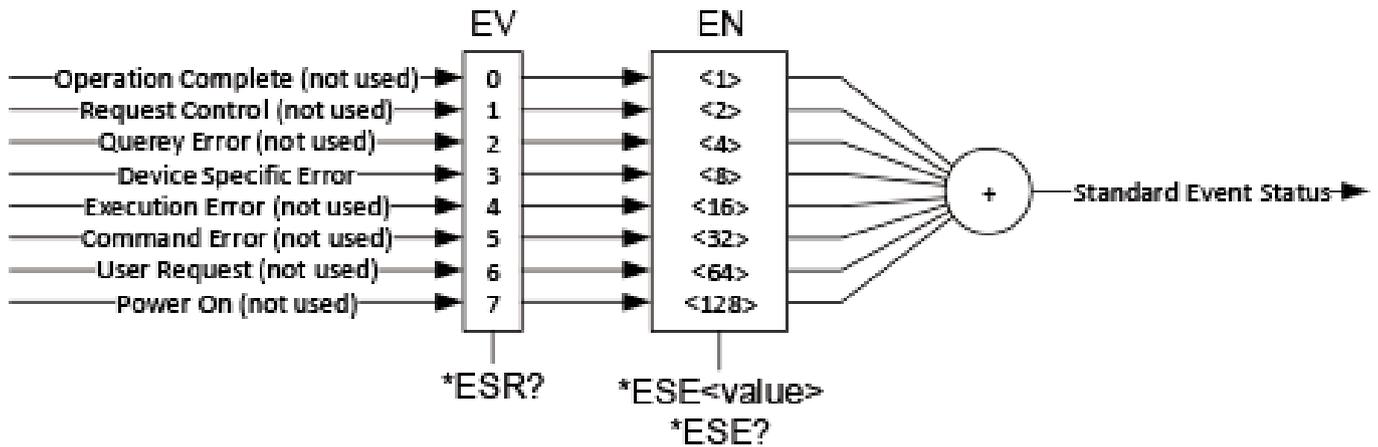
6.0.3.6 SCPI Access

Access to the Operation Status Register is via the following commands:

STATus:OPERation[:EVENT]?	Rtn Event register
STATus:OPERation:CONDition?	Rtn Condition register
STATus:OPERation:ENABle <value>	Set Enable register
STATus:OPERation:ENABle?	Rtn Enable register

6.0.4 Standard Event Status Register

Figure 6 shows the Standard Event Status Register.



The Standard Event Status Register takes the standard SCPI structure. The eight individual condition inputs are:

6.0.4.1 Operation Complete

This bit is not used by PLS.

6.0.4.2 Request Control

This bit is not used by PLS.

6.0.4.3 Query Error

This bit is not used by PLS.

6.0.4.4 Device Specific Error

This bit is set if a Device Specific Error occurs. These include all Questionable Register events and Error Queue Overflow.

6.0.4.5 Execution Error

This bit is not used by PLS.

6.0.4.6 Command Error

This bit is not used by PLS.

6.0.4.7 User Request

This bit is not used by PLS.

6.0.4.8 Power On

This bit is not used by PLS.

6.0.4.9 SCPI Access

Access to the Standard Event Status Register is via the following commands:

*ESR?	Rtn Event register
*ESE <value>	Set Enable register
*ESE?	Rtn Enable register
6.0.5	Error/Event Queue

The Error/Event Queue buffers the occurrence of Errors in a FIFO queue. The queue will store up to eight Errors.

6.0.5.1 Errors

The Errors recognized by PLS, identified by their error code and text string, are:

-100	"Command error"	111	"Output board over temperature"
-101	"Invalid character"	112	"Primary board temperature error"
-104	"Data type error"	113	"Transformer temperature error"
-113	"Undefined header"	114	"Fan stall error"
-115	"Unexpected number of parameters"	121	"PWM activation failure"
-120	"Numeric data error"	122	"Output error"
-123	"Exponent too large"	131	"12V bias error"
-131	"Invalid suffix"	132	"3.3V bias error"
-134	"Suffix too long"	141	"PFC failure pending"
-200	"Execution error"	142	"PFC failure error"
-201	"Invalid while in local"	151	"Watchdog error"
-221	"Settings conflict"	161	"Self-test error"
-222	"Data out of range"	171	"Unit not calibrated"
-234	"Insufficient data"	172	"Mode change not allowed"
-350	"Queue overflow"	173	"Configuration save not allowed"
101	"Over current"	181	"Resistance too large"
102	"Over voltage"	182	"Previous sample active"
103	"Over power"	1000	"Unknown error(s)"

6.0.5.2 SCPI Access

Access to the Error/Event Queue is via the following commands:

SYSTem:ERRor[:NEXT]? Return the next queue entry
SYSTem:ERRor:COUnT? Return the present number of queue entries
SYSTem:ERRor:CLear Clear the queue

6.0.6 Error Condition Register

Associated with the Error/Event Queue is a 16-bit Error Condition Register. It contains the present state of a number of sensed error conditions.

