

# ***Powermax65/85***

## ***Serial Communication Protocol***

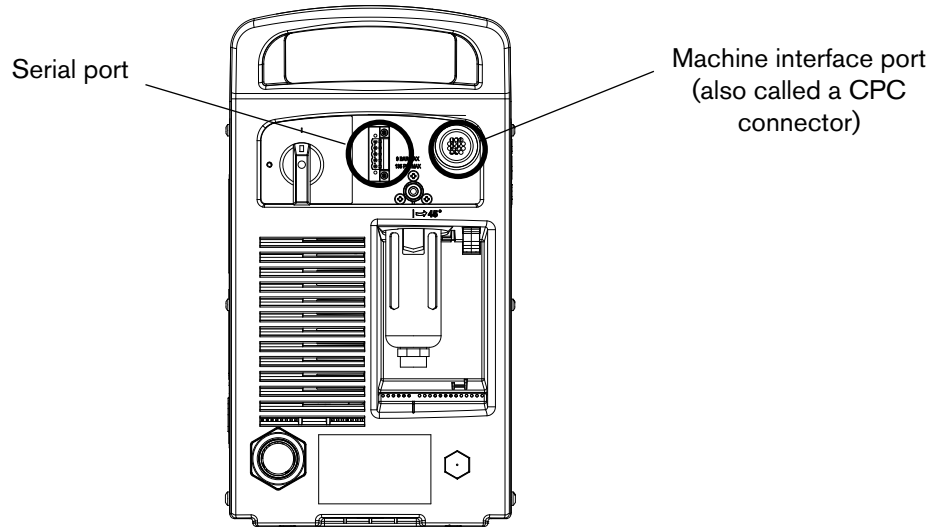
***807220 – Revision 1 – January, 2011***

***Hypertherm<sup>®</sup>***



## Overview

Both the Powermax65 and Powermax85 can support serial communications with a CNC. A five-pin serial port sends and receives the signals over an RS-485 connection using the ModBus ASCII serial protocol. The power supplies require both the serial port and the machine interface port (CPC connector) to be installed to provide full communications capability. Both ports are located on the rear panel of the Powermax65 and Powermax85:



## Power Supply Hardware Requirements

### Machine Torch

Using the Powermax65 and Powermax85 in a mechanized application requires a machine torch. Either the M65/M85 or M65m/M85m can be mounted to an X-Y table or other platform. See the *Powermax65/Powermax85 Operator Manual* (806650) for more information on mounting a machine torch.

### Communication Ports

The Powermax65 and Powermax85 may not have either the serial port or machine interface port installed at the factory.

### Serial Port

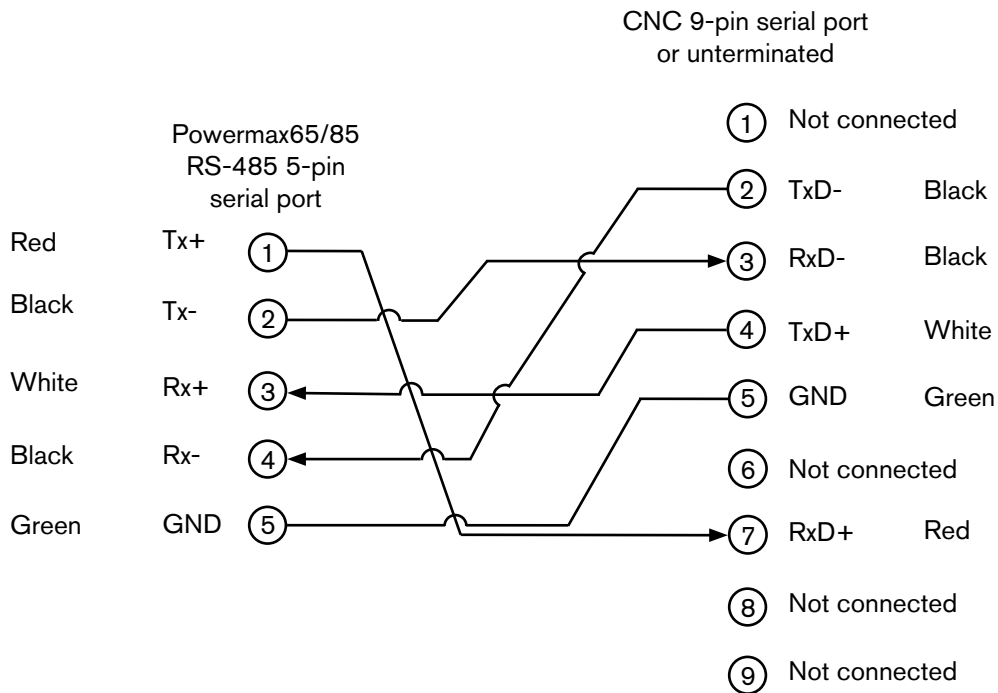
To upgrade a power supply for serial communication, order the following upgrade kit and cables:

