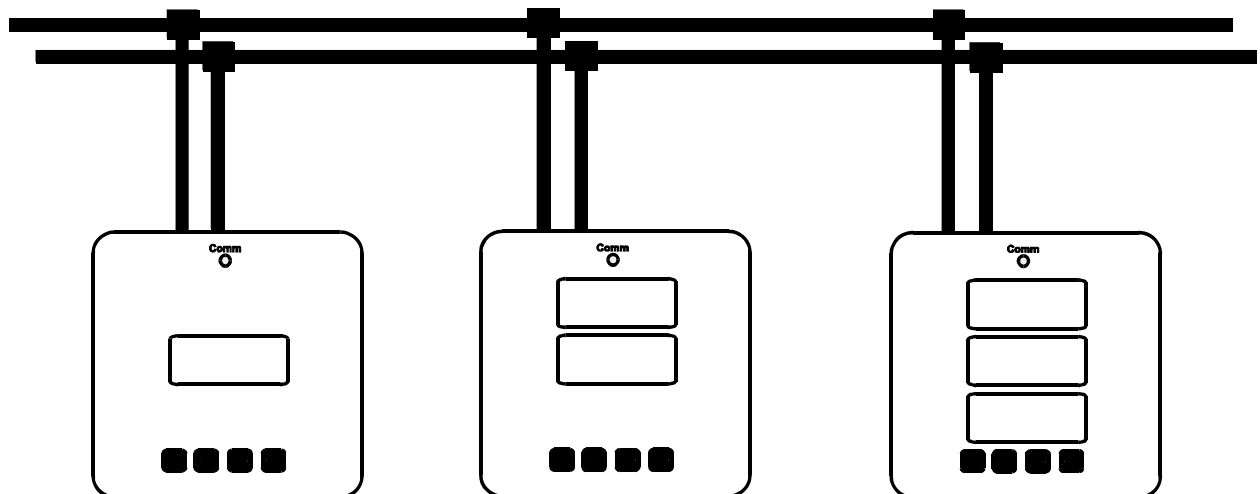


Communications Manual for the Power Series^{Plus} Digital Switchboard Meter



Communications for the Power Series^{Plus}

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Communications for the Power Series^{Plus}

INTRODUCTION:

The Power Series^{Plus} Digital Switchboard Meter has many settings that can be changed by the user. These settings can be displayed and changed by using the four (4) keys, also called pushbuttons, on its front panel. The user can also perform all these same changes over an RS-485 2-wire serial connection. You can read and change all the settings and read all measurements.

You can choose one of two available protocols for communications – ASCII or Modbus.

ASCII is a simple master-slave protocol. Almost any communications software will work with it.

Modbus was developed by Modicon. It is a popular protocol used in many control systems.

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ASCII Protocol

The ASCII protocol uses ASCII characters. All units act as slaves in a master-slave network. There is no broadcast option.

The communications settings for the software are as follows:

Baud Rate: 9600, 4800, 2400 or 1200 bps (set using the front panel)
8 Data Bits, 1 Stop Bit, No Parity.

To communicate with the unit over a serial line the following string is sent:

<stx> <COMMAND><SP> <ADDRESS><SP> <FUNCTION><SP> <parameters> <CR> <etx>

- The special characters 'stx' and 'etx' are standard communications codes and most software will insert them automatically. 'CR' stands for 'Carriage Return', also referred to as 'Enter'. 'SP' stands for the 'Space' character.
- The **COMMAND** can be one of two choices:
 - 'DG' - to get settings
 - 'DP' - to change settings
- The **ADDRESS** is a two-digit number from 01 to 32. These are needed when more than one unit is on the connection. They can only be changed from the front panel. Each unit in a network must have a unique number for communications to work. The default on all units is '01'.
- The **FUNCTION** is one of the following codes:
(Note: The functions available depend on the particular model)

