PCRC User's Manual

Precision Current Regulator Controller/Magna Power XR Series

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1.0 Introduction and General Overview

The BiRa Systems Precision Current Regulator Controller (PCRC) was designed to be used with a commercial power supply and DCCT (Direct Current Current Transformer) to enhance the current stability and resolution of the Power Supply. The PCRC uses an Ethernet port for remote control of the Power Supply and a serial port for remote programming of the daughtercard, which resides in the PCRC. The PCRC receives input (current) from the DCCT and provides feedback to the Power Supply for control of the Power Supply. See the Block Diagram below for a general overview.

1.1 System Block Diagram
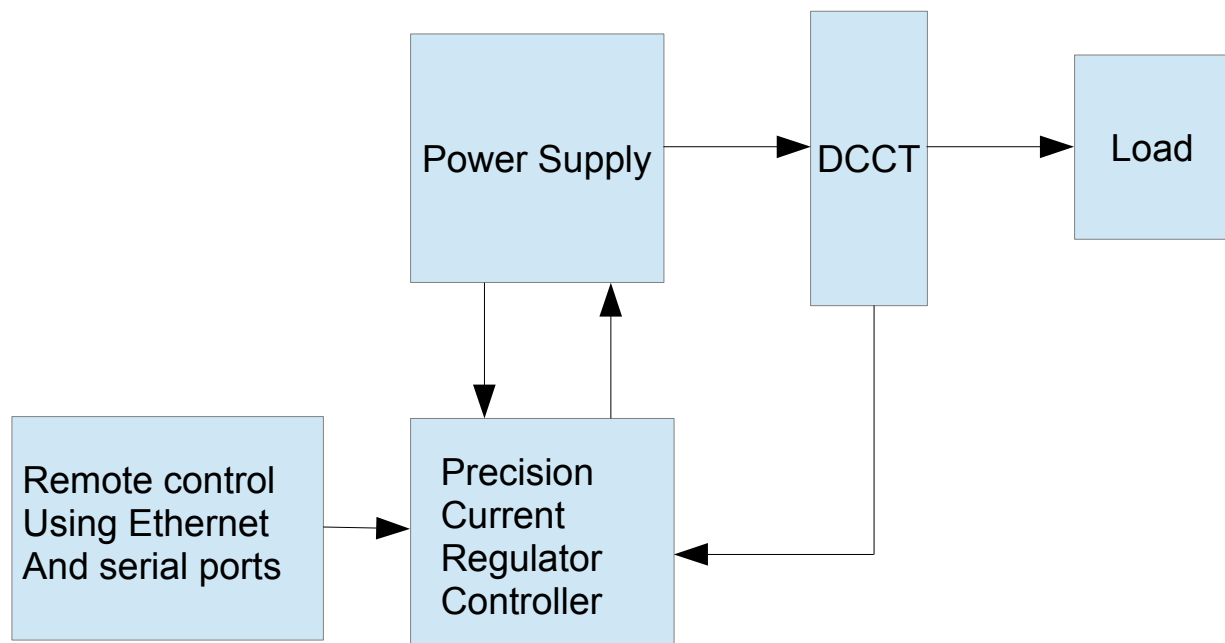
Figure 1- System Block Diagram

1.2 General Information

Front and rear panel connections of the PCRC are shown below.
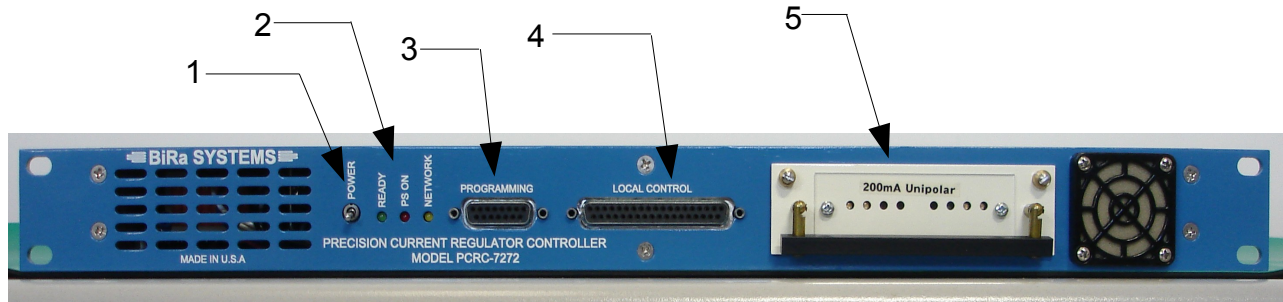
Figure 2- PCRC Front Panel
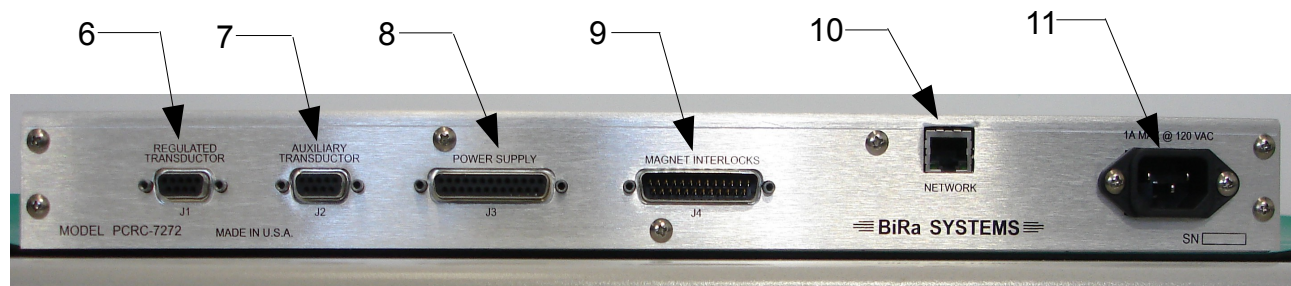
Figure 3- PCRC Rear Panel

1. On/Off Power Switch
2. Front Panel Status LEDs (see Table 1)
3. Serial Programming Port
4. Local Control interface
5. Daughtercard connection port
6. Regulated Transductor interface
7. Auxiliary Transductor interface
8. Power Supply interface
9. Magnet Interlock interface
10. Ethernet Port
11. 120/230 Vac 50/60hz power input receptacle

2.0 System Configuration

Figure 4 below is a block diagram of a typical setup configuration. The setup shown is for reference purposes only. Individual user setups may not appear as shown in figure 4.

The example shown in figure 4 uses a computer for remote programming of the daughtercard using the serial 'Programming' port and a terminal emulator. The daughtercard must be programmed prior to use depending on the DCCT used and other factors. The daughtercard may arrive already programmed if the PCRC is delivered as part of a system. Be sure to review programming details in section 3.5 prior to attempting to control the power supply using the PCRC. The Ethernet programming port of the PCRC is used to control the power supply and can also be used for power supply and PCRC status information. UDPWin.exe is an example of a software utility that can be used for control purposes. UDPWin may be provided by BiRa Systems if requested. See Appendix B for further information and instructions on how to use UDPWin.

The Power Supply does require an interface adapter (as shown in the 'Detailed System Diagram') before programming of the power supply can be accomplished. The custom designed interface adapter is discussed in further detail in Section 3 below.

The ±15VDC required by the DCCT (Direct Current Current Transformer) to operate is supplied by the Regulated and Aux outputs of the PCRC. See Table 2 and Table 3 below for pin-out connections of the PCRC Regulated Transductor connector (**J1**) to DCCT, and Auxiliary Transductor (**J2**) to DCCT. The DCCT current outputs are fed back to the PCRC as daughtercard inputs to the Regulated and Aux circuits. The Regulated inputs are used by the PCRC to regulate and control the power supply current output using a 0 to 5V (or 0 to 10V) voltage input to the Analog Input connection of the supply, while the Aux connection is used typically as an independent monitor. Note that the use of a separate DCCT for the Aux input is optional (not required).

The 'Magnet Interlocks' connector (**J4**) is used as a means of monitoring various interlocks. Magnet Interlocks 0,1,2 and 3 must be configured correctly for proper operation. The correct configuration for these four interlocks would be a closed switch across pins 3 and 16 (Magnet Interlock 0), pins 4 and 17 (Magnet Interlock 1), pins 5 and 18 (Magnet Interlock 2) , and pins 6 and 19 (Magnet Interlock 3). Tables 2-8 below show the pin-out of all the PCRC connectors.

The front panel LEDs may be used to indicate status of the PCRC or for troubleshooting purposes. See Table 1 below for status indication (note that 'X' indicates don't care).

Table 1- Front Panel LED status information

Green	Red	Yellow	Status/Indication
On	Off	X	Standby
Off	**On**	X	Power Supply On
On	**On**	X	Power Supply Ramping
X	X	Flash	Network traffic (.2sec/message)
Off	Off	Off	No power or hardware fault
On	**On**	**On**	Hardware fault or self test in progress
1Hz	Off	X	Power Supply Off, Hardware fault
Off	**1Hz**	X	Power Supply On, Hardware fault
2Hz	Off	X	Power Supply Off, Ethernet link down
Off	**2Hz**	X	Power Supply On, Ethernet link down