6.0.6.1 Error Conditions

The Error Conditions recognized by PLS, identified by their error code are listed below. If multiple error conditions are present, the register will contain the sum of the individual error values.

1	Over-current condition
2	Over-voltage condition
4	Over-power condition
8	Output board over-temperature condition
16	Fan stall condition
32	Output (loss of regulation) error condition
64	12V bias error condition
128	3.3V bias error condition
256	Primary (input) board temperature error condition
512	PFC failure condition
1024	Watchdog condition
2048	Self-test error condition
32,768	PFC failure pending condition
6.0.6.2	SCPI Access

To view the Error Condition Register, use the SCPI command: SYSTem:ERRor:CONDition?
Return the error condition register

6.0.7 Status Byte Register and Service Request Enable Register

Figure 7 shows the Status Byte Register and the Service Request Enable Register.

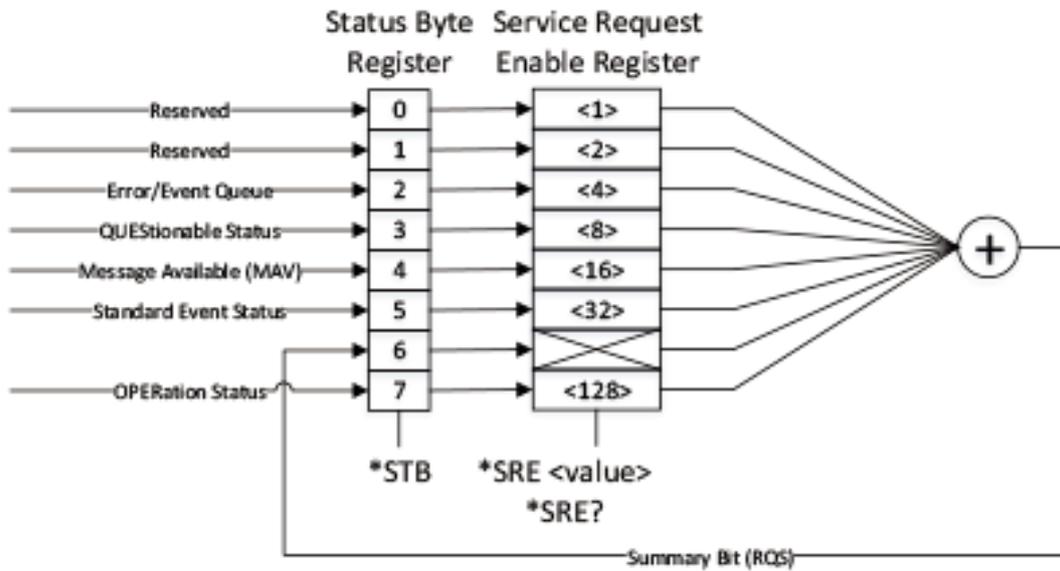


Figure 7. Status Byte Register

The six individual condition inputs of the Status Byte Register are:

6.0.7.1 Error/Event Queue

When the Error/Event Queue contains one or more entries, this bit will be set.

6.0.7.2 Questionable Status

If a Questionable Event has occurred and is enabled to feed the Status Byte Register, this bit will be set.

6.0.7.3 Message Available (MAV)

As PLS does not initiate any message, this bit is not used.

6.0.7.4 Standard Event Status

If a Standard Event has occurred and is enabled to feed the Status Byte Register, this bit will be set.

6.0.7.5 Summary Bit (RQS)

Any of the four functioning bits of the Status Byte Register being set and enabled (in the Service Request Enable Register) will cause this bit to be set.

6.0.7.6 Operation Status

If an Operation Event has occurred and is enabled to feed the Status Byte Register, this bit will be set.

