DynAmp

MODEL RCEM

PORTABLE FLEXIBLE VERSION

RECTIFIER MONITORING SYSTEM

Installation, Operation and Service Manual

Manual Item No. 043756

Rev. G

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DynAmp, LLC WARRANTY

Items and components manufactured by Seller for permanent installation are warranted for two (2) years from the date of shipment.

Items and components manufactured by Seller for portable and temporary use in more than one location are warranted to be free from defects in material and workmanship for a period of eighteen (18) months from the date of shipment.

Items and components not manufactured and resold by Seller are warranted by their manufacturer.

Warranty repair shall be, at DynAmp's option, in the form of repair or replacement of the defective items or components. Concerning warranty repairs, DynAmp will be responsible for DynAmp provided time, material and transportation costs (shipping or travel). Actual method of warranty repair / correction will be determined by DynAmp at DynAmp's sole option. Such warranty repair shall constitute a fulfillment of all DynAmp, LLC liabilities in respect to said items and components. In no event shall DynAmp, LLC be liable for consequential damages.

Information in this document is subject to change without notice.

This manual includes detailed drawings, installation, operation, service and maintenance. Users should evaluate the information in the manual and their particular application. DynAmp assumes no liability for any incidental, indirect, or consequential damages arising fro the use of this documentation.

While all information presented is believed to be reliable and in accordance with accepted engineering practices, DynAmp makes no warranties as to the completeness of the information.

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Hazard Warning!

GENERAL

Qualified technicians who are familiar with the warnings and instructions of this manual must perform all installation, maintenance and service.

Disconnect power to the system before servicing or replacing fuses.

Use of the equipment in a manner not specified by the manufacturer can impair the protection provided within.

DynAmp does not assume liability for the customer's failure to comply with the rules and requirements provided in this manual.

HAZARDOUS VOLTAGE

This equipment is designed to be connected to hazardous electric voltages. Ignoring the installation precautions and warnings can result in severe personal injury or equipment damage.

To avoid the risk of electrical shock or fire, the safety instructions and guidelines in this manual must be followed. The electrical specifications must not be exceeded and the unit must be installed according to directions provided.

INSTALLATION

This equipment is intended for indoor use only. It should be mounted in a well-ventilated area, away from high heat, dust, and corrosive atmosphere. The ambient temperature must not exceed 55°C.

The laptop computer must be located well away from magnetic fields. Failure to comply may result in damage to the computer.

For mounting considerations that fall outside the recommended specifications provided in this manual, the factory should be contacted for approval.

This unit is rated for installation category III, 300V and pollution degree 2.

Symbol Identification:

General definitions of safety symbols used on equipment and manual.

Caution/Warning: Refer to accompanying documents for instructions.

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DynAmp, LLC Customer Support

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REVISION PAGE

Page	Rev	Reason For Revision	Date
All	NEW		06/01
23, 37-46	A	Add Integrator PC Board calibration procedure and Update Appendix B to revised spreadsheets	10/01
37	B	Revise Appendix B-2: Minimum Requirements for Laptop Computer	10/03
45-54	C	ECO-3099 - Revise Appendix B: Add Devices/Leg Command Button	08/04
45-54	D	Update to DynAmp, LLC, ECO-3102 – Revise Appendix B: Add ANSI Rectifier Circuit select	12/04
v, 1, 27, 36	E	Update fuse precautions per ECR 1304	07/06
all	F	PAR 10245 – Handling & Storage, ECR 1440- Calibration Intervals / New Manual Format	06/11
35, 45	G	ECR1683 - Revise Spare Parts List, Table 8.1, Computer /Software requirments	03/12

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FIGURES

TABLES

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1. SAFETY

1.1 OVERVIEW

This equipment is designed to be connected to hazardous electric voltages. Ignoring the installation precautions and warnings can result in severe personal injury or equipment damage. The following are general guidelines that should be followed when installing, operating and servicing the RCEM.

- Qualified technicians who are familiar with the warnings and instructions of this manual must perform all installation, maintenance and service.
- Always follow all local and plant safety procedures.
- The equipment covers should remain closed at all times during operation to ensure safety of personnel. Only authorized personnel or technicians should be allowed to open and service the equipment.
- Cover #3 (PC Board Cover) may be removed if the operator needs access to the diode waveform connectors. Use caution whenever the cover is removed.
- Only qualified technicians should perform Service. If use of an oscilloscope becomes necessary during operation or servicing, either the scope must be floating or ungrounded, or differential probe(s) must be used. The equipment is isolated from the mains via the power transformers. If a grounded scope is used, a hazardous condition is created since current will flow through the probe to ground.
- Replace fuses with correct type, size and value. Refer to the servicing instructions or spare parts list for more information on replacement fuses. Do not bypass the fuses or modify the electronics. Disconnect power to the system before replacing fuses. Failure to follow these instructions will result in intermittent operation and premature failure and will void the warranty.
- The equipment is not intrinsically safe. Do not place in explosive atmospheres.
- The Current Transducers are double insulated to protect the operator from possible hazardous voltage potentials of the rectifier. The transducers are also protected from heat by a protective sheath.
- Make sure the transducer cables and interconnection cables are kept well away from hazardous voltage potentials and heat sources inside the rectifier.
- Keep the electronics enclosure as far as possible away from the hazardous voltage potentials of the rectifier.
- Use of the equipment in a manner not specified by the manufacturer can impair the protection provided.