2.1 Detailed System Diagram
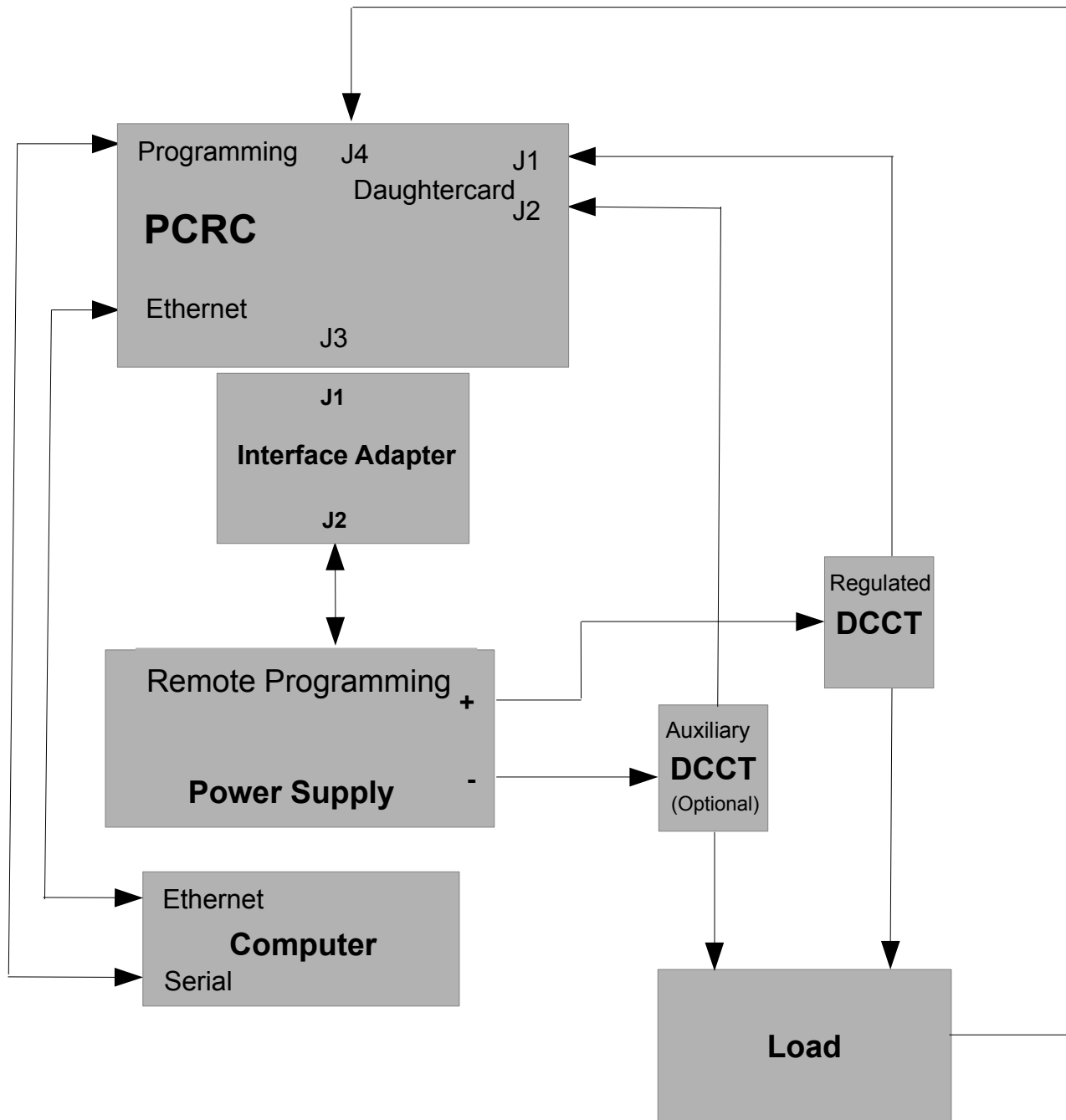
Figure 4- *Typical System Setup Diagram*

2.2 PCRC Connector Pin-Outs -Refer to Figures 2 and 3

Table 2- **J1 Regulated Transductor Connections**

Pin	Signal Name	Function
1	N/C	No Connection
6	XDUCT +OUT	Input from DCCT to daughtercard input amplifier (Regulated)
2	XDUCT -OUT	No Connection
7	NC	No Connection
3	GND	GND (Return) connection for DCCT input to daughtercard input amplifier (Regulated)
8	XDUCT OK	Logic input for DCCT status
4	GND	GND (Return) connection
9	+15VDC	+15VDC for DCCT supply
5	-15VDC	-15VDC for DCCT supply

Table 3- **J2 Auxiliary Transductor Connections**

Pin	Signal Name	Function
1	N/C	No Connection
6	XDUCT +OUT	Input from DCCT to daughtercard input amplifier (Auxiliary)
2	XDUCT -OUT	No Connection
7	NC	No Connection
3	GND	GND (Return) connection for DCCT input to daughtercard input amplifier (Auxiliary)
8	XDUCT OK	Logic input for DCCT status
4	GND	GND (Return) connection
9	+15VDC	+15VDC for DCCT supply
5	-15VDC	-15VDC for DCCT supply

Table 4-   **J3 Power Supply Connections**

Pin	Signal Name	Function
1	PS REF +	0-5V Voltage Programming Output from PCRC (+)
14	PS REF -	0-5V Voltage Programming Output from PCRC (-)
2	PS VOLTS +	0-10V Voltage Monitor Input from Power Supply (+)
15	PS VOLTS -	0-10V Voltage Monitor Input from Power Supply (-)
3	GND CUR +	Ground current monitor input (+)
16	GND CUR -	Ground current monitor input (-)
4	PS READY STATUS	N/C
17	GND	Return connection of PCRC
5	PS ON STATUS	Power Supply On Status monitor input
18	GND	Return connection of PCRC
6	PS STATUS 0	N/C
19	PS STATUS 1	N/C
7	PS STATUS 2	N/C
20	GND	Return connection of PCRC
8	INTERLOCK RESET Out	Interlocks Reset Output
21	INTERLOCKS READY OUT	N/C
9	PS ON OUT	PCRC output for PS Output Control
22	REV POL OUT	N/C
10	GND	Return connection of PCRC
23	PS STATUS 3	N/C
11	NC	N/C
24	NC	N/C
12	+5V POWER	N/C
25	GND	Return connection of PCRC
13	GND	Return connection of PCRC

Table 5-   **J4 Magnet Interlocks Connections**

Pin	Signal Name	Function
1	KLIXON INTERLOCK 0 (+)	Klixon Interlock Input (+)
14	KLIXON INTERLOCK 0 (-)	Klixon Interlock Input (-)
2	KLIXON INTERLOCK 1 (+)	Klixon Interlock Input (+)
15	KLIXON INTERLOCK 1 (-)	Klixon Interlock Input (-)
3	MAGNET INTERLOCK 0 (+)	Magnet Interlock Input (+)
16	MAGNET INTERLOCK 0 (-)	Magnet Interlock Input (-)
4	MAGNET INTERLOCK 1 (+)	Magnet Interlock Input (+)
17	MAGNET INTERLOCK 1 (-)	Magnet Interlock Input (-)
5	MAGNET INTERLOCK 2 (+)	Magnet Interlock Input (+)
18	MAGNET INTERLOCK 2 (-)	Magnet Interlock Input (-)
6	MAGNET INTERLOCK 3 (+)	Magnet Interlock Input (+)
19	MAGNET INTERLOCK 3 (-)	Magnet Interlock Input (-)
7	INTERLOCKS READY OUT	Interlocks Ready Output
20	PS ON OUT	PS On Output
8	INTERLOCK RESET OUT	Interlock Reset Output
21	GND	Return Connection
9	RS485 GLOBAL RAMP (+)	Ramp Input (+)
22	RS485 GLOBAL RAMP (-)	Ramp Input (-)
10	RS485 GLOBAL HOLD (+)	Hold Input (+)
23	RS485 GLOBAL HOLD (-)	Hold Input (-)
11	GROUND CURRENT OUT (+)	Ground current Output (+)
24	GROUND CURRENT OUT (-)	Ground current Output (-)
12	SPARE ADC INPUT (+)	Spare ADC Input (+)
25	SPARE ADC INPUT (-)	Spare ADC Input (-)
13	NC	N/C

Table 6-   **J5 Daughtercard Connections**

Pin	Signal Name	Function
1	GND	Daughtercard chassis ground
14	GND	Daughtercard chassis ground
2	+5V	Daughtercard +5V supply
15	EEPROM_CS1	Daughtercard EEPROM CS Input
3	EEPROM_CLK	Daughtercard EEPROM SCLK Input
16	EEPROM_DIN	Daughtercard EEPROM SD Input
4	EEPROM_DOUT	Daughtercard EEPROM SD Output
17	EN_ERR_AMP	Daughtercard Enable Input
5	GND_TRIP_REF	Voltage Ref output to PCRC
18	N/C	No Connection
6	AUX_XDUCT_IN+	Input to Aux Input Amp
19	AUX_XDUCT_IN-	Not used
7	AUX_XDUCT_OUT	Output of Aux Input Amp
20	COM	Daughtercard GND
8	REG_XDUCT_IN+	Input to Reg Input Amp
21	REG_XDUCT_IN-	Not used
9	REG_XDUCT_OUT	Output of Reg Input Amp
22	COM	Daughtercard GND
10	ERR AMP REFERENCE	Input from PCRC
23	COM	Daughtercard GND
11	ERR AMP OUT	Output to PCRC
24	N/C	No Connection
12	V15P	Daughtercard +15V Supply
25	COM	Daughtercard GND
13	V15N	Daughtercard -15V Supply

Table 7- **J6 Local Connections** used with a Local Control module (not provided) for local control

Pin	Signal Name	Function
1	GND	Digital Gnd
20	+5V VDD	Digital 5V
2	REGULATED +15V	15V Positive (regulated)
21	REGULATED-15V	15V Negative (regulated)
3	UNREGULATED+15V	15V Positive (unregulated)
22	UNREGULATED -15V	15V negative (unregulated)
4	LOCAL CONTROL REF	Local Reference Voltage
23	REFERENCE GROUND	Return for local Reference
5	AUX TRANSDUCTOR	AUX Transductor Out
24	REG TRANSDUCTOR	REG Transductor Out
6	N/C	No Connection
25	DAC	DAC Output
7	RIPPLE (X100)	Reg XDUCT Out Ripple X100
26	ABSOLUTE RIPPLE	Reg XDUCT Out Absolute Ripple Current
8	ISOLATION AMP INPUT	Iso Amp In
27	ANALOG GROUND	Analog Ground connection
9	TEMPERATURE	Chassis Temperature
28	ABSOLUTE GND CURRENT	Absolute Value of Ground Current
10	GND TRIP REF	Trip point for ground current fault (2.5V)
29	GND CURRENT	Buf_Gnd_Cur
11	PS VOLTS	Buffered Power Supply Voltage monitor
30	REFERENCE CON	ADC Ref gnd
12	REFERENCE REF	ADC Voltage Ref (7.025V)
31	ENABLE LOCAL	Select Local Reference or DAC
13	PS OFF	Local_PS_Off
32	PS ON	Local_PS_On
14	RESET	Processor_Local_Reset
33	VOLTAGE MODE	Loc_Volt_Mode
15	REV POLARITY	Loc_Rev_Pol
34	LOCAL CNTL UART RXD	EXT_URXD2
16	LOCAL CNTL UART TXD	EXT_UTXD2
35	LD	BUF_LOC_LED_LD
17	SERIAL LED DATA CLK	BUF_LOC_LED_CLK
36	SERIAL LED DATA DIN	BUF_LOC_LED_DAT
18	+5V POWER	VDD
37	GND	GND Connection
19	GND	GND Connection

Table 8- **J7 Programming Connections**

Pin	Signal Name	Function
1	URXD0	UART0 URXD0
9	UTXD0	UART0 UTXD0
2	UCTS0	UART0 UCTS0
10	URTS0	UART0 URTS0
3	URXD1	UART1 URXD1
11	UTXD1	UART1 UTXD1
4	UCTS1	UART1 UCTS1
12	URTS1	UART1 URTS1
5	GND	GND
13	V2D5	JTAG V2D5
6	TDI	JTAG TDI
14	TCK	JTAG TCK
7	TMS	JTAG TMS
15	TD0	JTAG TD0
8	GND	GND

Please note that a special cable is required to connect from a standard 9 pin serial port to the PCRC 15 pin 'Programming' connector shown in Table 8 above. The pin-out of the cable (required connections) is shown below:

Table 9- **DSUB-9 pin connector to DSUB-15 pin connector**

| Signal	PC 9 pin connector	PCRC 15 pin connector
TX	2	9
RX	3	1
GND	5	5
RTS	6	10
CTS	7	2

All unspecified pins should be open.

3.0- Interface Card General Information

An interface adapter is necessary for power supply control using the PCRC. Interface adapter PCRC-7278-INT is the correct interface adapter for use with the Magna Power XR series supplies. The PCRC-7278-INT is shown below. Note that J3 jumper connections between pins 1 and 2, 3 and 4, and 5 and 6, as shown in the rear photo, are required for normal operation.

