E-Cool 256 Corrector Voltage Monitor System

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Introduction

There are 256 current regulated corrector power supplies installed at MI-31. These 256 supplies are provided in 16 chassis that each contain 16 individual, bipolar, ground referenced power supplies. A total of 200 supplies correct the solenoidal fields in the cooling section and the balance of the supplies drive steering coils in the transport lines.

The need to monitor the output voltage of these supplies arose from the otherwise undetectable occurrence of ground faults developing in several of the corrector coils. Reading back current alone cannot reveal a ground fault in a load. It is necessary to determine the load resistance and compare it with a value that is known to be good for that device. Two voltage monitoring chassis were built to read back the output voltage of the 256 supplies—one voltage monitor chassis in each of the two relay racks. The I.R.M. chassis in each rack serves as the front end for the voltage monitor chassis in that rack and, therefore, knows the voltage and current for each of the supplies it controls. The I.R.M.s computes the load resistance of the coils, compares the resistance with known good values and alarms when it detects a ground faulted coil.

Inter-chassis wiring

Two I.R.M. chassis control the setting and read back of current for these supplies. Relay racks 213 and 214 equally control and monitor 128 correctors. Each of these relay racks contains an I.R.M., eight 16-channel corrector supplies, two 15 Vdc bulk supplies to provide +/- 15 V DC power for the correctors and voltage monitor, and one voltage monitor chassis. The +/-15 Vdc is distributed to the correctors through a distribution box, but the voltage monitor DC power is wired directly from the back of the bulk supplies.

The corrector chassis each have two cables for control and read back of current that connect to the I.R.M.s; and there is one cable on the rear of each corrector chassis for the voltage read back signals that connects to the voltage monitor chassis. Therefore, there are eight connectors on the rear of each voltage monitor chassis—one connector for each corrector chassis.

In Tables 1 and 2, the information in the first two columns shows which corrector chassis connects to which connector on the voltage monitor. “Chassis Connector #” is the connector as labeled on the back of the voltage monitor chassis. The “Chassis #” in column 2 identifies the corrector chassis. There is no label with this designation on it. Chassis 1 is the corrector chassis at the top of the rack, and chassis 8 is at the bottom. The “Device” column lists the devices monitored at the respective voltage monitor connector. The “PS Output” identifies the type of corrector. There are two slightly different types of bipolar supplies: a one amp and a two amp. The fifth column information is specific to the I.R.M.

Table 1. Relay Rack 213 Corrector Chassis Mapping and Cabling.
Voltage Monitor Chassis Node: VMON128A (131.225.137.72)
I.R.M. Node: node058C (131.225.137.54)

V. Mon. Chassis Connector #	Chassis # / Cable Len.	Device	P.S. Output	I.R.M. Chassis # / Memory Range
1	2 / 9’	CBC71 - C78	+/-1 A	8 / :0100 – 010F
2	6 / 6’	CBC40, C49, C50, C59, C60, C69, C70, C79	+/-1 A	12 / :0110 – 011F
3	1 / 9’	CBC61 - C68	+/-1 A	7 / :0120 – 012F
4	5 / 6’	CBC00, C09, C10, C19, C20, C29, C30, 39	+/-1 A	11 / :0130 – 013F
5	8 / 1.5’	CBS03, S04, S05, T02, T03, T04, T05; DYS1AZ, DYT6BZ	+/-2 A	16 / :0140 – 014F
6	4 / 7.5’	CBC91 - C98	+/-1 A	10 / :0150 – 015F
7	7 / 3’	CBC80, C89, C90, C99	+/-1 A	15 / :0160 – 016F
8	3 / 7.5’	CBC81 - C88	+/-1 A	9 / :0170 – 017F

Table 2. Relay Rack 214 Corrector Chassis Mapping and Cabling.
Voltage Monitor Chassis Node: VMON128B (131.225.137.73)
I.R.M. Node: node058A (131.225.137.53)

