

BBLR PLC Ladder Logic Description

Overview

The BBLR PLC program provides control for two power supplies. These power supplies are controlled remotely through the use of Modicon Momentum PLCs. The BBLR PLC sitewide name is plc-5e-bblr1 and the IP address is 130.199.111.66.

The PLC I/O base used for this project is the 170 ANR 120 91. This base has 8 discrete outputs, 8 discrete inputs, 6 analog inputs (+/- 10V), and 4 analog outputs (+/- 10V).

Each power supply controlled by the PLC utilizes the following Input/Output signals:

- 1) Voltage Set Point (Analog out)
- 2) On/Off Control (Discrete out)
- 3) Voltage Reference (Analog in)
- 4) Current Readback (Analog in)
- 5) On/Off Status (Discrete in)
- 6) Crowbar Status (Discrete in)
- 7) Klixon Faults (3) (Discrete in)

One I/O base is used for each power supply.

The master PLC consists of the I/O base, and a 171 CCC 960 20 processor adapter. The processor adapter has an Ethernet port for network communication, and an Interbus output port, for communicating with the slaves.

The slave PLCs consist of the I/O base and a 170 INT 110 00 communication adapter. The communication adapter has an Interbus input port and an Interbus output port. This allows for daisy-chaining multiple slaves to the master PLC. As many as 512 PLCs can be connected this way. The maximum cable length between PLCs is 1200 feet.

I/O Control Registers

The output of a PLC is controlled by writing specific data values to the I/O Control registers. The 8 discrete outputs of the master PLC are controlled through one discrete output control register. Each discrete output is mapped to one bit within that register. Likewise, each discrete input is mapped to a bit within a discrete input control register.

Each analog output and analog input is mapped to its own unique register within the master PLC. There are 6 analog input control registers and 4 analog output control registers. This means that there are 12 I/O Control registers in the master PLC.

When a slave PLC is connected to the master, another 12 registers within the master are reserved in order to control the slave's I/O. These reserved registers are assigned by a utility called "Traffic Cop", which is part of the ProWORX NxT application program.

Once a slave's control registers are assigned, communication between the master and the slaves is handled in the background. The ladder logic merely reads and writes to the registers as if the I/O were local to the master.

The I/O Control registers for the discrete I/O are listed below.

Discrete Outputs

Blue PS On (Logic 1 = On)	Register 40008, bit #16 (LSB)	to master PLC
Blue Common Fault (Logic 1 = Fault)	Register 40008, bit #15 (LSB)	to master PLC
Yellow PS On (Logic 1 = On)	Register 40020, bit #16 (LSB)	to slave PLC
Yellow Common Fault (Logic 1 = Fault)	Register 40020, bit #15 (LSB)	to slave PLC

Discrete Inputs

Blue PS On (1 = On)	Register 30002, bit #16 (LSB)	from master PLC
Blue PS Crowbar (0 = crowbar)	Register 30002, bit #15	from master PLC
Blue Klixon 1 (0 = temp high)	Register 30002, bit #14	from master PLC
Blue Klixon 2 (0 = temp high)	Register 30002, bit #13	from master PLC
Blue Klixon 3 (0 = temp high)	Register 30002, bit #12	from master PLC
Yellow PS On (1 = On)	Register 30014, bit #16 (LSB)	from master PLC
Yellow PS Crowbar (0 = crowbar)	Register 30014, bit #15	from master PLC
Yellow Klixon 1 (0 = temp high)	Register 30014, bit #14	from master PLC
Yellow Klixon 2 (0 = temp high)	Register 30014, bit #13	from master PLC
Yellow Klixon 3 (0 = temp high)	Register 30014, bit #12	from master PLC

The I/O Control registers for the analog I/O are listed below.