Figure 5- *PCRC 7278-INT Interface Adapter (Front/Rear)*

The following discussion involves the PCRC-7278-INT Interface module connections to the Magna Power XR series Power Supplies and the PCRC. Consult the applicable revision operations manual of the power supply in use for additional information.
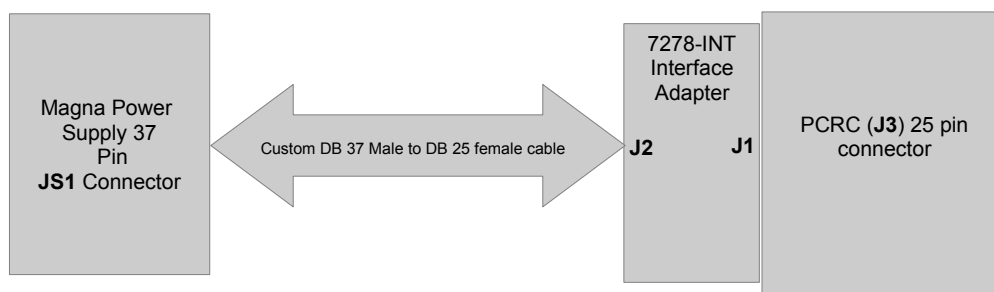
Figure 6- Interface Adapter Connection Diagram

3.1 Magna Power Interface Adapter Information

For a Magna Power XR series supply, a custom DB37 Male to DB 25 Female cable will be required to connect from J2 on the interface adapter to the rear panel (DB 37) JS1 connector of the Magna Power supply. J1 of the interface adapter attaches directly to the J3 connector of the PCRC controller.

Note: The power supply requires some initial settings before programming and control with the PCRC can occur. These steps are detailed below in section 3.2.

Interface Card Connections

Please reference Tables 10-12 below for a pin-out of all PCRC-7278-INT interface connections. Refer to Figure 5 and 6 above.

Table 10- **Interface Adapter Pin-Out Connections (J1)**

Pin	Signal Name	Function
1	PS_REF_+	0-5V Voltage Programming Output from PCRC (+)
14	PS_REF_-	0-5V Voltage Programming Output from PCRC (-)
2	PS_VOLTS_+	0-10V Voltage Monitor Input from Power Supply (+)
15	PS_VOLTS_-	0-10V Voltage Monitor Input from Power Supply (-)
3	GND_CUR_+	Gnd current monitor input + to PCRC
16	GND_CUR_-	Gnd current monitor input - to PCRC
4	PS_READY_STATUS	Status input to PCRC
17	GND	PCRC GND connection
5	PS_ON_STATUS	Status input to PCRC
18	GND	PCRC GND connection
6	N/C	No connection
19	N/C	No connection
7	N/C	No connection
20	GND	PCRC GND connection
8	N/C	No connection
21	N/C	No connection
9	PS_ON_OUT	Signal output from PCRC
22	REV_POL_OUT	Signal output from PCRC
10	GND	PCRC GND connection
23	N/C	No connection
11	N/C	No connection
24	N/C	No connection
12	N/C	No connection
25	GND	PCRC GND connection
13	GND	PCRC GND connection

Table 11- **Interface Adapter Pin-Out Connections (J2)**

Pin	Signal Name	Function
13	ALM	Fault Output from power supply
25	+5V_REF	+5V output as referenced to REF_GND
12	INTERLOCK_SET	Input for interlock signal
24	N/C	No Connection
11	N/C	No Connection
23	TIREF_EXT	Input for external over-current set point 0-10V
10	N/C	No Connection
22	IREF_EXT	Input for external current set point 0-10V
9	N/C	No Connection
21	+10V_REF	+10V supply referenced to Ref_GND
8	POWER	Output to indicate the supply output is enabled
20	REF_GND	Reference ground
7	GND	Earth ground
19	STOP	Input that disables the power supply output
6	N/C	No Connection
18	N/C	No Connection
5	VO2	Output voltage 0-10V proportional to power supply output
17	START	Input to enables the power supply output
4	TVREF_EXT	External over voltage trip set point reference
16	N/C	No Connection
3	VREF_EXT	External voltage set point reference 0-10V
15	N/C	No Connection
2	REF_GND	Reference ground
14	N/C	No Connection
1	REF_GND	Reference ground

Table 12- **Interface Adapter Pin-Out Connections (J3)**

Pin	Signal Name	Function	Notes
1	GND_CUR_-	Gnd current monitor - input (common with pin 5 of J3)	Pins 1 and 2 jumpered together
2	100 ohm resistor	Gnd current sense resistor	Not used
3	GND_CUR_+	Gnd current monitor + input	Pins 3 and 4 jumpered together
4	100 ohm resistor return	Resistor return connection	Not used
5	GND_CUR_-	Gnd current monitor - input (common with pin 1)	Pins 5 and 6 jumpered together
6	N/C	No connection	
7	330 ohms to REV_POL_OUT	Reverse polarity output from PS	Not used without an external polarity reversal switch (not supplied). No connection to pin 8.
8	GND	PCRC GND connection	No connection

3.2 Magna Power Supply Setup Instructions

The Power Supply must be properly configured before remote control and programming with the PCRC can be accomplished. Use the following instructions to configure the Power Supply prior to using. Consult the Magna Power technical manual for information on connecting AC power to the supply, and how to properly configure the supply using the front panel keypad. It is advisable to consult an electrician for proper connections from the power supply to AC power.

It is recommended that the supply be configured for use with the PCRC prior to connecting a load. Once the supply is properly configured, AC power should be physically removed from the Magna Power supply so that the load and all other connections to the PCRC and DCCT can be safely made. The Magna Power XR series power supply will be received (default conditions) set up for local control use (front panel configuration indications will be 'STANDBY', 'INT CTL', 'EXT CTL', and 'ROTARY'). Magna Power recommends that an electrical check be performed after unpacking the supply to ensure correct operation. Use the '**Electrical Check**' instructions in the Magna Power User manual to perform these checks.

Once the checks have been performed and it has been confirmed the supply is working properly, return the supply to 0 Volts, 0 Amps, and STANDBY (if not already done) and use the following instructions to configure the supply for use with the PCRC. Note that once the supply is reconfigured it will no longer be in the local mode, since the PCRC will be used to externally control the supply. Using the front panel 'Menu' and 'Item' keys, enter the 'conF' menu by pressing the 'Enter' key. This will enable the Configuration options seen on the right hand side of the display (see figures 7 and 8 below- configuration options are illuminated in green). Use the 'Item' key to select 'REM SEN' only if the user intends to use remote sense connections at the load. Press the Enter key to select 'REM SEN' or use the 'Item' key, to select 'INT CTL' which should be illuminated. Press the Clear key to deselect. Use the Item key again to select 'EXT CTL' and press the Enter key to select this option, which should now be illuminated. Use the Item key again to select the 'EXT PGM' option, and press the Enter key. This will cause the 'Rotary' lamp to extinguish, and the EXT PGM lamp to illuminate. Once the display is seen as shown in figure 8, the supply will be ready to be controlled using the PCRC.

Turn power off to the power supply and disconnect AC power to the supply so that the load, PCRC, and DCCT(s) connection can be made.

Connect the PCRC to the DCCT(s) using the DB9 cable(s) provided. Use figures 4 and 6 of this document as needed when configuring the system. If only one DCCT is to be used it must be connected to the 'Reg' connector on the back of the PCRC using the DB9 connector. Current feedback from this DCCT will be used by the PCRC to regulate and control the Magna Power supply. Review paragraph 2.0 for important information regarding the magnet interlocks before attempting to control with the PCRC.

Connect the power supply load cables through the DCCT (observe the proper current direction of the DCCT as indicated by the arrow on the DCCT) and to the supply output terminals.

Once all connections to the supply, DCCT(s), load, and PCRC have been made as required, power on the PCRC and observe that the DCCT power on lamp is lit. Do not attempt to output current from the supply if the DCCT(s) is not powered on.

With the PCRC and the DCCT powered on and daughtercard correctly programmed (see Appendix A and paragraph 3.5 of this document for information on Daughtercard programming), apply power to the supply and wait for the power-on cycle to complete. When the power-on cycle has completed, the Voltage and Current settings of the supply should be at 0 and the 'Standby' lamp of the supply should be lit. If all indications are as described, the power supply is ready to be controlled by the PCRC. Before proceeding see section 3.3 which describes Over Current Protection and Current Limit settings of the supply.

Appendix B of this document describes how to control the supply using UDPwin.exe as the controlling software.

Figure 7- *Magna Power Front Panel set for Local or Internal control*

Figure 8- *Magna Power Front Panel set for External control*

3.3- Over Current Protection with External Control

When using External control to control the output of the Magna Power supply, the user has the option of determining the Over-Current trip setting and/or the Current limit setting. Both settings can be set to the user's preference by replacing the factory default settings of two separate resistor divider networks on the Interface Adapter (PCRC 7278-INT, figures 5 and 6). The default settings are 100% of the rated current output for the current limit setting, and 110% of the rated current output for the Over-Current trip setting (see the Magna Power User Manual for additional information regarding the settings using External control). Each resistor divider consists of 2 surface mount (SMT 0603) resistors which should only be installed by certified assembly personnel. The current limit settings consists of resistors R8 and R10 of the Interface Adapter, and the current trip setting consists of resistors R7 and R9 of the Interface Adapter. BiRa Systems will attempt to determine the end user's preference for their particular supply for these settings so that any changes to the default settings can be made at the factory prior to shipping, otherwise default settings will apply.

Exceeeding the current trip level setting will cause the Magna Power supply to reset to 0 Amps and the 'OCT' lamp on the front of the power supply to illuminate. Additionally, the PCRC will reset as well. Should an over current event occur, both the power supply and PCRC will need to be reset by powering off and then back on again.

For the current limit setting, the output will not reset to 0 Amps, but the voltage output of the supply will 'fold back' to prevent any increase in current.

It should be noted that the Magna Power Over-Voltage trip setting has been set so that the Over-Voltage trip level setting is 110% of the supply rated output voltage. This setting is not adjustable.

3.4- Typical DCCT to PCRC connections

Caution: It is strongly recommended that no current be allowed through the DCCT until the DCCT is powered up, otherwise damage to the DCCT may occur. Observe the proper direction of current through the DCCT when making the load connections.

Table 13 below shows the connections between the J1 and J2 PCRC connections and a typical DCCT. This pin out allows the use of a straight through D-Sub9 cable. The DCCT pin out is fairly standard, but the specific DCCT user's manual should be referenced to verify the pin out prior to making this connection. A typical DCCT is shown below in Figure 10.

Note: The 'Current output' connection of the DCCT uses Pin 3 (GND) of the PCRC for return.

Table 13- Typical DCCT to PCRC Connections

DCCT Pin	Signal/ Function	PCRC Corresponding J1 Pin	Signal/Function
1	Not used	1	N/C
2	Not used	2	Reg XDUCT – In (not used)
3	Normal Operation Status	3	GND
4	GND	4	GND
5	-15V Supply	5	-15V DC output
6	Current Output	6	Reg XDUCT + In (current input from DCCT)
7	N/C	7	N/C
8	Normal Operation Status	8	Reg XDUCT input status
9	+15V Supply	9	+15V DC output
DCCT Pin	Signal/Function	PCRC Corresponding J2 Pin	Signal/Function
1	Not used	1	N/C
2	Not used	2	Aux XDUCT – In (not used)
3	Normal Operation Status	3	GND
4	GND	4	GND
5	-15V Supply	5	-15V DC output
6	Current Output	6	Aux XDUCT In (current input from DCCT)
7	N/C	7	N/C
8	Normal Operation Status	8	Aux XDUCT input status
9	+15V Supply	9	+15V DC output

Figure 9- Photo of a typical DCCT

3.5 Daughtercard Programming and general information

There are 4 types of daughtercards available:
200mA Unipolar
200mA Bipolar
400mA Unipolar
400mA Bipolar

In most cases, a unipolar daughtercard will be used. The bipolar daughtercard is used in systems with a reversing switch, which is used to generate a bipolar output.