V. Mon. Chassis Connector #	Chassis # / Cable Len.	Device	P.S. Output	I.R.M. Chassis # / Memory Range
1	2 / 9’	CBC11 - C18	+/-1 A	2 / :0100 – 010F
2	6 / 6’	CBC51 - C58	+/-1 A	6 / :0110 – 011F
3	1 / 9’	CBC01 - C08	+/-1 A	1 / :0120 - 012F
4	5 / 6’	CBC41 - C48	+/-1 A	5 / :0130 – 013F
5	8 / 1.5’	CBQ04, R01, R02, R03, R04, R05, R06, S02	+/-2 A	14 / :0140 – 014F
6	4 / 7.5’	CBC31 - C38	+/-1 A	4 / :0150 – 015F
7	7 / 3’	CBA07, A06, B01, B02, D06, D07, D08, Q01	+/-2 A	13 / :0160 – 016F
8	3 / 7.5’	CBC21 - C28	+/-1 A	3 / :0170 – 017F

Chassis wiring and channel mapping

The circuit boards from which the voltage monitor is built are those of the MECC system (Modular Ethernet Configurable Controller). Refer to the MECC Manual for a more comprehensive description of these boards. Three boards of the MECC system are used: the digital controller board (ED_385117), the DAQ boards (ED-385130) and the LED display board (EC-385141). Figure 1 is the chassis wiring diagram. Figures 2 and 3 are photos of the inside of the chassis.

The digital board is used to control eight DAQ boards. The digital board is equipped with a Rabbit RCM module that communicates over Ethernet with an I.R.M. that reads the voltages and computes resistance values. This data is accessible as ACNET parameters. The RCM CPU issues the commands to perform data acquisition.

The DAQ boards are each 16 channels of 16-bit A/D. There are eight of these boards in the chassis that enables the reading of 128 channels of voltages.

Not shown in the wiring diagram is the power distribution. The DAQ boards require +/- 15 Vdc, and there is a kludge board with a regulator that produces +5 V off of the +15 V for the digital controller board.

The rear panel mounted connectors accepting the corrector voltages are 37 pin D-type that crimp to ribbon. Only the first 32 pins have ribbon cable inserted, though. This ribbon is split into two pieces with 16 ribbon wires in each that go to J5 and J4 connectors on the DAQ boards. These cables between the DAQ boards and rear panel are observable in the photo of Figure 3.

The digital board controls the converters on each DAQ board by means of only four wires to each converter. These four wires are those defined by the SPI convention. (See the Wikipedia description of SPI for more information on this standard.) In this chassis, the SPI "master" is the MECC digital board, and the SPI devices are the A/D converters on the DAQ boards. The three serial lines that are in common with all these SPI devices are the clock (SCLK), the serial master data out (MO) and the serial master data in (MI). There is a fourth wire (a "chip select") that is unique to each device. There needs to be, therefore, a total 16 chip select (CS) lines to the eight DAQ boards. For the controller to communicate with all 16 ADCs, two cables and connectors are used, J10 and J11, shown in Figure 1. The manner that these two ribbon cables are connected between the controller board and eight DAQ boards can be seen in the photo of Figure 2.

Table 3, 4 and 5 documents the signal wiring for control on these two cables. The pins on the Altera PLD on the controller are configured as necessary for routing these signals, and the DAQ boards contain jumper wires to rout the CS lines. Table 3 shows the DAQ board jumper configurations of the CS lines.

Tables 4 and 5 describe the control cable wiring of the two ribbon cables between the digital control board and DAQ boards. Notice that both cables have SCLK, MO and MI, and the pin out of the controller J10 and J11 connectors is chosen so that no hardwire numbering is needed for routing these common bus signals. The other signals in "J6 Connector Signal" column are the CS lines for which there are jumper wires.

One other small thing to notice is that the controller J10 connector only uses 20 of its 26 pins. There are two reasons for this: 1) only 20 pins are able to connect to J6 on the DAQ boards, and 2) the J10 connector was off set to avoid a conflict of signals with grounds between the boards that are interconnected.