6.0.7.7 SCPI Access

Access to the Status Byte Register is via:

*STB? Rtn register

Access to the Service Request Enable Register is via:

*SRE <value> Set register

*SRE? Rtn register

7 DRIVERS

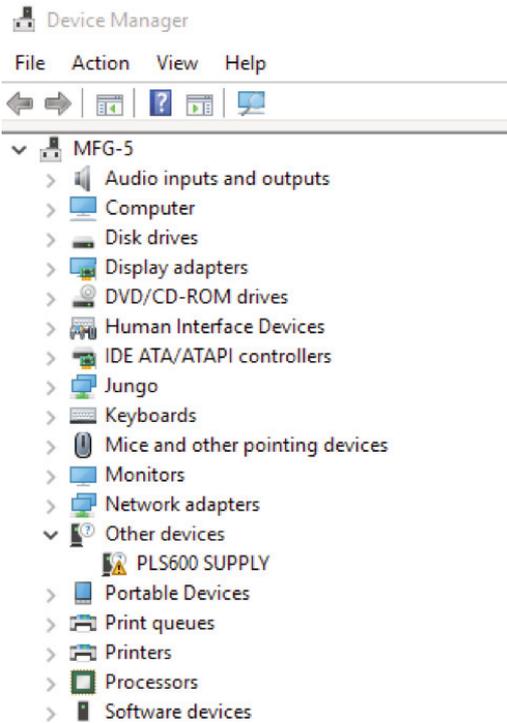
7.1.1 USB Drivers

USB drivers are available on the XP Power website <https://xppower.com>
Download and extract the PLS USB driver to your local drive. The extraction location will be required in later steps.

The standard USB input is a USB 2.0 full speed compatible USB port.

To install the USB drivers first make sure the unit is powered on and the PLS supply is connected to the computer's USB port.

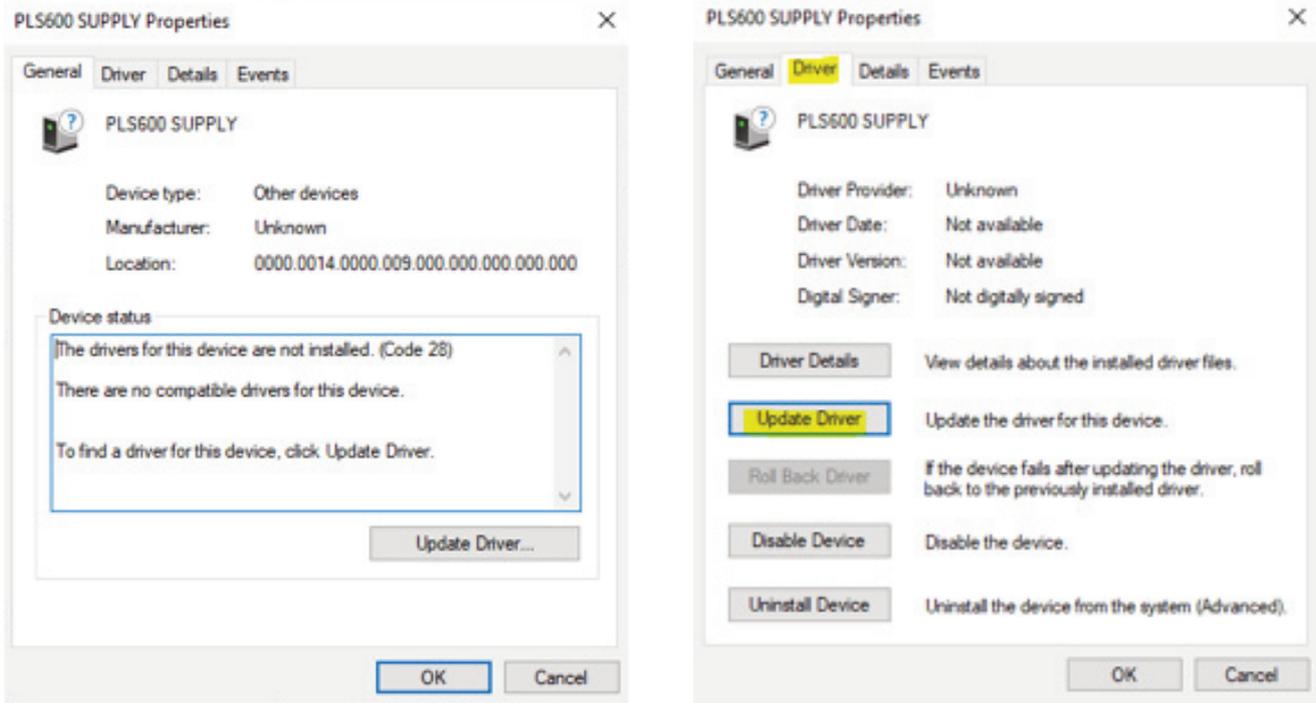
Open device manager and locate the PLS SUPPLY under other devices.