<u>Code</u>	<u>Function</u>
PT	- Potential Transformer Ratio
CT	- Current Transformer Ratio
OUT1	- Analog Output for upper (or single) display (upper limit, zero offset & center)
OUT2	- Analog Output for second display (if there is one) (2492/2493 only)
OUT3	- Analog Output for third display (if there is one) (2493 only)
LED1	- LED multiplier for upper(or single) display (2491/2492 only)
LED2	- LED multiplier for lower display (2492 only)
AVG	- Sample Average for all displays (2493 only)
AVG1	- Sample Average for upper (or single) display (2491/2492 only)
AVG2	- Sample Average for lower display (2492 only)
LOCK	- Disables/Enables the keys
DISP	- Show the latest measurement(s) (works only with the 'DG' command.)
F	- Gives the model code ('DG' only)
MIN	- Show or reset minimum measurement(s) (works only with the 'DG' command.)
MAX	- Show or reset maximum measurement(s) (works only with the 'DG' command.)
LL	- Line-to-line voltages or line-to neutral (Voltmeters only) (2493 only)

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- The **parameters** are dependent on the function. They are not needed when the command is 'DG', only for 'DP'. See the section "*Changing Settings*" for an explanation of all the parameters.

GETTING CURRENT SETTINGS and DISPLAY

To get the current setting value, or to see what's on the display, use the format :

DG aa bbbb <CR>

where 'aa' is the address of the unit (01 - 32) and 'bbbb' is the code of the function as shown above. Remember to put a space between each word.

For example, to get the present potential transformer setting from unit 21 send -

DG 21 PT <ENTER>

The unit will respond with a string of numbers. The format is shown below in "*Changing Settings*".

CHANGING SETTINGS

To change a setting send an ASCII string in the format:

DP aa bbbb xxxxxxxx <CR>

'aa' is the address.

'bbbb' is the code of the function.

'xxxxxxx' are the new settings (parameters). The format is described below.

Potential Transformer DP aa PT xxxxy/xxx

The part before the slash is the value that you want to make the primary side of the transformer. This could be in volts (e.g. 960.0) or in terms of the ratio (e.g. 8). It can be up to four (4) digits with or without a decimal point. If you put more than four digits you will get an error message.

The 'y' is where you can put a multiplier that corresponds to the LEDs under the display. If you put a 'K' it multiplies the value by 1,000. An 'M' will multiply by 1,000,000. You can omit it if there is no multiplier (i.e. multiplied by 1).

After the slash put the value you desire for the secondary side. This can be 120/240 volts depending on the model, or '1' for a simple ratio. If you enter anything except a '1' the unit will default to the voltage value (120 or 240).

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Examples: To set a 120V voltmeter PT to a 1:1 ratio you can enter:

DP 01 PT 120/120 or DP 01 PT 1/1

To set it to 120:1 you would enter:

DP 01 PT 120/1 or DP 01 PT 14.4K/120 or DP 01 PT .12K/1

Note that you cannot put 14400/120 because you can only have 4 digits on the left side.

Once you enter your new ratio, the unit will echo your entry with a question mark. For example:

01 PT 14.4K/120 ?

Within ten seconds you need to enter

DP 01 OK

If you enter a valid ratio the unit will respond

01 DONE

If you exceed the ratio limits (for PT that is <1:1 or >9999:1) or make some other mistake you will get an error message such as:

01 ERR 6C

The error codes are explained under the “*Unit Responses and Error Codes*” section.

Current Transformer DP aa CT xxxxy/x

same format as PT. If you have a 1 Amp unit you don't get a choice for the secondary value. It will always be '1'. You can leave it blank if you like, but don't forget the '/'. If you have a 5 Amp unit, the secondary can be '1' or '5'.

Analog Output DP aa OUT1 xxxxy/±xxxxxy/0 or
DP aa OUT2 xxxxy/±xxxxxy/0 (for the second channel) or
DP aa OUT3 xxxxy/±xxxxxy/0 (for the third channel)

The first section (before the first slash) is for the upper limit, or 'HI' setting.