The current rating (200mA or 400mA) is the maximum allowable input current to the daughtercard. The input current is the secondary current of the DCCT.

As shown in figure 4 (section 2.1), 2 DCCTs may be used in a system. J1 is associated with the Regulated Transductor, which is a required part of the control loop. J2 is associated with the Auxiliary Transductor, which is an optional independent measurement channel. Each transductor has an Amps/Volt coefficient programmed into the daughtercard. This setting is determined by the maximum system current and the DCCT turns ratio.

The first step is to choose a DCCT. The maximum system current (I_{MAX}) must be less than or equal to the DCCT nominal primary DC current rating (I_{PN}).
$I_{MAX} \leq I_{PN}$

Next, the daughtercard is selected. The DCCT secondary current (I_{SEC}) is the maximum system current (I_{MAX}) divided by the DCCT turns ratio (N). The DCCT secondary current must be less than or equal to the daughtercard current rating (I_D).
$I_{SEC} = I_{MAX} / N$
$I_{SEC} \leq I_D$

Finally, the Amps/Volt (I_{VA}) coefficient is determined by the DCCT turns ratio (N) divided by a constant (K). K=50 for the 200mA daughtercard, K=25 for the 400mA daughtercard.
$I_{VA} = N/K$

Example 1:
$I_{MAX} = 100A$
The DS200ID DCCT is selected with $I_{PN} = 300A$ and N = 500.
$I_{SEC} = I_{MAX} / N = 100A/500 = 200mA$
The 200mA daughtercard is selected, K = 50
$I_{VA} = N/K = 500/50 = 10$
The daughtercard is programmed with $I_{VA} = 10$.

Example 2:
$I_{MAX} = 600A$
The DS400ID DCCT is selected with $I_{PN} = 600A$ and N = 2000.
$I_{SEC} = I_{MAX} / N = 600A/2000 = 300mA$
The 400mA daughtercard is selected, K = 25
$I_{VA} = N/K = 2000/25 = 80$

The daughtercard is programmed with $I_{VA} = 80$.

The instructions for programming the Amps/Volt coefficient into the daughtercard are given in **Appendix A** below.

Appendix A- Using MTTTY for Daughtercard Programming

Programming of the daughtercard is performed by using a terminal emulator (such as MTTTY) and using the 'Programming' connector on the PCRC front panel. A special cable provided by BiRa Systems must be used to connect to a serial port connection on the PC or terminal used. Refer to Table 9 in this document for details regarding the programming cable. Connect the cable between the serial port on the PC or terminal device and the PCRC 'Programming' connector on the front panel.

It may not be necessary to program daughtercard settings, however the instructions below should be used in the event new settings on the daughtercard are required, or if it is desired to check the existing settings. When configuring the programming utility, use the following settings:
- Baud rate to '115200'
- Parity to 'None'
- Data bits to '8'
- Stop Bits to '1'

After the above settings have been made, perform a carriage return and observe that the display is similar to the screen shot below, which will be considered the **'Top'** menu option.
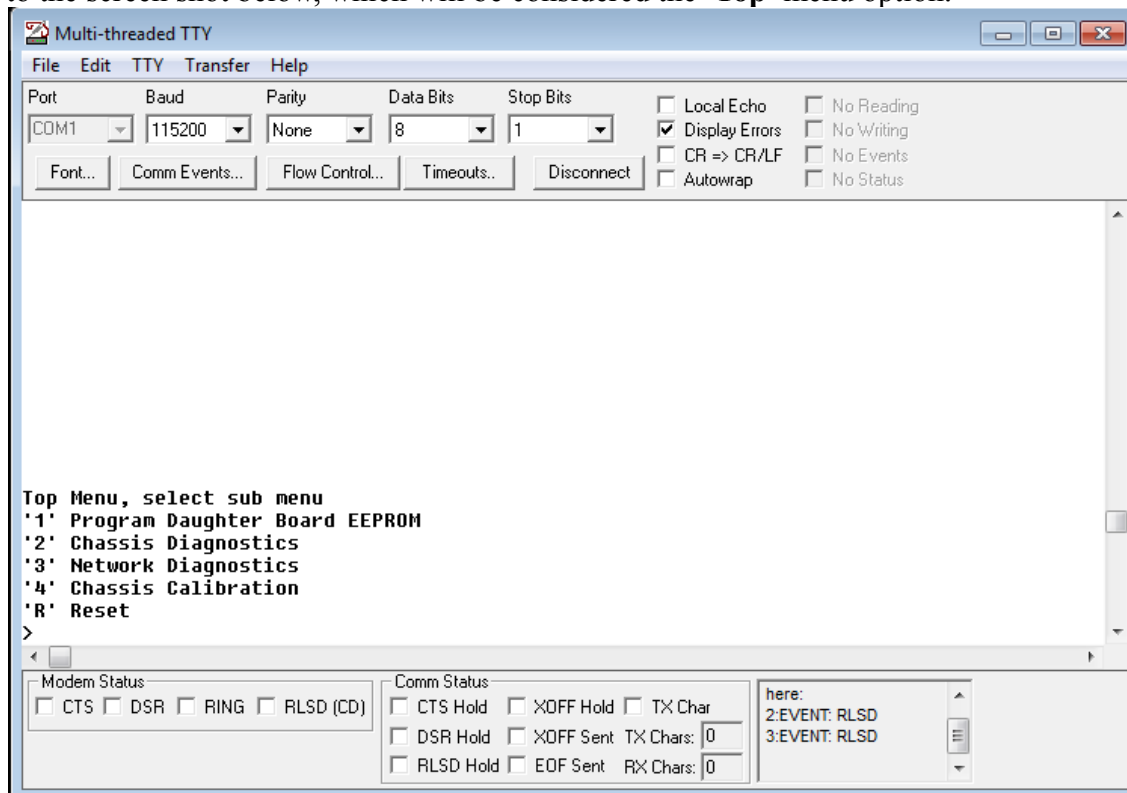
Screen Shot 1

To execute a check of the existing **Amps/Volt** settings on the daughtercard, perform the following:

Enter <**'2' Chassis Diagnostics**> and a carriage return and observe the following display.
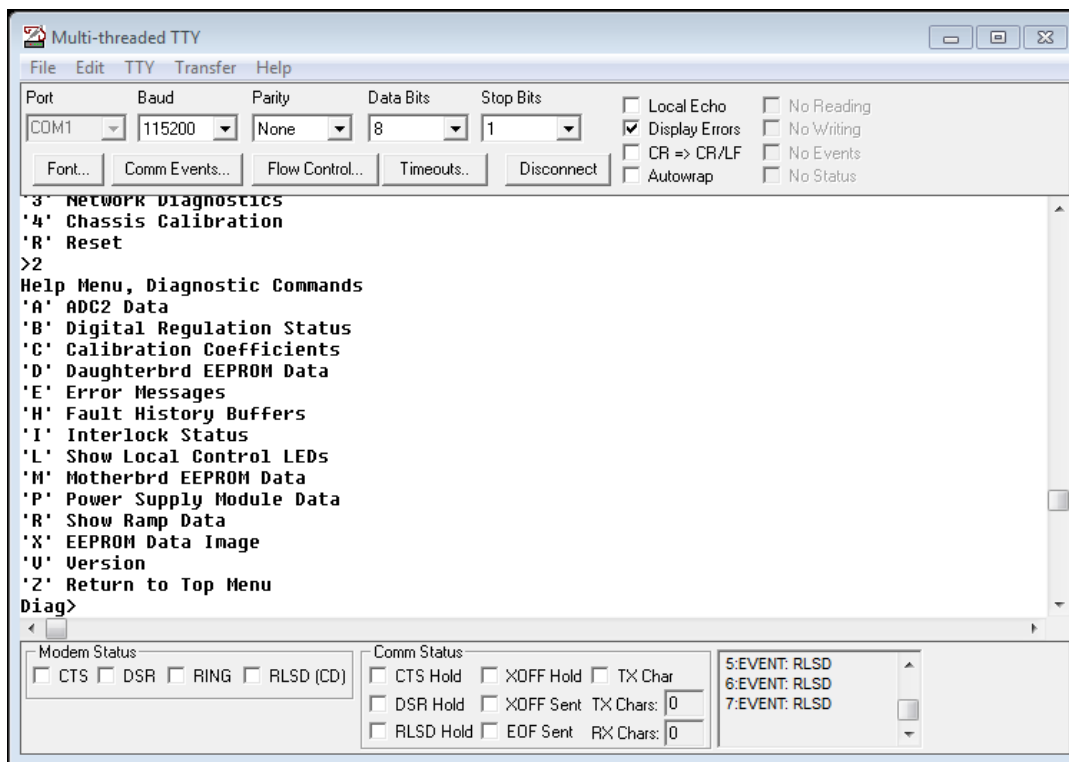
Screen Shot 2

Type <**'D' Daughterbrd EEPROM Data>**, and a carriage return and observe the following display.
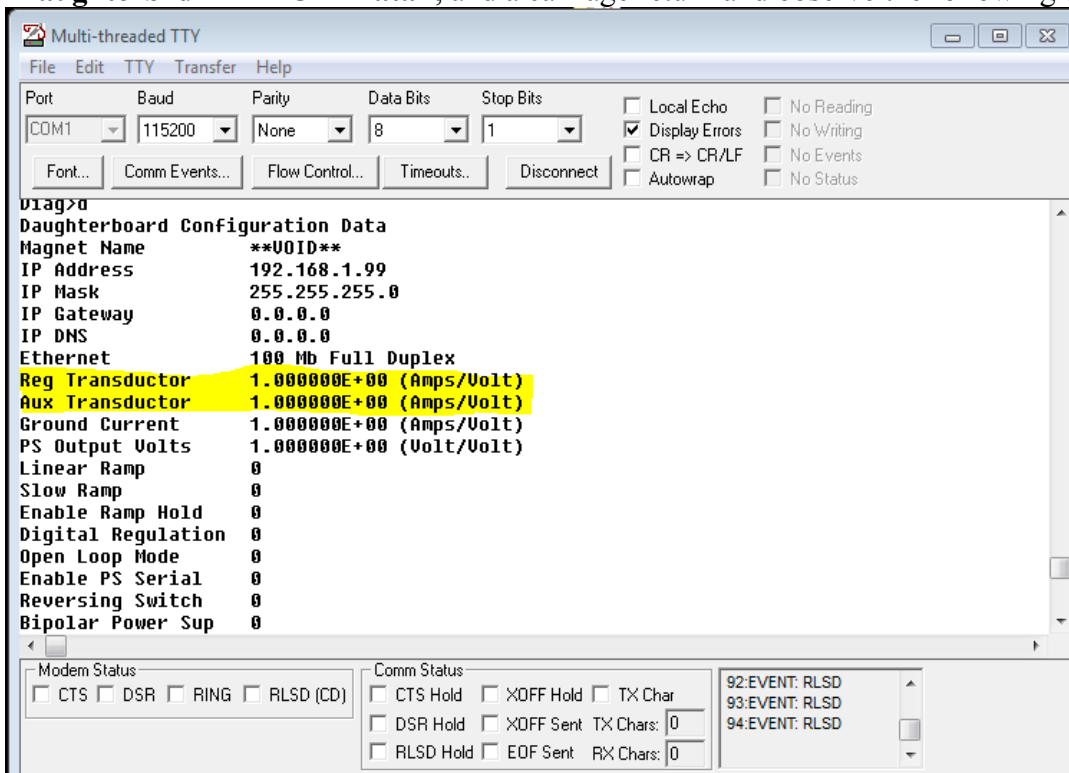
Screen Shot 3