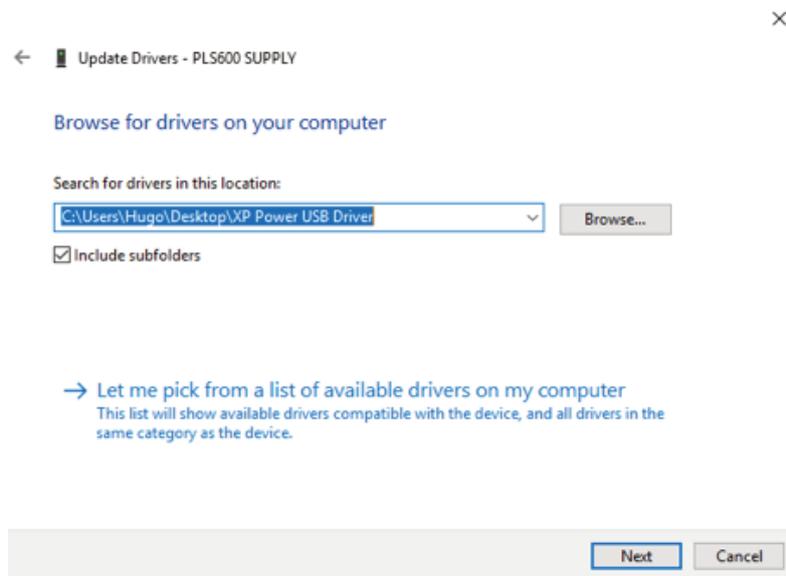
7 DRIVERS

7.1.1 USB Drivers

Right click on the PLS SUPPLY and select properties. On the driver tab, select Update Driver:



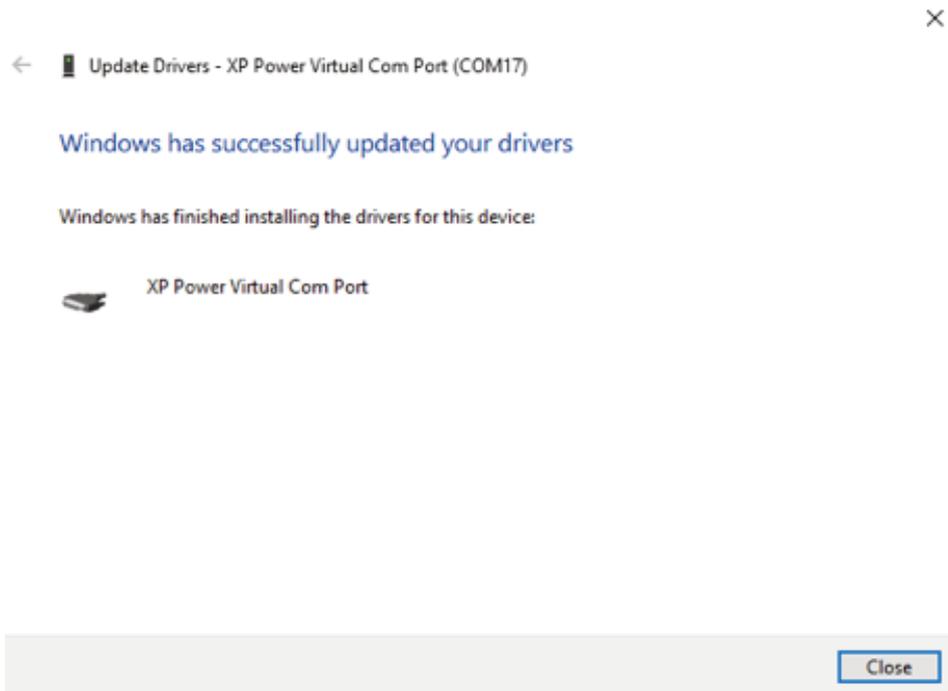
Click Browse to locate where the PLS supply USB drive was extracted to and click next.



7 DRIVERS

7.1.1 USB Drivers

Once the driver has been successfully installed, windows will verify the installation and the PLS Supply can now be accessed through the USB communication.



7 DRIVERS

7.1.2 IVI Drivers

7.1.2.1 To improve users experience when they combine drivers and other software from various vendors, it is important to have some key software components common to all implementations. In order to accomplish this, the IVI Foundation provides a standard set of shared components that must be used by all the compliant drivers and ancillary software. These components provide services to drivers and driver clients that need to be common to all drivers, for instance, the administration of system-wide configuration. These software components may be found at: http://www.ivifoundation.org/shared_components/

Use the descriptions on the IVI foundation page referenced above to choose the components necessary for your installation. Note that both the IVI and IVI.net components must both be installed.