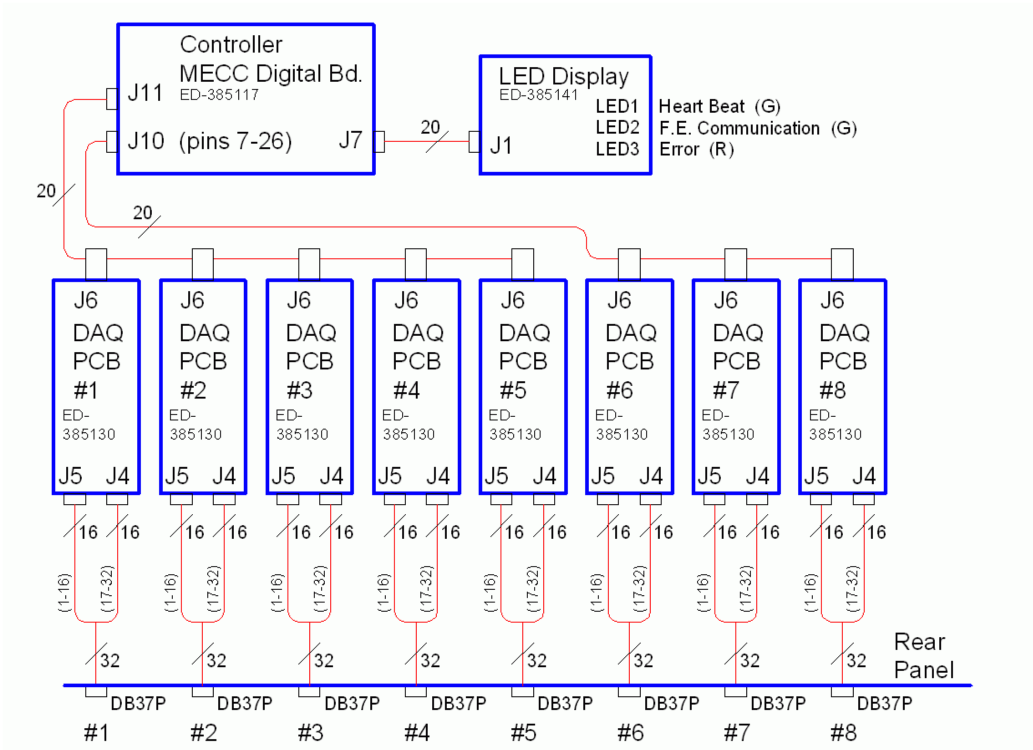

Figure 1. MECC system board wiring diagram. The only board not shown is the 5 V regulator.

Table 3. DAQ board jumper wires. Each DAQ board contains jumper wires for addressing purposes. The jumpers are the same in both voltage monitor chassis.

DAQ Board Jumper Connections	
Board #	**Chip Select Jumper Connections**
1	J6/6 to JP4 center
	J6/9 to JP5 center
2	J6/8 to JP4 center
	J6/10 to JP5 center
3	J6/11 to JP4 center
	J6/12 to JP5 center
4	J6/18 to JP4 center
	J6/20 to JP5 center
5	J6/15 to JP4 center
	J6/16 to JP5 center
6	J6/14 to JP4 center
	J6/9 to JP5 center
7	J6/15 to JP4 center
	J6/16 to JP5 center
8	J6/11 to JP4 center
	J6/12 to JP5 center

Table 4. Digital board J11 connector signals.

RIBBON 'A' – Bussed from Digital Board J11 to J6 on DAQ Boards 1 – 5					
Digital Board J11 Connector [20]		Altera Pin	DAQ Board		
Pin	Power or Altera I/O		J6 Pin	J6 Connector Signal	Jumper Connection
1	O	**37**	1	notClrA	
2	O	**38**	2	SPI SCLK	
3	DGND		3	DGND	
4	O	**39**	4	SPI MO	
5	I	40	5	SPI MI	
6	O	41	6	Bd 1 Mux 1	J6/6 to JP4
7	DGND		7	DGND	
8	O	42	8	Bd 2 Mux 1	J6/8 to JP4
9	O	43	9	Bd 1 Mux 2	J6/9 to JP5
10	O	44	10	Bd 2 Mux 2	J6/10 to JP5
11	O	45	11	Bd 3 Mux 1	J6/11 to JP4
12	O	48	12	Bd 3 Mux 2	J6/12 to JP5
13	DGND		13	DGND	
14	I/O	49	14		
15	O	50	15	Bd 5 Mux 1	J6/15 to JP4
16	O	51	16	Bd 5 Mux 2	J6/16 to JP5
17	DGND		17	DGND	
18	O	52	18	Bd 4 Mux 1	J6/18 to JP4
19	DGND		19	DGND	
20	O	**53**	20	Bd 4 Mux 2	J6/20 to JP5

Table 5. Digital board J10 connector signals.