Analog Outputs

Blue PS Voltage SetPoint (Out)	Register 40009	to master PLC
Yellow PS Voltage SetPoint (Out)	Register 40021	to slave 1 PLC

Analog Inputs

Blue PS Voltage Reference	Register 30003	from master PLC
Blue PS Current Read Back	Register 30004	from master PLC
Blue RTD 1 Temp	Register 30005	from master PLC
Blue RTD 2 Temp	Register 30006	from master PLC
Blue RTD 4 Temp	Register 30007	from master PLC
Yellow PS Voltage Ref	Register 30015	from slave PLC
Yellow PS Current ReadBack	Register 30016	from slave PLC
Yellow RTD 1 Temp	Register 30017	from slave PLC
Yellow RTD 2 Temp	Register 30018	from slave PLC
Yellow RTD 4 Temp	Register 30019	from slave PLC

FEC Registers

The FEC communicates with the master PLC via the Ethernet port. It utilizes a specific set of read and write registers within the master PLC to control each power supply.

FEC Write Registers

Blue PS Voltage Setpoint	analog output value	Register 40100
Blue PS Command Register		Register 40101
Blue RTD Temp Threshold Register	analog output value	Register 40102
Blue Fault Reset Register		Register 40103
Yellow PS Voltage Setpoint	analog output value	Register 40110
Yellow PS Command Register		Register 40111
Yellow RTD Temp Threshold	analog output value	Register 40112
Yellow Fault Reset Register		Register 40113

FEC Read Registers

Blue PS Status Register		Register 40200
Blue Fault Status Register		Register 40201
Blue PS Voltage Reference	analog input from master	Register 40202
Blue PS Current Readback	analog input from master	Register 40203
Blue RTD 1 Temp	analog input from master	Register 40204
Blue RTD 2 Temp	analog input from master	Register 40205
Blue RTD 3 Temp	analog input from master	Register 40206
Yellow PS Status Register		Register 40210
Yellow Fault Register		Register 40211
Yellow PS Voltage Reference	analog input from master	Register 40212
Yellow PS Current Readback	analog input from master	Register 40213
Yellow RTD 1 Temp	analog input from master	Register 40214
Yellow RTD 2 Temp	analog input from master	Register 40215
Yellow RTD 3 Temp	analog input from master	Register 40216

The PLC passes the data back and forth between the FEC registers and the I/O Control registers under control of the ladder logic. The FEC should not “talk” directly to the I/O control registers.

Reading or Writing FEC Analog Registers

Each FEC analog register contains 16 bits. The analog registers do not use the MSB, and the LSB is always 0. The minimum value in an analog register is 0, representing 0 volts. The maximum value is 32,766d, which represents 10.238 volts.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0

MSB

LSB

The FEC analog input and analog output registers may be accessed at any time. The current read back and voltage read back analog input registers are constantly updated by the PLCs.

Reading Status Registers

Each Power Supply status register is 16 bits, of which 2 are utilized. It may be read by the FEC at any time.

X,X,X,X X,X,X,X X,X,X,X X, X, STBY, ON

ON = Power Supply On/Off (1 = On, 0 = Off)
 STBY = Standby (1 = standby)

Each Fault status register is 16 bits, of which 7 are used. It may be read by the FEC at any time. Each Fault bit is latched by the PLC. All fault bits are reset when the Fault Reset command is issued.

X,X,X,X X,X,X,X X, RTD3, RTD2, RTD1 K3, K2, K1, CB

CB = Crowbar Fault (1 = Crowbar Fault, 0 = Normal)
 K1 = Klixon 1 Fault (1 = Klixon 1 Fault, 0 = Normal)
 K2 = Klixon 2 Fault (1 = Klixon 2 Fault, 0 = Normal)
 K3 = Klixon 3 Fault (1 = Klixon 3 Fault, 0 = Normal)
 RTD1 = RTD 1 Overtemp Fault (1 = Over Temp Fault, 0 = Normal)
 RTD2 = RTD 2 Overtemp Fault (1 = Over Temp Fault, 0 = Normal)
 RTD3 = RTD 3 Overtemp Fault (1 = Over Temp Fault, 0 = Normal)

Writing Command Registers

The command registers are written by the FEC to control the Power Supplies. The master PLC takes no action until commanded by the FEC, unless a fault occurs. The power supply is set to off upon detection of a fault. The FEC must issue a Fault Reset command to clear the fault bit. The PLC will not allow the power supply to turn on when a fault exists. When commanded to standby, the power supply is turned on, and the voltage setpoint is forced to 0.

Each power supply command register is 16 bits, of which 3 are utilized.