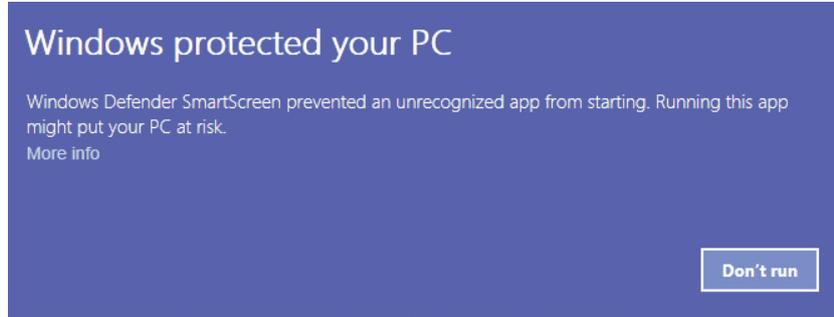
7.1.2.2 Next the National Instruments NI-VISA component must be installed. This component can be found at <https://www.ni.com/en-us/support/downloads/drivers/download.ni-visa.html#305862>. Choose and install the appropriate version for your OS.

7.1.2.3 Finally, the XP Power specific drivers must be installed. LXI-compliant IVI-C and LXI-compliant IVI.NET drivers are available on the XP Power website at <https://xppower.com>. These drivers will act as a programmers API to the PLS power supply.

7 DRIVERS

7.1.2 IVI Drivers

7.1.2.4 When installing the XP Power specific drivers, you may be prompted with the below warning. If this occurs, select Run Anyway,



7.1.2.5 After installing the XP Power drivers, additional documentation may be found in your local drive in the folder:
C:\ProgramData\Microsoft\Windows\StartMenu\Programs\XPPower\XPPowerDC

7.1.3 LabVIEW Drivers

7.1.3.1 Prior to installing the LabVIEW drivers, LabVIEW itself must be installed on your machine.

7.1.3.2 Once LabVIEW is installed, to install the XP Power LabVIEW drivers, download them from the National Instruments website, then unzip the files and copy to your local directory: C:\Program Files (x86)\National Instruments\LabVIEW 2016\instr.lib

Note that your version of LabVIEW may be different than the example shown and so the “2016” may change.

APPENDIX

SCPI Commands

***CLS** — This command clears the following registers:

- The Standard Event Status Register
- The Event register of the Questionable Status Register structure.
- The Event register of the Operation Status Register structure.
- The Event register of the Temperature Status Register (a part of the Questionable Status Register structure).
- The Event register of the Hardware Status Register (a part of the Questionable Status Register structure).
- The Error/Event Queue.

***ESE <value>** — This command sets the Standard Event Status Enable Register to the specified value. The value is specified in decimal form with the following value assignments:

- 1 Operation Complete
- 2 Request Control (not used)
- 4 Query Error (not used)
- 8 Device-Specific Error – Set for:
 - Calibration Error
 - Error Queue Overflow
 - Hardware Error
 - 12V Bias Error
 - 3.3V Bias Error
 - PFC Failure Pending
 - PFC Failure
 - Output Error
 - Over-Voltage Condition
 - Over-Current Condition
 - Over-Power Condition
 - Self-Test Error
 - Temperature Error
 - Output Board Over-Temperature
 - Primary Board Over-Temperature
 - Fan stall
 - Watchdog Error
- 16 Execution Error (not used)
- 32 Command Error (not used)
- 64 User Request (not used)
- 128 Power On (not used)

The command ***ESE 0** clears this register.

***ESE?** — Returns the present contents of the Standard Event Status Enable Register. The contents are described in the description of *ESE. If multiple bits are set, the result is the sum of the set bit values.

***ESR?** — Returns the present contents of the Standard Event Status Event Register.

***IDN?** — Returns the identification string for this unit. The string will contain:

- Company name – “Versatile Power”
- Model – For example “Bench 100-10 XR”
- Unit serial number. For example, “031418032001”.
- Control/Interface processor software revisions. For example, “1.00.0051/1.00.1361”.

Fields are separated by commas. Serial numbers and software revisions are separated by forward slashes.

***OPC** — This command triggers the Operation Complete Flag in the Standard Event Status Event Register.

***OPC?** — This command responds with an indication of whether the current operation is complete. Because this unit does not support concurrent command execution, this command will always return the value 1.

***RST** — This command executes a soft reset of the system. The output is deactivated, all error Conditions are cleared (however, error Events are not), and the unit is returned to its Output Off state. The operating mode (e.g., LOC or REM) is not changed.

***SRE <value>**

This command sets the Service Request Enable Register to the specified value. The value is specified in decimal form with the following value assignments:

- | | |
|-----|------------------------------|
| 1 | Reserved (not used) |
| 2 | Reserved (not used) |
| 4 | Error/Event Queue |
| 8 | Questionable Status |
| 16 | Message Available (not used) |
| 32 | Standard Event Status |
| 64 | Not user settable |
| 128 | Operation Status |

The command *SRE 0 clears this register.

***SRE?**

This command returns the present contents of the Service Request Enable Register. The contents are described in the description of *SRE. If multiple bits are set, the result is the sum of the set bit values.