Up to four digits with an optional decimal point and an optional multiplier.

The second section is for the zero offset, or 'LO' setting. It has the same format as 'HI' with the addition of a plus or minus sign at the beginning. If the sign is omitted it defaults to plus.

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Note: Both the LO and HI values are based on the primary side of the PT and CT and will change proportionally if the PT or CT settings are changed.

For example, if you wish to set a voltmeter with 0-1 milliamps output to send out 1 mA when the input voltage is 160V and 0 mA when the input is 0 you would enter:

DP 01 OUT1 160/0/0 (HI = 160, LO=0)

If you want a wattmeter with -1to1 mA output to give max output (+1mA) when the input is 15050 Watts and minimum output (-1mA) when the input is -15050 Watts you would enter:

DP 01 OUT1 15.05K/-15.05K/0

For HI you can't put '15050' because that is more than four digits.

Sample Average DP aa AVG xx

'xx': number of samples taken before displaying measurement. Valid values are 00 to 29. Must always be two digits. If you want to set the unit to eight samples enter '08' not '8'.

Key Lock DP aa LOCK

This will disable the buttons on the front panel. No parameter is necessary to change this setting. When you send the 'DP' command it will just change to the opposite setting. Lock >> unlock or unlock >> lock.

If you send a 'DG' command it will respond with 1 for locked or 0 for unlocked.

Model Code DG aa F

This command will get the model code from the unit. You cannot use it to change the model code. The code is in the format

8abc0ddd (the '8' is a constant. It will never change.)

a - Inputs Measured :	0 - Volts	9 - DUAL - Volts/Hertz
	1 - Amps	A - DUAL - Watts/VARs
	2 - Watts	B - DUAL - Watts/Power Factor
	3 - VARs	C - TRIPLE - Volt/Volt/Volt
	5 - Power Factor	D - TRIPLE - Amp/Amp/Amp
	6 - Phase Angle	E - TRIPLE - Volt/Amp/Hertz
	7 - Hertz	F - TRIPLE - Watt/VAR/PF
	8 - DUAL - Volts/Amps	

b - Input Frequency : 0 - 45-65 Hertz
1 - 400 Hertz

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- c - Input Source :
- 0 - 1P2W, 120V, 1A (W/VAR/PF) *or* 150V (V/Hz) *or* 1 Amp
 - 1 - 1P2W, 240V (W/VAR/PF) *or* 300V (V/Hz) *or* 1 Amp
 - 2 - 1P2W, 120V, 5A *or* 5 A
 - 3 - 1P2W, 240V, 5A
 - 4 - 1P3W *or* 3P3W, 120V, 1A
 - 5 - 1P3W *or* 3P3W, 240V, 1A
 - 6 - 1P3W *or* 3P3W, 120V, 5A
 - 7 - 1P3W *or* 3P3W, 240V, 5A
 - 8 - 3P4W, 120V, 1A
 - 9 - 3P4W, 240V, 1A
 - A - 3P4W, 120V, 5A
 - B - 3P4W, 240V, 5A
 - C - 1P2W, 480V, 1A (W/VAR/PF) *or* 600V (V/Hz)
 - D - 1P2W, 480V, 5A (W/VAR/PF) *or* 600V (V/Hz)
 - E - 1P3W/3P3W, 480V, 1A
 - F - 1P3W/3P3W, 480V, 5A
 - G - 3P4W, 480V, 1A
 - H - 3P4W, 480V, 5A
- d - Analog Output :
- 1 - 0 to 1mA
 - 3 - 4 - 20 mA

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UNIT RESPONSES AND ERROR CODES

The unit will always respond to any message addressed to it. If you send a 'DG...' and it is a legitimate request the response will be the setting value you requested. Some other responses are:

SYN !	When the function code is not recognized.
N/A !	When the function code does not apply to this model. (e.g. using 'CT' on a Volt/Frequency meter. Or 'OUT1' on a unit with no analog output.)
TMER !	When you send a 'DP' message to change a setting, you must confirm it within ten (10) seconds, or the change is discarded and the unit replies with this.
DONE	When a change has been made successfully.
ERR xxx	When a change was not successful. The 'xxx' gives the reason for the failure as listed below.