Observe the Amps/Volt settings show in highlight. Note that in the **'Chassis Diagnostics'** mode it is not possible to make changes to the settings- it is just to observe that the settings are as desired. To actually make changes to the daughtercard, perform the following:

Go back to the '**Top**' menu by typing 'Z' and return. (the '**Top**' menu is shown above in **screen shot 1**).
Type <'**1**' **Program Daughter Board EEPROM**> and then hit return. Observe the screen shown below
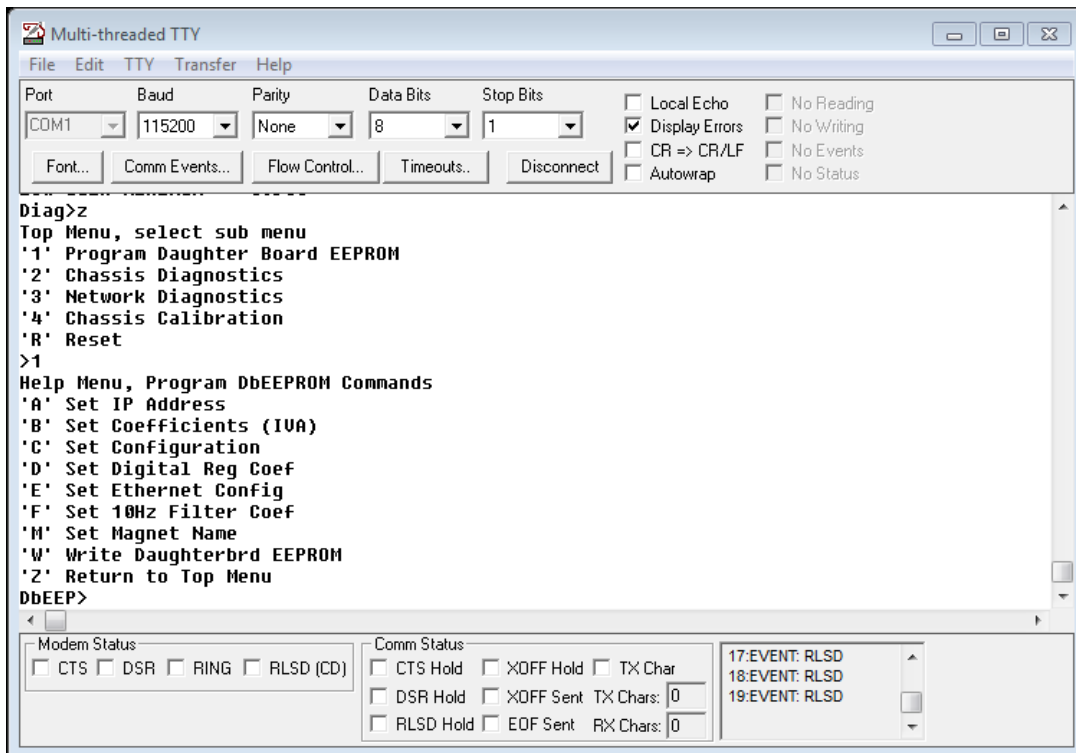
Screen Shot 4

Next type <'**B**' **Set Coefficients (IVA)**> and hit return. This will give you the following screen and allow you to make Amps/Volt setting changes.
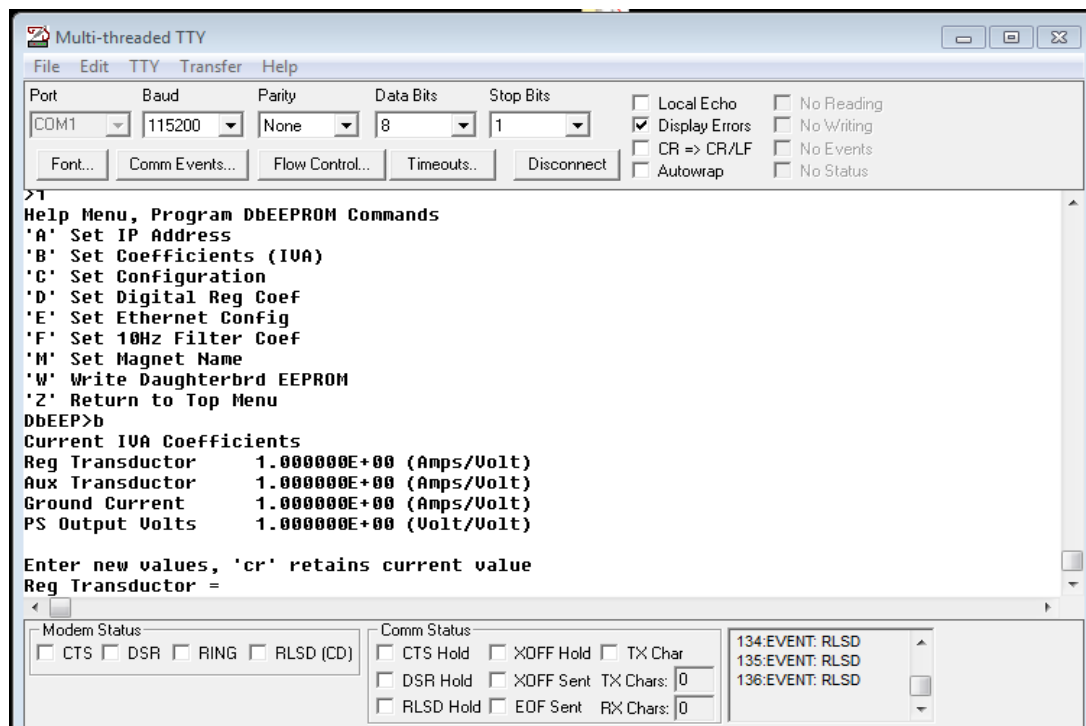
Screen Shot 5

To make **Reg and Aux Transductor Amps/Volt** setting changes, begin making the new entry at the '=' sign (**screen shot 5** above). As each entry is made and a carriage return is executed, the next item in the list will appear with an '=' sign. It is only necessary to make an entry if the setting needs to be changed. If the setting does not need to be changed, just typing a carriage return will ensure that the setting remains the same. So assuming that the 'Reg Transductor' and 'Aux Transductor' only need to be changed (and not 'Ground Current' and 'PS Output Volts') then make entries for 'Reg Transductor' and 'Aux Transductor' and simply hit Return for 'Ground Current' and 'PS Output Volts'. The Ground Current should be set to .01 Amps/Volt, and the PS Output Volts should be set to the power supply rated output (volts) divided by 10. If these values are not set when the daughtercard is received, make them when setting the Reg and Aux Transductor settings. Once the entries have been made, it is necessary to save the settings by typing a **'W'** and then carriage return at the 'Dbeep' prompt as shown on **screen shot 6** below. After typing a 'W' the screen will ask you if you want to save the changes. Type 'Y' or 'N', (**screen shot 7** below) depending on whether the changes should be saved or not.
Next it is necessary to type **'Z'** to return to the Top menu, Type **'R'** to reset, and then type **'S'** to perform a Soft Reset. Once the Soft Reset (or Hard Reset) has been performed, the changes have been saved.

It is advisable to go back and confirm that the settings were changed correctly once the changes have been saved. Perform the instructions under **screen shot 1** as necessary to accomplish the confirmation.
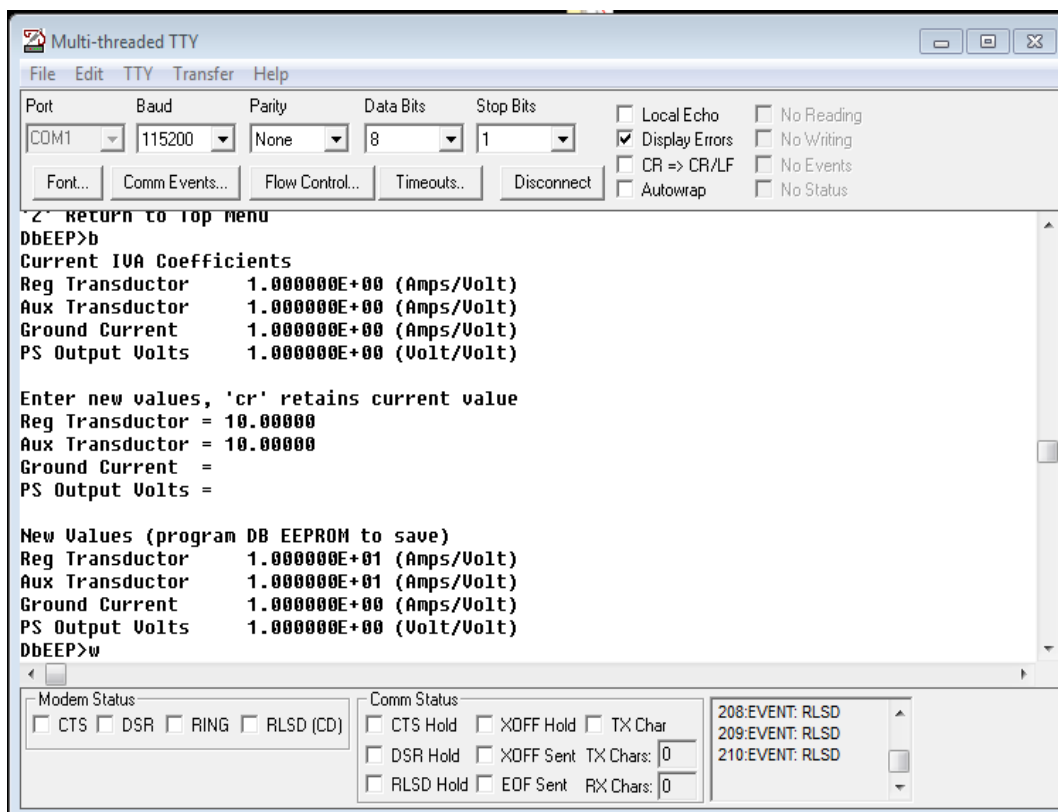
Screen shot 6
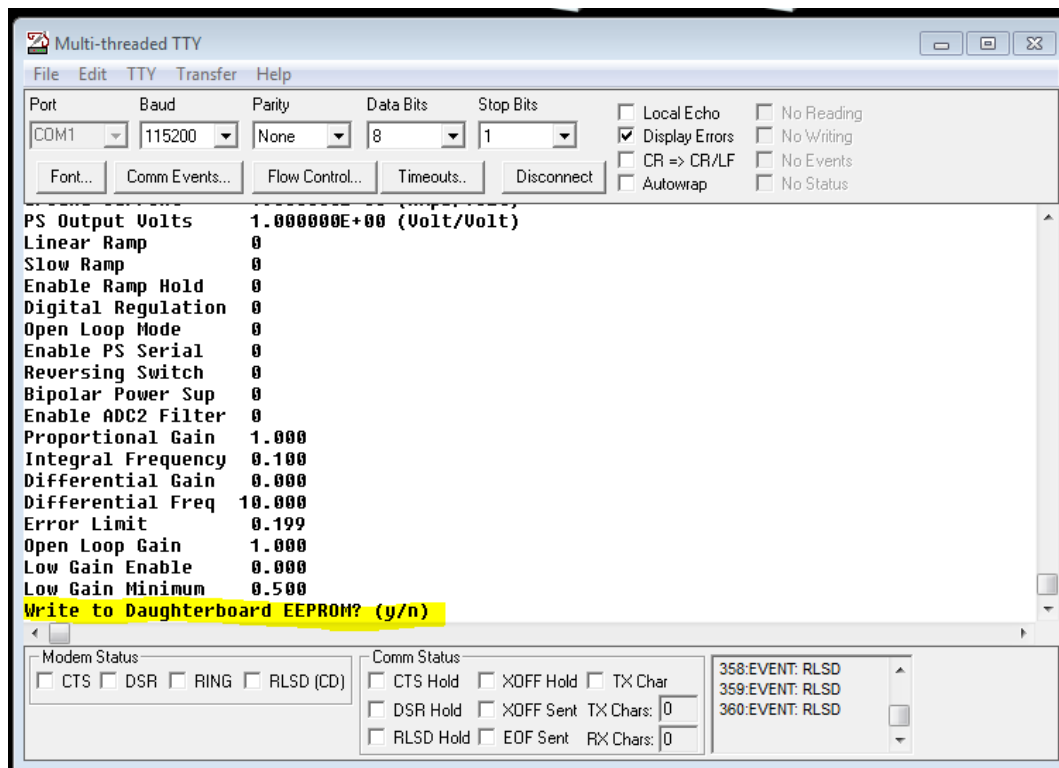
Screen shot 7