***STB?**

This command returns the present contents of the Status Byte Register. If multiple bits are set, the result is the sum of the set bit values.

- | | |
|-----|------------------------------|
| 1 | Reserved (not used) |
| 2 | Reserved (not used) |
| 4 | Error/Event Queue |
| 8 | Questionable Status |
| 16 | Message Available (not used) |
| 32 | Standard Event Status |
| 64 | Summary Bit (RQS) |
| 128 | Operation Status |

***TST?**

This command processes the Self-Test command, executing the unit self-test and returning the results. This command is identical to the command “TEST:SELFtest[:EXECUT]” The returned results are:

0	No self-test error
1	Output Voltage/Current ADC failed

*WAI — Because no concurrent command execution is allowed, the command performs no function.

CALibration:CALCulate:CURRENT:PARAMeters <setpoint1>,<measured1>,<setpoint2>,<measured2>

This command uses the four parameters provided to compute slope/offset calibration parameters for current control.

CALibration:CALCulate:VOLTage:PARAMeters <setpoint1>,<measured1>,<setpoint2>,<measured2>

This command uses the four parameters provided to compute slope/offset calibration parameters for voltage control.

MEASure[:SCALAR]:CURRENT[:DC]?

This command returns the most recently measured output current. Output current is measured and buffered every 100 msecs. The returned value is in amperes.

MEASure[:SCALAR]:VOLTage[:DC]?

This command returns the most recently measured output voltage. Output voltage is measured and buffered every 100 msecs. The returned value is in volts.

OUTPut:AUTOstart <ON|OFF>

This command sets the configuration auto-start flag either ON or OFF.

Note: This flag determines whether or not the unit automatically activates its output at power-up. This command sets or clears the flag in volatile memory. For the modified flag to be valid after cycling primary power, it must first be additionally stored to non-volatile memory, which is done with the SYSTem:CONFIguration:SAVE command.

OUTPut:AUTOstart?

This command returns the present configuration auto-start flag. The returned value will be either ON or OFF.

OUTPut[:STATe] <ON|OFF>

This command activates (ON) or deactivates (OFF) the unit output.

OUTPut[:STATe]?

This command returns the present output activation state, ON or OFF.

RSENse <ON|OFF>

This command enables (ON) and disables (OFF) remote Remote Sense mode. It must be executed with ON before any further remote sense commands can be execution (except for queries).

RSENse?

This command returns the present remote Remote Sense mode, ON or OFF.

RSENse:RESistance <ohms>

Sets the remote sense resistance directly (as opposed to running current through a lead and calculating it)

RSENse:RESistance?

Returns the remote sense resistance in ohms.

RSENse:RESistance:CALCulate <current>

This command initiates calculation of the Remote Sense lead resistance at the specified load current. The current is specified in amperes.

RSENse:RESistance:CALCulate?

This command queries the Remote Sense calculation status. The response is:

- DORMANT – No calculation is active.
- CALCULATING – A calculation is currently active.
- COMPLETE – Most recent calculation is complete. This query returns the state to Dormant.

[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude] <MIN|MAX| value>

This command sets the Current setpoint as specified. The setpoint can be set to MIN (0.0 amperes), MAX (model-specific maximum current), or a specified value, in amperes. DEF is accepted but ignored.

[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]?

This command returns the present Current setpoint, in amperes.

[SOURce:]CURRent:PROTection[:LEVel] <value>

This command sets the over-current protection threshold to value, which is specified in amperes. Note: If storage of this threshold to non-volatile memory is desired, SYStem:CONFIguration:SAVE must also be executed.

[SOURce:]CURRent:PROTection[:LEVel]?

This command returns the present over-current protection threshold, in amperes.

[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude] <MIN|MAX|value>

This command sets the Power setpoint as specified. The setpoint can be set to MIN (0.0 watts), MAX (model-specific maximum power), or a specified value, in watts.

[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude]?

This command returns the present Power setpoint, in watts.

[SOURce:]POWer:PROTection[:LEVel] <value>

This command sets the over-power protection threshold to value, which is specified in watts. Note: If storage of this threshold to non-volatile memory is desired, SYStem:CONFIguration:SAVE must also be executed.

[SOURce:]POWer:PROTection[:LEVel]?

This command returns the present over-power protection threshold, in watts.

[SOURce:]VOLTagE[:LEVel][:IMMediate][:AMPLitude] <MIN|MAX| value>

This command sets the Voltage setpoint as specified. The setpoint can be set to MIN (0.0 volts), MAX (model-specific maximum voltage), or a specified value, in volts. DEF is accepted but ignored.

[SOURce:]VOLTagE[:LEVel][:IMMediate][:AMPLitude]?