U,X,X,X X,X,X,X X,X,X,X X,X, STDBY, ON

U = Update bit (1 = update, 0 = take no action)
ON = On/Off bit (1 = turn power supply ON, 0 = turn power supply OFF)
STDBY = Standby bit (1 = set power supply to Standby, 0 = On/Off bit to control)

The master PLC constantly polls the update bit. No action is taken by the PLC until the update bit is set. When it is set, the PLC enables or disables the PLC, depending on the state of the On/Off and Standby bits. The following table defines actions taken on each control bit combination. 'X' indicates don't care.

<u>U</u>	<u>ON</u>	<u>STDBY</u>	<u>Action</u>
0	X	X	No action taken
1	0	0	Turn Power Supply OFF
1	X	1	Set Power Supply to Standby
1	1	0	Turn Power Supply ON

The master PLC automatically resets the update bit once the command is recognized. The On/Off bit and Standby bit are not reset by the PLC.

Each Fault Reset command register is 16 bits, of which 2 are utilized.

U,X,X,X X,X,X,X X,X,X,X X,X,X,FR

U = Update bit (1 = update, 0 = take no action)
FR = Fault Reset bit (1 = Reset all Faults, 0 = no action)

ADO/PLC Interface

Following are recommended ADO setting and measurement parameters.

ADO Settings

<u>Name</u>	<u>Type</u>	<u>Legal Values</u>	<u>Notes</u>
ErrorResetA	Action	Reset	
BluePScontrolsS	Disc.Setting	Off /On/Standby	
BluePScontrolsS	Disc.Setting	Off /On/Standby	
BluePSVoltageS	Cont.Setting	0-6 volts	
YellowPSVoltageS	Cont.Setting	0-6 volts	
BlueTempThresholdS	Cont.Setting	0-100 Deg C	
YellowTempThresholdS	Cont.Setting	0-100 Deg C	

ADO Measurements

<u>Name</u>	<u>Type</u>	<u>Values</u>
BluePSstatusM	Disc. Meas.	Off /On/Standby
YellowPSstatusM	Disc.Meas.	Off /On/Standby
BluePScrowbarM	Disc. Meas.	Fail/Normal
YellowPScrowbarM	Disc.Meas.	Fail/Normal
BluePSVoltageM	Cont.Meas.	0-6 Volts
BluePSCurrentM	Cont.Meas.	0-100 Amps
YellowPSVoltageM	Cont.Meas.	0-6 volts
YellowPSCurrentM	Cont.Meas.	0-100 Amps
BlueKlixonHiTemp1M	Disc.Meas.	Fail/Normal
BlueKlixonHiTemp2M	Disc.Meas.	Fail/Normal
BlueKlixonHiTemp2M	Disc.Meas.	Fail/Normal
YellowKlixonHiTemp1M	Disc.Meas.	Fail/Normal
YellowKlixonHiTemp2M	Disc.Meas.	Fail/Normal
YellowKlixonHiTemp2M	Disc.Meas.	Fail/Normal
BlueHiTemp1M	Disc.Meas.	Fail/Normal
BlueHiTemp2M	Disc.Meas.	Fail/Normal
BlueHiTemp3M	Disc.Meas.	Fail/Normal
YellowHiTemp1M	Disc.Meas.	Fail/Normal
YellowHiTemp2M	Disc.Meas.	Fail/Normal
YellowHiTemp3M	Disc.Meas.	Fail/Normal
BlueTemp1M	Cont.Meas.	0-100 Deg C
BlueTemp2M	Cont.Meas.	0-100 Deg C
BlueTemp3M	Cont.Meas.	0-100 Deg C
YellowTemp1M	Cont.Meas.	0-100 Deg C
YellowTemp2M	Cont.Meas.	0-100 Deg C
YellowTemp3M	Cont.Meas.	0-100 Deg C

PLC Program

The name of the ladder logic file programmed into the master PLC is BBLR1.DCF. The PLC is configured so that if power is turned off and then on again, the program will be reloaded into the program memory from flash memory.

When the PLC is first powered up, the I/O control registers used for the discrete outputs and analog outputs are all set to zero. All FEC registers are also set to zero. This means all discrete outputs will be in the low state, and all analog outputs are at 0 volts.

Manual Date

This manual supercedes all others written before 1/11/06.

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