ERROR CODES

21	- 'OK' was sent without a prior 'DP' command
64	- value is too low (PT ratio)
65	- value is too high (PT ratio, AVG1, AVG2)
67	- value is too low (CT ratio)
68	- value is too high (CT ratio)
6B	- value is too high (PT primary, OUT1-HI)
6C	- value is too low (PT primary, OUT1-LO)
6D	- output span is too small (OUT1 - LO)
6E	- value is too high (CT primary, OUT2-HI)
6F	- value is too low (CT primary, OUT2-LO)
70	- output span is too small or exceeds low limit (OUT2-LO)
71	- LED multiplier cannot be changed (LED1, LED2)
72	- more than 4 digits entered (PT, CT, OUT1, OUT2)
73	- unrecognized parameter value (only 0 thru 9, ., +, -, /, K, k, or M are valid)
75	- invalid value (LED1, LED2)
76	- missing the slash '/' (PT/CT)
77	- zero input (PT)
78	- zero input (CT)
79	- EEPROM write error (return for repair)
7A	- EEPROM write error
80	- value is too high (OUT3-HI)
81	- value is too low (OUT3-LO)
82	- output span is too small (OUT3-LO)

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Modbus Protocol

Modbus is an open communications protocol developed by Modicon Inc. to connect controllers and other devices over a network. It defines a standard way of passing messages between devices so that they will be able to parse an incoming message and take any appropriate action necessary.

Devices communicate using a master-slave technique, in which only one device (the master) can initiate transactions (called ‘queries’). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. The master can address individual slaves, or can initiate a broadcast message to all slaves. Slaves return a message (called a ‘response’) to queries that are addressed to them individually. Responses are not returned to broadcast queries.

The Power Series^{Plus} always acts as a slave in accordance with The Modicon Modbus Reference Guide PI-MBUS-300. It has the following characteristics:

Interface:	RS-485
Transmission modes:	ASCII (7 data bits) or RTU (8 data bits). Both use 2 stop bits
Parity:	even, odd, or no parity
Baud Rate:	9600, 4800, 2400 or 1200 bps

The default settings from the factory are RTU mode, no parity, 9600 bps.

Function Codes:

The following function codes are supported:

03 – Read Holding Registers

04 – Read Input Registers

The device will respond to either of these codes in the exact same way. They were both included to allow compatibility with a wider range of systems. You can read any single register or the following sets of registers:

1 thru 14 - all the settings, except output ranges

22 thru 36 - all the output range settings

37 thru 50, 67 thru 80, 97 thru 110 – Latest, Minimums and Maximums for Volts, Amps and Frequency

51 thru 56, 81 thru 86, 111 thru 116 – Latest, Minimums and Maximums for Watts, VARs, and Power Factor

06 – Preset Single Register

Sets a single register. Cannot be used to change values that fill more than one register. (e.g. PT ratio)

08 – Diagnostics

Only the loopback subroutine (Return Query Data) is supported. This simply returns a response identical to the query.

16 – Preset Multiple Registers

Can set single or multiple registers. If this command is sent to a Maximum or Minimum register, no data should be included with the query. The Power Series Plus will simply reset the register(s) so that the next measurement will become the maximum or minimum.

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Register Table

All registers are 2 bytes in size. Shaded registers are for factory use only.