RIBBON 'B' – Bussed from Digital Board J10 to J6 on DAQ Boards 6 – 8					
Digital Board J10 Connector [26]		**Altera Pin**	**DAQ Board**		
Pin	**Power or Altera I/O**		**J6 Pin**	**J6 Connector Signal**	**Jumper Connection**
1	(+)5V		n.c.	no header pin	
2	(+)5V		n.c.	no header pin	
3	I/O	55	n.c.	no header pin	
4	I/O	57	n.c.	no header pin	
5	I/O	58	n.c.	no header pin	
6	I/O	59	n.c.	no header pin	
7	O	**62**	1	notClrB	
8	O	**63**	2	SPI SCLK	
9	I	66	3	DGND	
10	O	**67**	4	SPI MO	
11	I	**68**	5	SPI MI	
12	DGND		6		
13	DGND		7	DGND	
14	DGND		8		
15	O	**69**	9	Bd 6 Mux 2	J6/9 to JP5
16	I/O	70	10		
17	O	71	11	Bd 8 Mux 1	J6/11 to JP4
18	O	72	12	Bd 8 Mux 2	J6/12 to JP5
19	I	73	13	DGND	
20	O	74	14	Bd 6 Mux 1	J6/14 to JP4
21	O	**75**	15	Bd 7 Mux 1	J6/15 to JP4
22	O	76	16	Bd 7 Mux 2	J6/16 to JP5
23	I	77	17	DGND	
24	I/O	78	18		
25	I	79	19	DGND	
26	I/O	80	20		

Figure 2. Chassis photo. The controller board is on the lower left with cables connected to its J10 and J11 connectors.

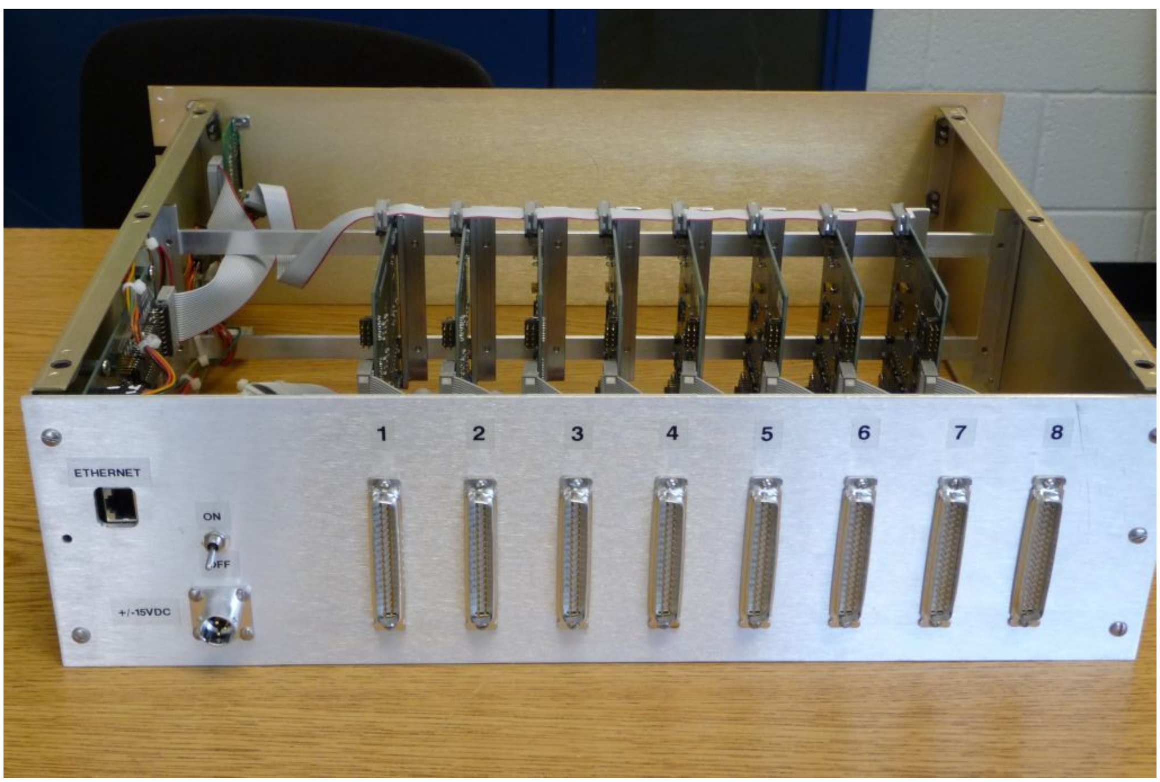

Figure 3. Photo of the chassis rear panel.