- 228539 – Includes serial interface port, internal cables, and RS-485 board.
- Serial cables:
  - 223236 – RS-485 cable, unterminated, 25 ft / 7.6 m
  - 223237 – RS-485 cable, unterminated, 50 ft / 15 m
  - 223239 – RS-485 cable, 9-pin D-sub connector for Hypertherm controls, 25 ft / 7.6 m
  - 223240 – RS-485 cable, 9-pin D-sub connector for Hypertherm controls, 50 ft / 15 m

## Serial Port Pin Assignments

The serial port on the Powermax65 and Powermax85 is a 5-pin male connector (also called a Phoenix connector). The wiring diagram below shows the signals and show they would connect to a 9-pin connector on the CNC. The 9-pin connector shown below is the one used on the Hypertherm EDGE Pro control. Be sure to check the serial port on your CNC for the correct pin assignments.

If you will be using one of the unterminated serial cables (223236 or 223237) the diagram below shows the wire colors and the signals carried on each of the wires.



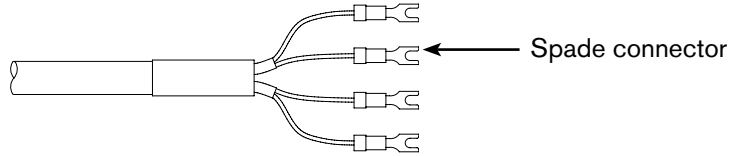
## Machine Interface Port

The machine interface port (also called a CPC connector) gives the CNC access to arc start and transfer, and to the voltage divider. To add the machine interface port to the Powermax65 or Powermax85, order the following upgrade kit:

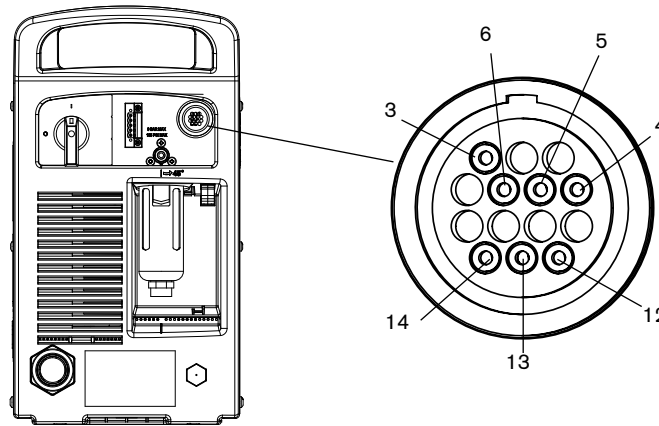
- 228697 – Includes machine interface port, internal cables, and voltage divider board.
- Cables:
  - To use the built-in voltage divider that provides a scaled down arc voltage, in addition to signals for arc transfer and plasma start:
    - 228350 – terminated with spade (fork) connectors, 25 ft / 7.6 m
    - 228351 – terminated with spade (fork) connectors, 50 ft / 15 m
    - 123896 – terminated with D-sub connector (compatible with Hypertherm's controls), 50 ft / 15 m

# POWERMAX65/85 SERIAL COMMUNICATION PROTOCOL

- To use signals for arc transfer and plasma start only:
  - 023206 – terminated with spade (fork) connectors, 25 ft / 7.6 m
  - 023279 – terminated with spade (fork) connectors. 50 ft / 15 m



Refer to the following diagram and table when connecting the Powermax65 or Powermax85 to a CNC with a machine interface cable.



Signal	Type	Notes	Connector sockets	Cable wires
Start (start plasma)	Input	Normally open. 18 VDC open circuit voltage at START terminals. Requires dry contact closure to activate.	3, 4	Green, black
Transfer (start machine motion)	Output	Normally open. Dry contact closure when the arc transfers. 120 VAC/1 A maximum at the machine interface relay or switching device (supplied by the customer).	12, 14	Red, black
Ground	Ground		13	
Voltage divider	Output	Divided arc signal of 20:1, 21.1:1, 30:1, 40:1, 50:1 (provides a maximum of 18 V).	5 (-), 6 (+)	Black (-), white (+)

## Serial Communications with ModBus ASCII

For information on the ModBus ASCII serial protocol, please see the following documents:

- [http://www.modbus.org/docs/Modbus\\_Application\\_Protocol\\_V1\\_1b.pdf](http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf)
- [http://www.modbus.org/docs/Modbus\\_over\\_serial\\_line\\_V1\\_02.pdf](http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf)

The ModBus ASCII standard defines the serial frame as:

- 19200 baud
- 8 data bits
- even parity
- 1 start bit
- 1 stop bit

The most significant bit is the first bit and the least significant bit is the last bit.