REGISTER	NAME	R / W	UNITS	FORMAT	CONTENTS
1 (0000)	VER	R	-	Unsigned int	Firmware Version Number * 100
2 (0001)	MODEL	R	-	Unsigned int	Model Code 1=DCV; 2=ACV; 3=ACA; 4=W; 5=VAR; 7=PF; 8=PA; 9=Hz; 10=V/A; 11=V/Hz; 12=W/VAR; 13=W/PF; 14=V/V/V; 15=A/A/A; 16=V/A/Hz; 17=W/VAR/PF
3 (0002)	CONN	R	-	Unsigned int	Terminal Connections 0=2Wire; 1=3Wire; 2=4Wire
4 (0003)	VOLT	R	-	Unsigned int	Input Voltage Rating 0=120/150Volts; 1=240/300Volts; 2=480/600Volts
5 (0004)	AMP	R	-	Unsigned int	Input Current Rating 0=1Amp; 1=5Amps
6 (0005)	FREQ	R	-	Unsigned int	Input Frequency Rating 0=55Hz; 1=400Hz
7 (0006)	ANOUT	R	-	Unsigned int	Analog Output Code 0=No Output; 1=0-1mA; 3=4-20mA
8 (0007)	AVG	R/W	-	Unsigned int	Rolling Average Setting 0~29 samples
9 (0008)	LL	R/W	-	Unsigned int	Line-Line Setting (Voltmeters Only) 0=Line-Neutral; 1=Line-Line
10 (0009)	LOCK	R/W	-	Unsigned int	Front Panel Lockout 0=unlocked; 1=locked
11 (000A)	VARPOL	R/W	-	Unsigned int	<i>Not yet implemented</i>
12 (000B) (4 bytes)	PT	R/W	-	IEEE float	Potential Transformer Ratio 1.0:1 ~ 9999.0:1
14 (000D) (4 bytes)	CT	R/W	-	IEEE float	Current Transformer Ratio 1.0:1 ~ 9999.0:1
16 (000F)	<i>Spare</i>				
17 (0010)	<i>Spare</i>				
18 (0011)	<i>Spare</i>				
19 (0012)	<i>Spare</i>				
20 (0013)	<i>Spare</i>				
21 (0014)	<i>Spare</i>				
22 (0015) (10 bytes)	OUT1	R/W	Channel dependent	Hi & Lo: float Cen: int	Channel 1 Output Range Settings HI limit; LO limit; Zero Center
27 (001A) (10 bytes)	OUT2	R/W	Channel dependent	Hi & Lo: float Cen: int	Channel 2 Output Range Settings HI; LO; CEN
32 (001F) (10 bytes)	OUT3	R/W	Channel dependent	Hi & Lo: float Cen: int	Channel 3 Output Range Settings HI; LO; CEN
37 (0024) (4 bytes)	V1 or V12	R	Volts	IEEE float	Latest V1 Measurement
39 (0026) (4 bytes)	V2 or V23	R	Volts	IEEE float	Latest V2 Measurement