Changing the Daughtercard IP Address

It is possible that the IP address of the daughtercard would need to be changed. In order to perform this function, follow the steps listed below after having made the serial cable connection as described above and powering the PCRC on.

Establish that the connection to the PCRC has been made by performing a carriage return and confirming the screen below, which is the 'Top' menu display.
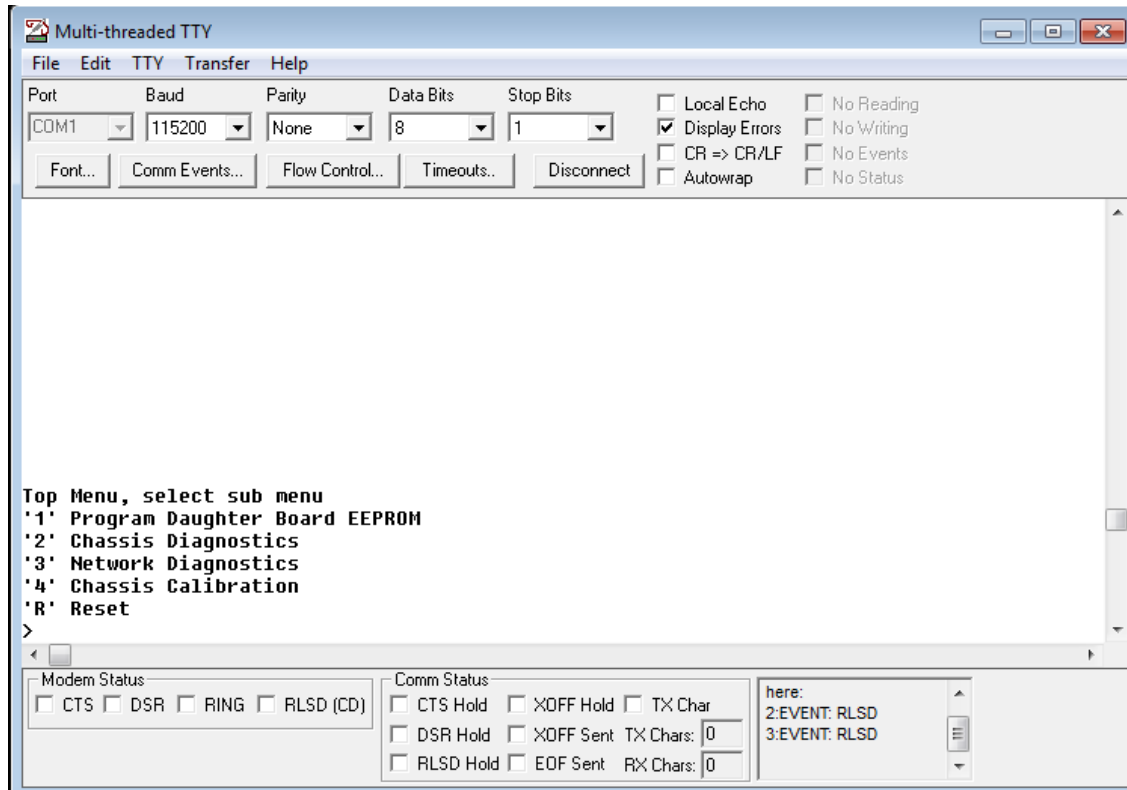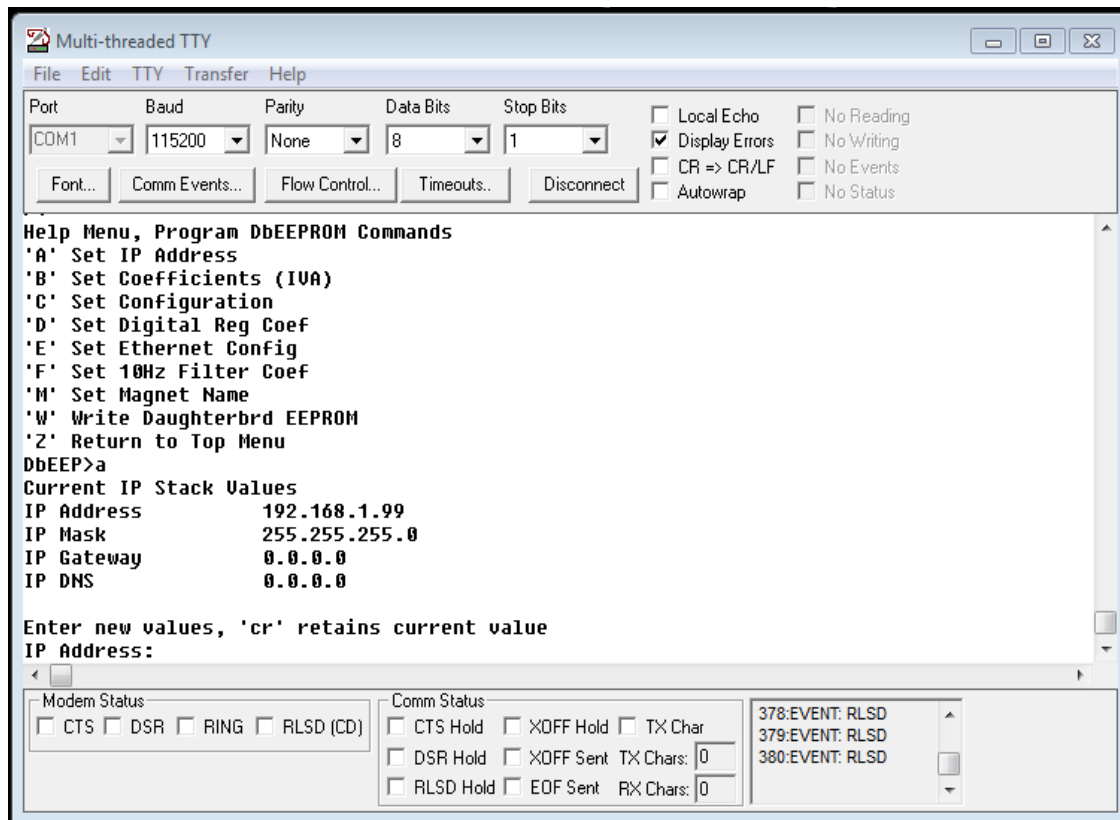

Screen shot 8

From the 'Top' menu type <**'1' Program Daughter Board EEPROM'**> and return. Then type <**'A' Set IP Address**> and observe that the screen shown below appears.
Enter the new IP address at the prompt and hit return. If necessary also enter the new **IP Mask** setting, the **IP Gateway** setting, and the **IP DNS** setting. If it is not necessary to enter any new values other than the **IP Address**, simply hit return at the prompt and the existing settings will be maintained. Once a carriage return has been entered for all four of the settings, type a '**W**' to write the settings, and at the prompt type either a '**Y**' or '**N**' depending on whether the settings should be saved or not. Type '**Z**', then '**R**' for Reset, and then either an '**S** or '**H**' to complete the process.
Once the reset process has completed, it is advisable to go back and confirm that the new settings were made as expected.

Screen Shot 9

Appendix B- Using UDPwin to control the PCRC

UDPWin.exe is a program that may be used with any PC with an Ethernet port to control the PCRC. With this program (available from BiRa Systems), the supply can be remotely turned on/off, current levels set based on a ramp time, status and error messages displayed. This section gives detailed instructions on how to use this program with the PCRC.

Before the program can be used the PC must be set up or configured with the correct IP address to communicate with the PCRC.

The default IP address of the PCRC is **192.168.1.99**. This IP address may be changed if necessary by following the instructions in Appendix A (Changing the daughtercard IP Address). It should be understood that the IP address of the PC and the IP address of the PCRC cannot be the same. It should also be understood that if more than one PCRC is on the same network, each PCRC must have its own unique IP address. If the PCRC IP address has been changed from the default address, see instructions at the bottom of this Appendix, 'What to do if the PCRC IP address has changed'.

If it is not necessary to change the IP address of the PCRC, continue following the instructions below to configure the PC to communicate with the PCRC. It may be useful to consult with IT before proceeding.

Instructions shown here to change the local IP address are based on a Windows 7 operating system and may need to be adjusted depending on the OS of the computer used. Note that the controlling PC must be manually configured for a static IP address on the same network, which means that the first three digits of the IP address (as shown in screen shot 4 below) must be the same as the controller's IP address indicated above in the previous paragraph. The fourth digit entered for the IP address must be different from the controller's IP address.