This command returns the present Voltage setpoint, in volts.

[SOURce:]VOLTagE:PROTection[:LEVel] <value>

This command sets the over-voltage protection threshold to value, which is specified in volts. Note: If storage of this threshold to non-volatile memory is desired, SYStem:CONFIguration:SAVE must also be executed.

[SOURce:]VOLTagE:PROTection[:LEVel]?

This command returns the present over-voltage protection threshold, in volts.

STATus:OPERation:CONDition?

This command returns the present contents of the Operation Status Condition Register. If multiple bits are set, the result is the sum of the set bit values.

1	Calibrating (not used)
2	Setting (not used)
4	Ranging (not used)
8	Sweeping (not used)
16	Measuring
32	Waiting for Trigger (not used)
64	Waiting for Armed (not used)
128	Correcting (not used)
256	Output Activated
512	Constant Voltage mode
1024	Constant Current mode
2048	Constant Power mode
4096	Not used
8192	Instrument Summary Bit (not used)
16384	Program running (not used)

STATus:OPERation:ENABLE <value>

This command sets the Operation Status Enable Register to the specified value. The value is specified in decimal form described in the description of “STATus:OPERation:CONDition?”. A value 0 clears all Enables.

STATus:OPERation:ENABLE?

This command returns the Operation Status Enable Register contents. The returned value is in decimal form described in the description of “STATus:OPERation:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:OPERation[:EVENT]?

This command returns the Operation Status Event Register contents. The returned value is in decimal form described in the description of “STATus:OPERation:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:PRESet

Set the Enable Registers for Operation Status, Questionable Status, Temperature Status, and Hardware Status to their default values. (Default value of all four Enable Registers is zero.)

STATus:QUESTionable:CONDition?

This command returns the present contents of the Questionable Status Condition Register. If multiple bits are set, the result is the sum of the set bit values.

1	Over-Voltage Error
2	Over-Current Error
4	Summary of Time (not used)
8	Over-Power Error
16	Summary of Temperature
32	Summary of Frequency (not used)
64	Summary of Phase (not used)
128	Summary of Modulation (not used)
256	Not Calibrated
512	Summary of Hardware
1024	Watchdog Error
2048	Self-Test Error
4096	Output Error
8192	Instrument Summary Bit (not used)
16384	Command Warning (not used)

STATus:QUESTIONable:ENABLE <value>

This command sets the Questionable Status Enable Register to the specified value. The value is specified in decimal form described in the description of “STATus:QUESTIONable:CONDition?”. A value 0 clears all Enables.

STATus:QUESTIONable:ENABLE?

This command returns the Questionable Status Enable Register contents. The returned value is in decimal form described in the description of “STATus:QUESTIONable:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:QUESTIONable[:EVENT]?

This command returns the Questionable Status Event Register contents. The returned value is in decimal form described in the description of “STATus:QUESTIONable:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:QUESTIONable:HARDware:CONDition?

Return the present contents of the Questionable Status Hardware Condition Register. If multiple bits are set, the result is the sum of the set bit values.

1	12V Bias Error
2	3.3V Bias Error
4	PFC Failure Pending
8	PFC Failure

STATus:QUESTIONable:HARDware:ENABLE <value>

This command sets the Questionable Status Hardware Enable Register to the specified value. The value is specified in decimal form described in the description of “STATus:QUESTIONable:HARDware:CONDition?”. A value 0 clears all Enables.

STATus:QUESTIONable:HARDware:ENABLE

This command returns the Questionable Status Hardware Enable Register contents. The returned value is in decimal form described in the description of “STATus:QUESTIONable:HARDware:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:QUESTIONable:HARDware[:EVENT]?

This command returns the Questionable Status Hardware Event Register contents. The returned value is in decimal form described in the description of “STATus:QUESTIONable:HARDware:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:QUESTIONable:TEMPerature:CONDition?

This command returns the present contents of the Questionable Status Temperature Condition Register. If multiple bits are set, the result is the sum of the set bit values.

1	Output Board Over-Temperature Error
2	Primary Board Over-Temperature Error
4	Fan stall Error

STATus:QUESTionable:TEMPerature:ENABLE <value>

This command sets the Questionable Status Temperature Enable Register to the specified value. The value is specified in decimal form described in the description of “STATus:QUESTionable:TEMPerature:CONDition?”. A value 0 clears all Enables.

STATus:QUESTionable:TEMPerature:ENABLE?

This command returns the Questionable Status Temperature Enable Register contents. The returned value is in decimal form described in the description of “STATus:QUESTionable:TEMPerature:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

STATus:QUESTionable:TEMPerature[:EVENT]?