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41 (0028) (4 bytes)	V3 or V13	R	Volts	IEEE float	Latest V3 Measurement
43 (002A) (4 bytes)	I1	R	Amps	IEEE float	Latest I1 Measurement
45 (002C) (4 bytes)	I2	R	Amps	IEEE float	Latest I2 Measurement
47 (002E) (4 bytes)	I3	R	Amps	IEEE float	Latest I3 Measurement
49 (0030) (4 bytes)	HZ	R	Hertz	IEEE float	Latest Frequency Measurement
51 (0032) (4 bytes)	W	R	Watts	IEEE float	Latest Watt Measurement
53 (0034) (4 bytes)	VAR	R	VARs	IEEE float	Latest VAR Measurement
55 (0036) (4 bytes)	PF	R	-	IEEE float	Latest PF Measurement
57 (0038)	<i>Spare</i>				
58 (0039)	<i>Spare</i>				
59 (003A)	<i>Spare</i>				
60 (003B)	<i>Spare</i>				
61 (003C)	<i>Spare</i>				
62 (003D)	<i>Spare</i>				
63 (003E)	<i>Spare</i>				
64 (003F)	<i>Spare</i>				
65 (0040)	<i>Spare</i>				
66 (0041)	<i>Spare</i>				
67 (0042) (4 bytes)	V1MIN	R/W	Volts	IEEE float	Minimum V1 Measurement
69 (0044) (4 bytes)	V2MIN	R/W	Volts	IEEE float	Minimum V2 Measurement
71 (0046) (4 bytes)	V3MIN	R/W	Volts	IEEE float	Minimum V3 Measurement
73 (0048) (4 bytes)	I1MIN	R/W	Amps	IEEE float	Minimum I1 Measurement
75 (004A) (4 bytes)	I2MIN	R/W	Amps	IEEE float	Minimum I2 Measurement
77 (004C) (4 bytes)	I3MIN	R/W	Amps	IEEE float	Minimum I3 Measurement
79 (004E) (4 bytes)	HZMIN	R/W	Hertz	IEEE float	Minimum Frequency Measurement
81 (0050) (4 bytes)	WMIN	R/W	Watts	IEEE float	Minimum Watt Measurement
83 (0052) (4 bytes)	VARMIN	R/W	VARs	IEEE float	Minimum VAR Measurement
85 (0054) (4 bytes)	PFMIN	R/W	-	IEEE float	Minimum PF Measurement
87 (0056)	<i>Spare</i>				
88 (0057)	<i>Spare</i>				

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89 (0058)	<i>Spare</i>				
90 (0059)	<i>Spare</i>				
91 (005A)	<i>Spare</i>				
92 (005B)	<i>Spare</i>				
93 (005C)	<i>Spare</i>				
94 (005D)	<i>Spare</i>				
95 (005E)	<i>Spare</i>				
96 (005F)	<i>Spare</i>				
97 (0060) (4 bytes)	V1MAX	R/W	Volts	IEEE float	Maximum V1 Measurement
99 (0062) (4 bytes)	V2MAX	R/W	Volts	IEEE float	Maximum V2 Measurement
101 (0064) (4 bytes)	V3MAX	R/W	Volts	IEEE float	Maximum V3 Measurement
103 (0066) (4 bytes)	I1MAX	R/W	Amps	IEEE float	Maximum I1 Measurement
105 (0068) (4 bytes)	I2MAX	R/W	Amps	IEEE float	Maximum I2 Measurement
107 (006A) (4 bytes)	I3MAX	R/W	Amps	IEEE float	Maximum I3 Measurement
109 (006C) (4 bytes)	HZMAX	R/W	Hertz	IEEE float	Maximum Frequency Measurement
111 (006E) (4 bytes)	WMAX	R/W	Watts	IEEE float	Maximum Watt Measurement
113 (0070) (4 bytes)	VARMAX	R/W	VARs	IEEE float	Maximum VAR Measurement
115 (0072) (4 bytes)	PFMAX	R/W	-	IEEE float	Maximum PF Measurement
117 (0074)	<i>Spare</i>				
118 (0075)	<i>Spare</i>				
119 (0076)	<i>Spare</i>				
120 (0077)	<i>Spare</i>				
121 (0078)	<i>Spare</i>				
122 (0079)	<i>Spare</i>				
123 (007A)	<i>Spare</i>				
124 (007B)	<i>Spare</i>				
125 (007C)	<i>Spare</i>				
126 (007D)	<i>Spare</i>				
127 (007E)	<i>Internal</i>				
128 (007F)	<i>Internal</i>				
129 (0080)	<i>Internal</i>				
130 (0081)	<i>Internal</i>				
131 (0082)	<i>Internal</i>				
132 (0083)	<i>Internal</i>				
133 (0084)	<i>Internal</i>				
134 (0085)	<i>Internal</i>				

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135 (0086) (8 bytes)	<i>Internal</i>				
139 (008A)	<i>Empty</i>				

Exception Codes:

If there is a communication error, such as parity, LRC or CRC the Power Series Plus will not respond. If there is no communication error, but the device cannot handle the query for some reason, it will return one of the following exception codes:

01 – Illegal Function

The function code received in the query is not an allowable action for the slave.