The ModBus data envelope is:

Start	Address	Function	Data	LRC	End
1 character	2 characters	2 characters	0 up to 2x252 characters	2 characters	2 characters
Colon :					CR/LF: 0D0A

**Address** The power supply address is set by the first valid ModBus message it receives from the CNC. The power supply uses this address until it is powered down. When it is powered up again, the power supply will not have retained the address, and will again take its address from the first valid ModBus message it receives.

**Function** Functions are defined in the ModBus ASCII documents referenced earlier. Examples include 04 for register read and 06 for a single register write.

**Data** Includes the register location, and the data being requested from the Powermax or sent to the CNC.

**LRC** Longitudinal Redundancy Check, a method for performing a checksum on the message.

**CR/LF** Carriage return, line feed in hexadecimal: 0D0A. The end characters are typically removed on incoming messages by the CNC.

The CNC can control the following Powermax operations by writing to specific input registers, also called force registers.

- Cut mode (normal, continuous pilot arc (CPA), gouge)
- Amperage
- Gas pressure and control mode

To put the power supply into remote control mode, the CNC needs to write to all three force registers together, once, with correct non-zero values (see the sample command string tables later in this document). Afterward, the CNC can write to the force registers one at a time as needed. To return the power supply to manual control, all force registers must be set to zero.

After the CNC takes control of the power supply, the switches and adjustment knob on the front panel are disabled, and the LCD displays the remote control icon:



The power supply responds to commands with either the ModBus function code and data, or with a ModBus exception function code followed by an error code. For a list of the Modbus function and exception codes, see [http://www.modbus.org/docs/Modbus\\_Application\\_Protocol\\_V1\\_1b.pdf](http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf).

## Calculating the checksum (LRC)

ModBus ASCII requires a **longitudinal redundancy check** (LRC, also called a checksum) on each message.

NOTE: In the example below, and throughout this document, when you see **0x**, the characters following the 0x are **hexadecimal (hex) numbers**.

To calculate the LRC:

Example: :010108080001ED0D0A – the LRC is 0xED

Add the hex values of the message but exclude the start (:) and end characters (0D0A) and the LRC itself:

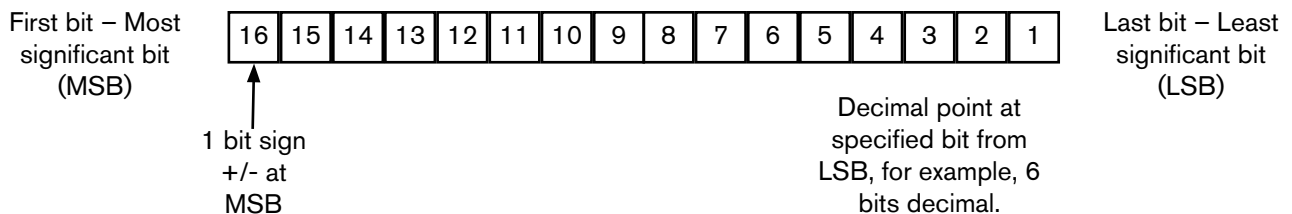
$0x01 + 0x01 + 0x08 + 0x08 + 0x00 + 0x01 = 0x13$

Subtract from 0xFF:  $0xFF - 0x13 = 0xEC$

Add 1:  $0xEC + 0x01 = 0xED$

## Variable Scaling

In addition, Hypertherm uses variable scaling on some of the values as defined below:



**Sample ModBus Command String Tables**

The following tables show sample command strings that could be sent from the CNC and the responses from the power supply. The sample command strings show a single register write function. While the ModBus protocol allows you to write to and read multiple registers, these functions are not shown in the samples.