This command returns the Questionable Status Temperature Event Register contents. The returned value is in decimal form described in the description of “STATus:QUESTionable:TEMPerature:CONDition?”. If multiple bits are set, the result is the sum of the set bit values.

SYSTem:AOUTput:MODE <DISabled|PARAllel|SERies>

This command controls the function of the analog output of the power supply to facilitate series or parallel operation. In parallel mode the analog output is proportional to the output current of the power supply, in series mode the analog output is proportional to the output voltage of the power supply.

SYSTem:AOUTput:Mode?

This command returns the current state of the analog output of the power supply.

SYSTem:CAPability?

Display the unit capability string. For PLS, the string (DCPSUPPLY WITH MEASURE) is returned.

SYSTem:CONFiguration:SAVE

This command saves configuration parameters to non-volatile memory. Contents consist of:

- Analog current scaling select (3V/5V/10V)
- Analog current calibration slopes
- Analog voltage scaling select (3V/5V/10V)
- Analog voltage calibration slopes
- Auto-start (Enabled/Disabled)
- Calibrated flag (Calibrated/Not Calibrated)
- Control source (Local/Remote/Remote with Lock/Analog Voltage Control/Analog Current Control/Analog Dual Control)
- Conversion current user slope and offset
- Conversion current factory slope and offset
- Conversion voltage user slope and offset
- Conversion voltage factory slope and offset
- Model
- Over-current protection level
- Over-power protection level
- Over-voltage protection level
- Power setpoint
- Remote sense (Enabled/Disabled)
- Remote sense lead resistance
- Master mode
- Unit serial number
- LAN configuration

This command can be executed from any of the six operating modes (Local, Remote, Remote with Lock, Analog Voltage Control, Analog Current Control, or Analog Dual Control), but only when the output is deactivated.

SYSTem:IFC:IPAddress? – This command returns the IP address of the power supply.

SYSTem:MODE <LOCa|REMote|RWLock|VOLTage|CURRent|DUAL>

This command sets Control Source to the specified value.

- **LOCa** – Local. Control is from the front panel, with limited SCPI command interface capability.
- **REMote** – Remote. Control is over the SCPI command interface, with limited front panel capability.
- **RWLock** – Remote with Lock. Control is over the SCPI command interface, with no front panel capability.
- **VOLTage** – Analog Voltage Control. The voltage setpoint is determined by the Analog Voltage input. SCPI commands provide the rest of the control, with limited front panel capability.
- **CURRent** – Analog Current Control. The current setpoint is determined by the Analog Current input. SCPI commands provide the rest of the control, with limited front panel capability.
- **DUAL** – Analog Dual Control. The voltage setpoint is determined by the Analog Voltage input. The current setpoint is determined by the Analog Current input. SCPI commands provide the rest of the control, with limited front panel capability.

SYSTem MODE?

This command returns the presently selected Control Source.

SYSTem:MODE:ASCaLe <VOLTage|CURRent>,<3|5|10>

This command sets the specified analog channel (voltage or current) to the specified scaling level (3volt, 5 volt, or 10 volt).

SYSTem:MODE:ASCaLe?

This command returns the presently selected scaling level of the specified analog channel (voltage or current).

SYSTem:ERRor:CLEAr

This command clears the Error/Event Queue.

SYSTem:ERRor:CONDition?

This command returns the present Error Conditions state. Contents consist of:

1	Over-Current Error
2	Over-Voltage Error
4	Over-Power Error
8	Output Board Over-Temperature Error
16	Fan Stall Error
32	Output (loss of regulation) Error
64	12V Bias Error
128	3.3V Bias Error
256	Primary (input) Board Temperature Error
512	PFC Failure
1024	Watchdog Error
2048	Self-Test Error
32768	PFC Failure Pending

If multiple bits are set, the result is the sum of the set bit values.

SYSTem:ERRor:COUNT?

This command returns the number of Errors/Events in the Errors/Events Queue.

SYSTem:ERRor[:NEXT]?

This command returns the next Error/Event in the Errors/Events Queue. This results in both the Error number and text string being returned.

SYSTem:PROMpt <ON|OFF>

This command enables (ON) or disables (OFF) the SCPI prompt. The prompt is a newline (0x0A) character.

SYSTem:VERSion?

This command returns the version of the SCPI specification which is supported. For PLS, the string 1999.0 is returned.

TEST:SELFtest:CLE

This command clears Self-Test results.

TEST:SELFtest[:EXECute] or *TST?

Execute Self-Test

These commands execute Self-Test and return the Self-Test results. The commands are identical in function. The returned results are:

0	No error
1	Output Voltage/Current ADC failed

TEST:SELFtest:QUERy?

This command returns the Self-Test results without executing Self-Test. The returned results are those described for "TEST:SELFtest[:EXECute]?".