Navigate to the 'Local Area Connection Properties' display panel and select 'Internet Protocol Version 4 (TCP/IPv4)' as shown in the screen shot below.
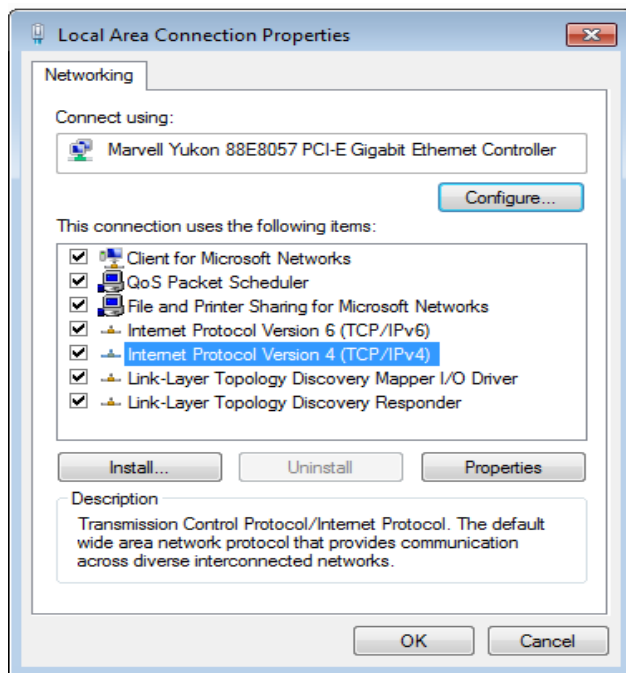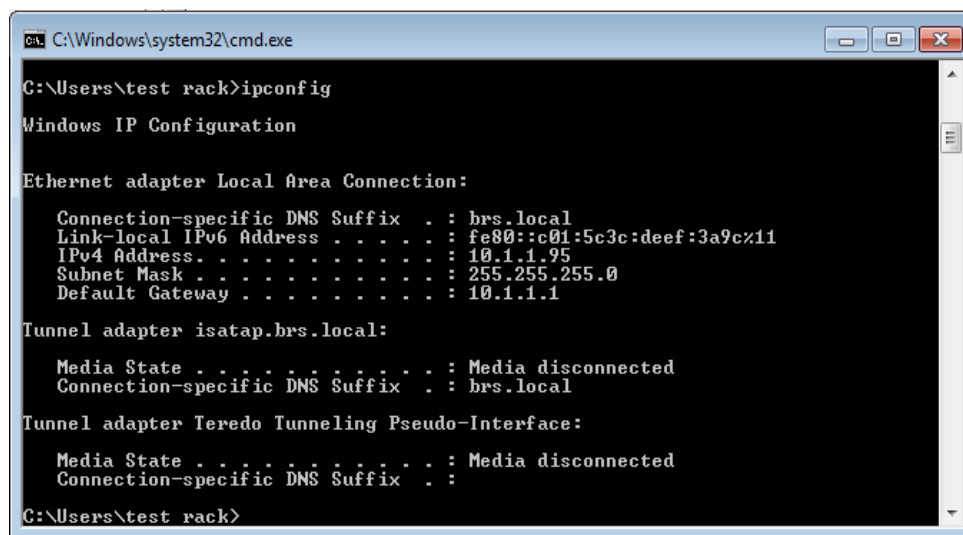

Screen shot 1

Click on the 'Properties' tab and observe the following display panel (Screen Shot 2), which is typical. It will be necessary to enter the actual IP address, Subnet mask, and Default Gateway that the LAN has provided into the display by using the 'Use the following IP address' display. One way to find out those IP values (assuming they are not already known) is to open up a Windows command window and use the command 'ipconfig'. Using the ipconfig command will display the actual IP values of the PC so that they can be entered. Screen shot 3 is an example of what the display will look like when the 'ipconfig' command has been entered. Note that the IPv4 Address, Subnet Mask, and Default Gateway values are shown and will be entered into the display shown in Screen shot 2 once the 'Use the following IP address' selection has been made. When those values have been entered, click on the 'Advanced...' button and follow the instructions below.
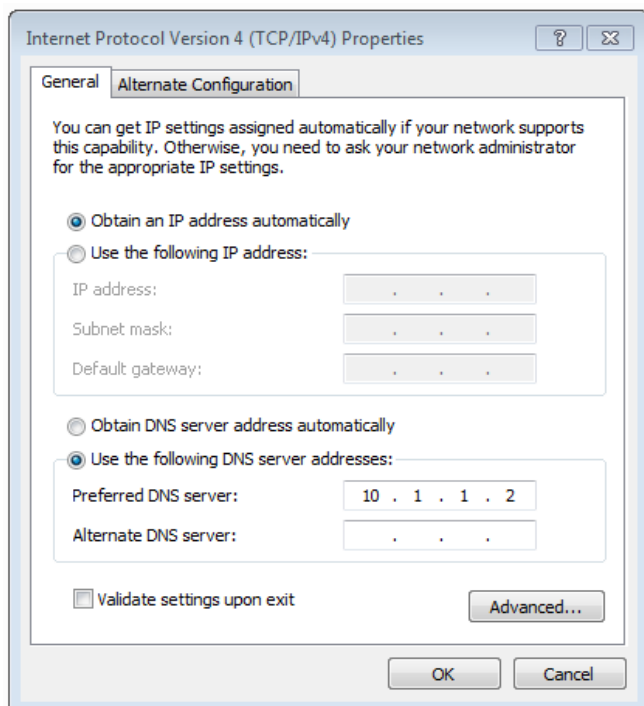
Screen shot 2

Screen Shot 3- Windows command window after the ipconfig command has been entered.

In the 'Advanced' tab window, click on the 'Add' button, and enter in the IP address window the following as shown in screen shot 4 below. IP address- **192.168.1.100**
Subnet mask- **255.255.255.0**

When done click the 'Add' button, then 'OK' and then 'OK' again to exit the display panel.
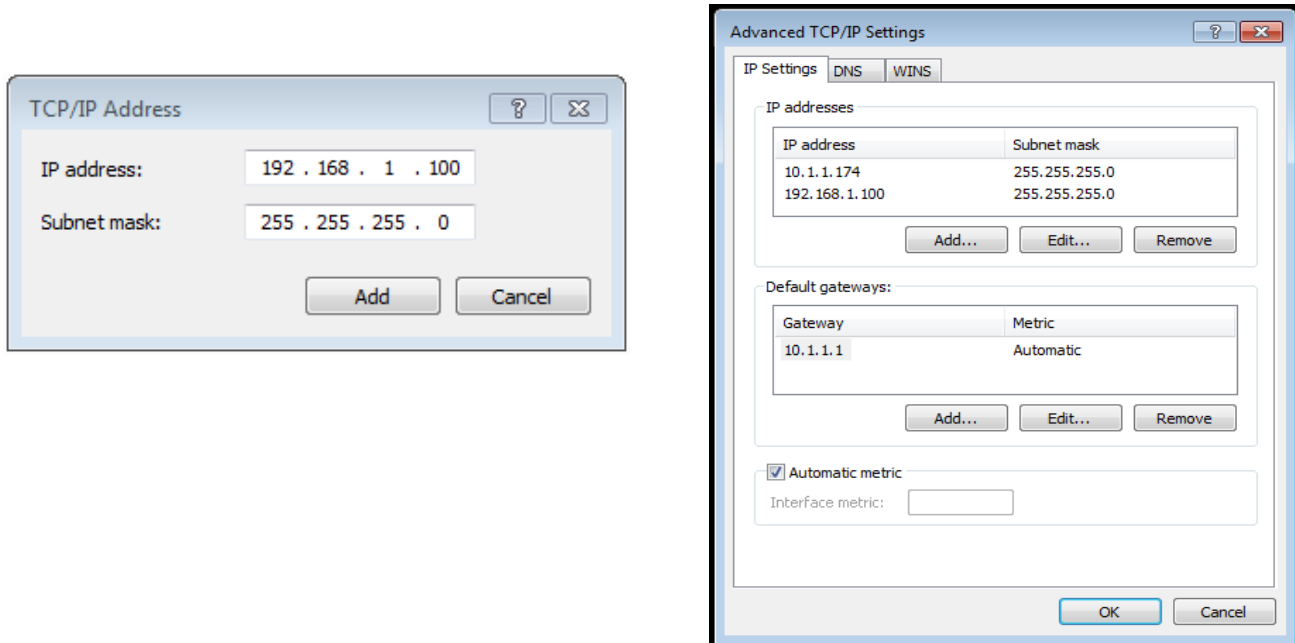
Screen shot 4-IP Address and Subnet mask entry panel, and 'Advanced' screen after entries were made.

Once these entries have been made, communication between the PC and the PCRC can now be established. Use the instructions immediately below if it is desired to use a PC not on a LAN to control the PCRC. Otherwise, proceed with the instructions below '**Using UDPwin to control'**.

If the PC used in not on a LAN and is connected directly to the PCRC with an Ethernet cable, enter the IP address and Subnet mask information shown above, directly into the 'Internet Protocol Version 4' panel (screen shot 2) after clicking on the 'Use the following IP address' button. It is not necessary to enter any information into the 'Preferred DNS Server' window if the connection is direct from the controlling PC to the PCRC.
When the IP address and Subnet mask information have been entered correctly the following commands will be used to program the power supply:

Precision Current Regulator Controller (PCRC) Command Summary
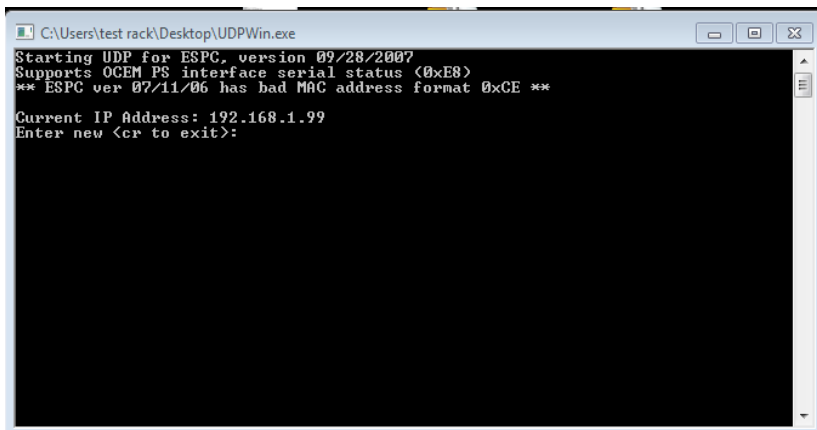
0xC0 Short Status check (wait for current data from ADC)
0xC1 Set Power Supply Current with unsynchronized ramp
0xC2 Set Power Supply Current with synchronized ramp
0xC3 Read ramp setpoints and Times
0xC4 Reset Interlocks
0xC5 Turn OFF Power Supply
0xC6 Turn ON Power Supply
0xC7 Turn ON Power Supply, reverse polarity

0xC8 Read Analog (reads 8 different ADC inputs)
0xC9 Read Error Message
0xCA Diagnostic Message 1
0xCB Diagnostic Message 2
0xCC Diagnostic Message 3
0xCD Short Status check (same as 0xC0 except uses stored ADC data)
0xCE Configuration Summary (new message with all configuration data)
0xCF Dynamic Data Message (new message with all configuration data)
0xE1 Communications Check Message (echo)
0xE3 Reset PCRC
0xE8 PS Serial Status (07-31-07 and later, for OCEM ATF2 modular PS)

Using UDPwin to Control
After ensuring that all connections between the PCRC, Power Supply, DCCT and Load are as described above, power on the PCRC and supply and confirm that the power on LED on the DCCT is lit. Proceed with the instructions below.