<b>Command Name</b>	<b>Register (Hex)</b>	<b>Description</b>
<b>cut_mode_force</b> Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 0-bit decimal at LSB.	0x2093	Sets the cut mode to one of these values:  Normal = 1 CPA = 2 Gouge = 3  cut_mode_force <i>value</i> :01062093xxxxcc where xxx equals the cut mode value cc equals LRC (checksum)  Samples: <b>Normal</b> :010620930001450D0A Response: :01062093000145 <b>CPA</b> :010620930002440D0A Response: :01062093000244 <b>Gouge</b> :010620930003430D0A Response: :01062093000343



<b>Command Name</b>	<b>Register (Hex)</b>	<b>Description</b>
<p><b>current_set_force</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 6 bit decimal at LSB.</p>	<p>0x2094</p>	<p>Changes the amperage setting.</p> <p>current_set_force <i>value</i> :01062094xxxxcc</p> <p>where xxx equals the hex value of the amperage decimal multiplied by 64.</p> <p>cc equals LRC (checksum)</p> <p>Samples:</p> <p><b>40 A</b></p> <p>:010620940A003B0D0A</p> <p>40 A × 64 = 2560 = 0xA00</p> <p>Response: :010620940A003B</p> <p><b>45 A</b></p> <p>:0106209400B40FA0D0A</p> <p>45 A × 64 = 2880 = 0x0B40</p> <p>Response: :0106209400B40FA</p> <p><b>65 A</b> :010620941040F50D0A</p> <p>65 A × 64 = 4160 = 0x1040</p> <p>Response: :010620941040F5</p> <p><b>85 A</b> :010620941540F00D0A</p> <p>85 A × 64 = 5440 = 0x1540</p> <p>Response: :010620941540F0</p> <p>Note: Assigning a value to current such as 55.5 follows the same equation:</p> <p><b>55.5 A</b> :010620940DE0580D0A</p> <p>55.5 A × 64 = 3552 = 0x0DE0</p> <p>Response: :010620940DE058</p>

## POWERMAX65/85 SERIAL COMMUNICATION PROTOCOL

Command Name	Register (hex)	Description
<p><b>pressure_set_force</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 7-bit decimal at LSB.</p>	0x2096	<p>When pressure_set_force = 0, the gas mode is set to Automatic mode at the power supply.</p> <p>When pressure_set_force &gt; 0, the CNC controls the gas pressure and the pressure controls on the power supply are disabled.</p> <p>pressure_set_force <i>value</i> :01062096xxxxcc</p> <p>Where xxx equals the hex value of the PSI decimal value multiplied by 128</p> <p>cc equals LRC (checksum)</p> <p>Samples:</p> <p><b>45 PSI</b> :010620961680AD0D0A</p> <p>45 PSI × 128 = 5760 = 0x1680</p> <p>Response: :010620961680AD</p> <p><b>70 PSI</b> :010620962300200D0A</p> <p>70 PSI × 128 = 8960 = 0x2300</p> <p>Response: :01062096230020</p>
<p><b>fault_code</b></p>	0x2098	<p>Reads the fault condition.</p> <p>Sample: :010420980001420D0A</p> <p>Response: :010402006F8A</p> <p>fault_code <i>value</i> :010402xxxxcc</p> <p>where xxx equals the hex value of the decimal fault code</p> <p>cc equals LRC (checksum)</p> <p>0x006F = 111</p> <p>Fault code 0-11-1 Current setting value is out of range</p> <p>The full set of fault codes is shown on page 11.</p>

<b>Command Name</b>	<b>Register (hex)</b>	<b>Description</b>
<p><b>current_set_min</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 6 bit decimal at LSB.</p>	0x2099	<p>Reads the minimum current setting limit for the power supply.</p> <p>Sample: :010420990001410D0A</p> <p>Response: :0104020500F4</p> <p>current_set_min value :010402xxxxcc</p> <p>Where xxx equals the hex value of a decimal value. Divide by 64 to get the amperage.</p> <p>cc equals LRC (checksum)</p> <p>0x0500 = 1280 ÷ 64 = 20</p> <p>The minimum current setting limit in this example = 20Amp</p>
<p><b>current_set_max</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 6 bit decimal at LSB.</p>	0x209A	<p>Reads the maximum current setting limit for the power supply.</p> <p>Sample: :0104209A0001400D0A</p> <p>Response: :0104021040A9</p> <p>:010402xxxxcc</p> <p>Where xxx equals the hex value of a decimal value. Divide by 64 to get the amperage.</p> <p>cc equals LRC (checksum)</p> <p>0x1040 = 4160 decimal ÷ 64 = 65</p> <p>The maximum current setting limit in this example = 65 Amp</p>
<p><b>pressure_set_min</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 7-bit decimal at LSB.</p>	0x209C	<p>Reads the minimum pressure setting limit for the power supply.</p> <p>Sample: :0104209C00013E0D0A</p> <p>Response: :0104021F805A</p> <p>:010402xxxxcc</p> <p>Where xxx equals the hex value of the decimal value. Divide by 128 to get the PSI.</p> <p>cc equals LRC (checksum)</p> <p>0x1F80 = 8064 decimal ÷ 128 = 63</p> <p>The minimum pressure setting in this example = 63 PSI</p>