02 – Illegal Data Address

The data address received in the query is not an allowable address for the slave.

03 – Illegal Data Value

A value contained in the query data field is not an allowable value for the slave.

09 – EEPROM Write Error

Data was not correctly saved to EEPROM. If there is a power outage, the unit will not save the changes made. Contact your distributor.

Changing Modbus Settings:

The network address, baud rate, transmission mode and parity setting can only be changed using the front panel interface.

To get to the setting mode press the keys in the following order –

Mode - Mode - Set.

The display will now be showing the PT ratio 'Pt' or the CT ratio 'Ct'. Now press **Next** repeatedly until you see 'Addr' in the top display. The middle display will be showing the current address of the unit. To change it, press **Set**. The first digit will start blinking. Press **Inc** to increment the first digit, or press **Next** to move to the second digit. When you are finished changing the value, press **Set**. Both digits will begin blinking. Press **Set** once again to save the value in EEPROM and move on the next settings. Pressing **Mode** at any time will back you out of the process.

Now the top display will show 'Sci' – Serial Comm Interface. The middle display will show three values – the baud rate, the transmission mode and the parity, separated by dots. The default looks like – '96.r.n', meaning 9600 bps, RTU mode, no parity. To change a setting press **Set**. The baud rate will start to blink. To change the baud rate press **Inc**. To move to the mode setting press **Next**. The symbols are:

<u>Baud rate:</u>	96 – 9600 bps	<u>Trans mode:</u>	r – RTU	<u>Parity:</u>	n – no parity
	48 – 4800		A – ASCII		E – even
	24 – 2400				o – odd
	12 – 1200				

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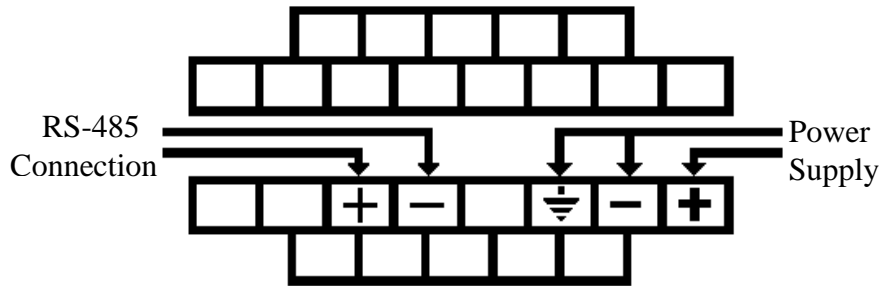
When you are finished changing the settings press **Set**. All the values will blink. Press **Set** again to save the values and return to the first setting in the cycle.

Miscellaneous Notes on Modbus

- Out of range floating-point values are shown as $\pm 3.40282347 \times 10^{38}$.
- The PSP uses a Motorola microcontroller. This means that Intel-based software, such as Windows, might interpret the floating-point data transmitted from the Power Series Plus as “swapped”.
- A Watt/VAR/PF meter cannot access the Volt, Amp or Hertz registers and other meters cannot access the Watt, VAR or PF registers.
- VARs and PF are negative values if leading and positive if lagging.
- Min and Max for VARs and PF disregard lead and lag. The smallest absolute value is always the Min and the largest absolute value is always the Max.

HARDWARE

The 2-wire serial line is connected to the back of the unit as shown -



The far end can be connected to any communications device that is acting as the master, such as a computer. The unit can also be connected in parallel with other units. If you wish to use a personal computer to communicate with the *Power Series^{Plus}* an RS-232/RS-485 converter will be needed.

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