Open the **UDPWin.exe** application and observe the screen shown below.
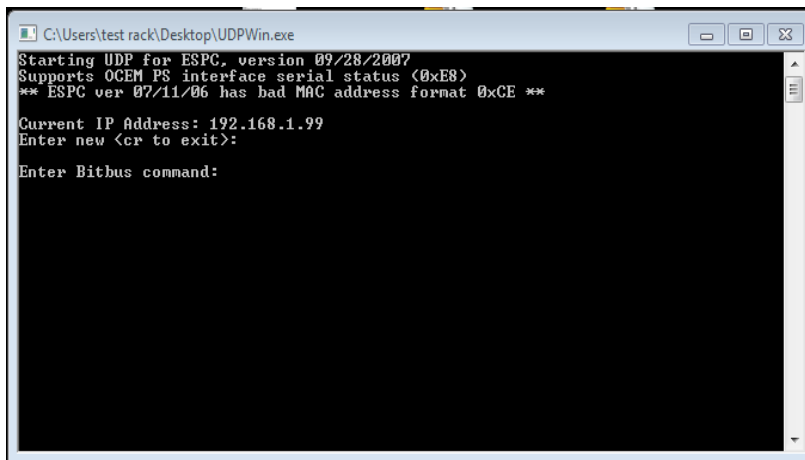
Screen Shot 5- UDPwin Initial Display

Note that the IP Address of the PCRC is displayed and that it is different than the IP Address that was entered in the instructions above for the 'Advanced' tab.

Hit the Return button on the computer keyboard and observe the 'Enter Bitbus command' prompt. Note that the green 'Ready' LED lamp on the PCRC front panel is solid lit and not flashing whenever an active Ethernet connection on the PCRC has been installed. Note also that each time that a UDPwin command is given that the 'Network' LED lamp on the PCRC front panel will flash briefly (assuming that proper communication has been established between the PC and PCRC).
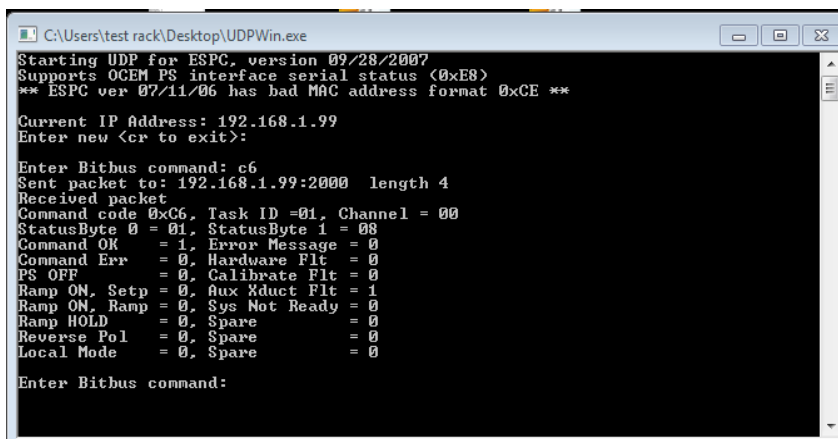
Screen Shot 6- Bitbus command prompt

The power supply output can be turned on by entering the command C6 as shown in the screen shot below.

Screen Shot 7- Using the 'C6' command to turn the supply on

The display indicates the command was successful. The 'Power' lamp on the front panel of the supply should be lit, and the red 'PS On' LED on the PCRC should also be lit. Observe that the display shows "PS OFF   = 0", which indicates that the output of the supply is On.

Turn the power supply output off by entering C5 at the command prompt as shown below.

```
C:\Users\test rack\Desktop\UDPWin.exe                          □ ▣ ⊠

StatusByte 0 = 01, StatusByte 1 = 08
Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF        = 0, Calibrate Flt = 0
Ramp ON, Setp = 0, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD     = 0, Spare         = 0
Reverse Pol   = 0, Spare         = 0
Local Mode    = 0, Spare         = 0

Enter Bitbus command: c5
Sent packet to: 192.168.1.99:2000  length 4
Received packet
Command code 0xC5, Task ID =02, Channel = 00
StatusByte 0 = 05, StatusByte 1 = 08
Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF        = 1, Calibrate Flt = 0
Ramp ON, Setp = 0, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD     = 0, Spare         = 0
Reverse Pol   = 0, Spare         = 0
Local Mode    = 0, Spare         = 0

Enter Bitbus command:
```

Screen Shot 8- Using the 'C5' command to turn the supply off

The power supply output is now turned off. Observe that the display indicates "PS OFF   = 1" indicating that the output of the supply is off. Note that simply turning the supply output on does not mean there is any output current. The output must first be turned on (by using the C6 command) before the command to set current can be delivered as shown below. First, enter the C6 command, ensure that the output of the supply is on, and then type in the C1 command as seen in screen shot 9. Observe the display is asking for number of setpoints to enter from 1 to 5.


```
C:\Users\test rack\Desktop\UDPWin.exe                          □ ▣ ⊠

Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF        = 1, Calibrate Flt = 0
Ramp ON, Setp = 0, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD     = 0, Spare         = 0
Reverse Pol   = 0, Spare         = 0
Local Mode    = 0, Spare         = 0

Enter Bitbus command: c6
Sent packet to: 192.168.1.99:2000  length 4
Received packet
Command code 0xC6, Task ID =03, Channel = 00
StatusByte 0 = 01, StatusByte 1 = 08
Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF        = 0, Calibrate Flt = 0
Ramp ON, Setp = 0, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD     = 0, Spare         = 0
Reverse Pol   = 0, Spare         = 0
Local Mode    = 0, Spare         = 0

Enter Bitbus command: c1
Enter number of setpoints (1 to 5)
```

Screen Shot 9- Using the 'C1' command

Enter 1 and hit return. At the prompt shown below enter the level of current desired, and then at the next prompt, the desired time the supply will take to reach the current setpoint. No current will be output until the time to setpoint value has been entered. It is recommended that a reasonable amount of time be allowed for the supply to reach the current output setpoint. 1Amp/second is a reasonable value to start with. For example, if 50 Amps is the current setpoint, then an entry of 50 for the setpoint time would result in the supply reaching 50 Amps in 50 seconds, or 1 Amp/second. An entry of 25 as the setpoint time would result in the output reaching 50 amps in 25 seconds, or 2 Amps/second.

```
C:\Users\test rack\Desktop\UDPWin.exe
PS OFF          = 0, Calibrate Flt = 0
Ramp ON, Setp = 0, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD      = 0, Spare         = 0
Reverse Pol    = 0, Spare         = 0
Local Mode     = 0, Spare         = 0

Enter Bitbus command: c1
Enter number of setpoints (1 to 5) 1
Enter setpoint 0 Power Supply current: 1
Enter setpoint 0 time (0.01 - 655.35): 1
Sent packet to: 192.168.1.99:2000  length 11
Received packet
Command code 0xC1, Task ID =04, Channel = 00
StatusByte 0 = 09, StatusByte 1 = 08
Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF          = 0, Calibrate Flt = 0
Ramp ON, Setp = 1, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD      = 0, Spare         = 0
Reverse Pol    = 0, Spare         = 0
Local Mode     = 0, Spare         = 0

Enter Bitbus command:
```

Screen Shot 10- 'C1' command to set the output to 1 Amp

The screen shot above highlights the number of setpoints (1), current setpoint (1 Amp), and the time that the supply took to reach 1 Amp (1 second). Once the supply has reached 1 Amp it will remain there until the next command is given. Note that the power supply front panel current display should indicate 1 Amp. Return the supply to 0 Amps by again entering the C1 command as shown below.


```
C:\Users\test rack\Desktop\UDPWin.exe
PS OFF          = 0, Calibrate Flt = 0
Ramp ON, Setp = 1, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD      = 0, Spare         = 0
Reverse Pol    = 0, Spare         = 0
Local Mode     = 0, Spare         = 0

Enter Bitbus command: c1
Enter number of setpoints (1 to 5) 1
Enter setpoint 0 Power Supply current: 0
Enter setpoint 0 time (0.01 - 655.35): 1
Sent packet to: 192.168.1.99:2000  length 11
Received packet
Command code 0xC1, Task ID =05, Channel = 00
StatusByte 0 = 09, StatusByte 1 = 08
Command OK    = 1, Error Message = 0
Command Err   = 0, Hardware Flt  = 0
PS OFF          = 0, Calibrate Flt = 0
Ramp ON, Setp = 1, Aux Xduct Flt = 1
Ramp ON, Ramp = 0, Sys Not Ready = 0
Ramp HOLD      = 0, Spare         = 0
Reverse Pol    = 0, Spare         = 0
Local Mode     = 0, Spare         = 0

Enter Bitbus command:
```

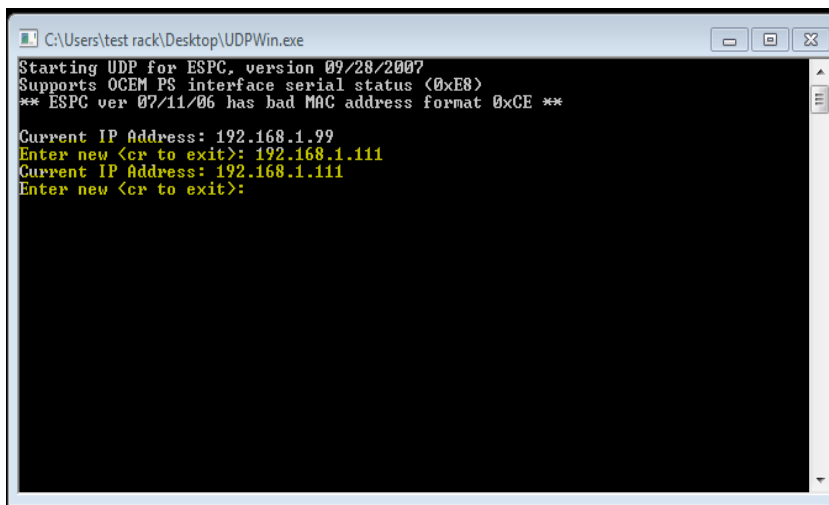*Screen Shot 11-* 'C1' command to return the supply to 0 Amps

After the C1 command is entered, the highlighted portion above shows 1 setpoint was entered, 0 Amps as the setpoint, and 1 second to return to 0 Amps. Once the supply has been returned to 0 Amps the output can be turned off. Never attempt to turn the supply output off when current is being output. Always return the supply to 0 Amps and then turn the output off.

What to do if the PCRC IP address has been changed
Follow these instructions in the event that a PCRC has had it's IP address changed:
Appendix A has instructions for changing the daughtercard PCRC IP address when that process becomes necessary, such as if there are two or more PCRCs on the same network. If using UDPWin to communicate with the PCRC, you must change the IP address in UDPWin each time that the application is reopened. Screen Shot 12 shows the application when it is initially opened, and shows the default IP Address (192.168.1.99), not the actual IP address if it was changed. In order to communicate with the PCRC, you must enter the actual IP address at the prompt 'Enter new <cr to exit>:' and then hit the Return button. In the example below the IP address was changed from 192.168.1.99 to 192.168.1.111 as seen in the highlighted portion.
If the IP address has not been changed since the application was last opened, simply hit Return at the prompt.

Screen Shot 12