## POWERMAX65/85 SERIAL COMMUNICATION PROTOCOL

Command Name	Register (hex)	Description
<p><b>pressure_set_max</b></p> <p>Scaling is 16-bit, fixed-point binary with 1-bit sign at MSB and 7-bit decimal at LSB.</p>	0x209D	<p>Reads the maximum pressure setting limit for the power supply.</p> <p>Sample: :0104209D00013D0D0A</p> <p>Response: :0104022700D2</p> <p>pressure_set_max value :010402xxxxcc</p> <p>Where xxx equals the hex value of a decimal value. Divide by 128 to get the PSI.</p> <p>cc equals LRC (checksum)</p> <p>0x2700 = 9984 decimal ÷ 128 = 78</p> <p>In this example, the maximum pressure setting limit for the power supply is 78 PSI.</p>
<p><b>arc_time_low</b></p> <p><b>arc_time_high</b></p>	<p>0x209E</p> <p>0x209F</p>	<p>Reads the amount of time the arc has been on in seconds. The commands work together to read the upper and lower 16 bits of the 32-bit unsigned integer.</p> <p>Sample: :0104209E00023B0D0A</p> <p>Response: 010404lllhhcc</p> <p>llll = ARC time lower 16 bits</p> <p>hhhh – ARC time higher 16 bits</p> <p>cc equals LRC (checksum)</p> <p>Sample responses:</p> <p>1 second – :01040400010000F6</p> <p>60 seconds (1 minute) - :010404003C0000BB</p> <p>3600 seconds (1 hour) - :0104040E100000D9</p> <p>360000 seconds (100 hour) - :0104047E40000534</p>

Command Name	Register (Hex)	Description												
<b>torch_index</b>	0x0808 0x0809  (Coils)	<p>Reads the torch lead length. Hypertherm controls use this command to set gas pressure and load the correct cut charts.</p> <p>The sample below reads the two coils.</p> <p>Sample: :010108080002EC0D0A</p> <p>Response: :010101xccc</p> <p>Where xx equals torch length</p> <p>cc equals LRC (checksum)</p> <p>Torch lead length is contained in the last 2 bits of the 8-bit response value.</p> <table border="1" data-bbox="727 730 1369 894"> <thead> <tr> <th align="center">Bit 1</th> <th align="center">Bit 0</th> <th align="center">Length</th> </tr> </thead> <tbody> <tr> <td align="center">0</td> <td align="center">0</td> <td align="center">15 - 25 ft (<math>\leq 7.6</math> m)</td> </tr> <tr> <td align="center">0</td> <td align="center">1</td> <td align="center">35 - 50 ft (<math>\leq 15</math> m)</td> </tr> <tr> <td align="center">1</td> <td align="center">0</td> <td align="center">75 ft (<math>\leq 23</math> m)</td> </tr> </tbody> </table> <p>Responses:</p> <p>:01010100FD 15 – 25 ft (<math>\leq 7.6</math> m)</p> <p>:01010101FC 35 – 50 ft (<math>\leq 15</math> m)</p> <p>:01010102FB 75 ft (<math>\leq 23</math> m)</p>	Bit 1	Bit 0	Length	0	0	15 - 25 ft ( $\leq 7.6$ m)	0	1	35 - 50 ft ( $\leq 15$ m)	1	0	75 ft ( $\leq 23$ m)
Bit 1	Bit 0	Length												
0	0	15 - 25 ft ( $\leq 7.6$ m)												
0	1	35 - 50 ft ( $\leq 15$ m)												
1	0	75 ft ( $\leq 23$ m)												

## Fault Codes

The chart below summarizes some fault codes that could be returned by the power supply. For a complete list of fault codes, see the Powermax65 and Powermax85 Service Manual (80xxxx) All values are decimal without the symbol “-”.

<b>Fault code</b>	<b>Description</b>
0-11-0	Invalid cut mode setting
0-11-1	Current setting value is out of range
0-11-2	Gas pressure setting value is out of range
0-12-0	Low input gas pressure
0-13-0	AC input unstable warning
0-19-0	Power board hardware protection
0-20-0	Low gas pressure
0-21-0	Gas flow lost while cutting
0-22-0	No gas input
0-30-0	Torch consumables stuck
0-40-0	Over temperature
0-50-0	Retaining cap off
0-51-0	Start/trigger signal on at power-up
0-52-0	No torch connected to the power supply.
0-60-0	AC input voltage error
0-61-0	Arc input unstable, shutdown
0-98-0	Internal communication error
0-99-0	System hardware fault – service required



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