DynAmp does not assume liability for the customer's failure to comply with the rules and requirements provided in this manual.

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2. HANDLING AND STORAGE

DynAmp products are engineered and manufactured for use in industrial environments. However, they contain sensitive electronic and mechanical components which may be damaged and fail if not handled and stored properly. All products must be handled and stored with the same care as any precision measurement instrument. Severe bumps or jolts may damage internal parts and cause malfunction or premature failure. DynAmp products are designed and assembled with conformal coating, shock mounting, and environmental seals, when appropriate or when specified. However, this protection requires that the product must be properly installed and operational before the protection is fully functional. Therefore, adequate protection from humidity, shock, and temperature must be provided during handling and storage prior to installation.

The handling and storage of equipment must be sufficient to meet the storage temperature and humidity specifications of the product and to prevent any condensation or contact with water or any other liquid. The storage location and container or crate must provide adequate protection from precipitation (rain, snow, ice) and direct water contact. Adequate shelter must be provided to prevent the accumulation of precipitation (rain, snow, ice) and water which can lead to the deterioration or failure of shipping containers or crates and cause water ingress. Storage in coastal or industrial areas subject to salt-laden or corrosive air or areas of wind-driven sand or other abrasive dust must be adequate to prevent the deterioration or failure of shipping containers or crates and cause ingress. Frequent inspection of storage areas and storage containers or crates is required to ensure proper storage conditions are being maintained.

If the shipping container or crate is opened and/or the equipment is removed for inspection prior to installation, the equipment must be repackaged in the original undamaged container or crate in the same manner as it was shipped to prevent environmental damage or placed in a storage location that meets the required environmental and storage conditions.

General product storage temperature and humidity requirements:

Storage Temperature:	-40 to 70°C
	-40 to 158°F
Storage Humidity:	85%, non-condensing

DynAmp, LLC does not assume liability for the customer’s failure to comply with handling and storage requirements.

For further assistance, contact DynAmp customer support.

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3. DESCRIPTION

3.1 GENERAL

The DynAmp **RECTIFIER MONITORING SYSTEM Model RCEM** is designed for isolated measurement of device currents in multiple path power rectifiers.

Model RCEM is a monitoring system composed of a 120 Channel Data Acquisition Unit, a laptop computer, Flexible Current Sensors, and the interconnection cables.

A 240 Channel RCEM is also available. This system consists of two 120 Channel Data Acquisition Units, a laptop computer, LEM~flex Current Transducers, and interconnection cables.

3.2 DEFINITIONS

The following terms are used extensively in this manual:

Channel	Flexible Current Sensor and associated electronic circuitry
DAU	Abbreviation for Data Acquisition Unit; rectifier monitoring system active electronics hardware
Device	Rectifier semiconductor device (such as a diode or thyristor).
Current Sensor	DynAmp Flexible Current Sensor
I/O	Input/Output device.
Laptop Computer	Portable computer used to display the rectifier data
Leg	Group of rectifier devices connected in parallel. Symbolically referred to as **R** or **S** in ANSI circuit diagrams
Multiplexer Address	The binary address that selects one-of-six integrator card leg output signals.
USB	Universal Serial Bus
RCEM	DynAmp Rectifier Condition Evaluation Monitor
RMS	root mean square – Effective value of a waveform

3.3 DATA ACQUISITION UNIT

The Data Acquisition Unit contains the following elements:

1.) Analog Card Rack containing:

2.) Backplane

3.) Reset Sync Cards

4.) Integrator Cards

5.) Personal Daq/56 – USB Data Acquisition Module

6.) USB Extender Receiver

7.) Digital Interface Module

3.4 LAPTOP COMPUTER

The laptop computer is connected to the Data Acquisition Unit via the USB Extender Sender and RJ-45 cable. The laptop computer provides a means of displaying the rectifier data. It also allows access to the internal test signal generator. The data is displayed on a spreadsheet program.

3.5 FLEXIBLE CURRENT SENSORS

The 3.625 ID Flexible Current Sensor is the standard sensor supplied with the RCEM. Other Flexible Current Sensor sizes are available from DynAmp, if required. Presently they include inside diameter (I.D.) sizes of 1.000", 1.500", 2.750", 4.250", and 2.875” x 5.500” models. All Flexible Current Sensors have the same output, so they may be interchanged.

3.6 MAGNETIC FIELD STATEMENT

The magnetic field from a high current DC bus may damage or destroy the laptop computer hard disk drive, or floppy disks. To avoid damage **the laptop and floppy disks should be kept as far from the DC bus as practicable.** Protect floppy disks in a magnetic shielded case. This warning applies at all times.

The destructive effect of a magnetic field on a hard disk drive depends on the orientation of the laptop computer within the field, and the degree of magnetic shielding provided by the hard disk enclosure. Laptop computer and hard disk manufacturers do not provide specifications for maximum magnetic field outside the hard disk enclosure.

It is difficult to accurately specify a maximum safe Gauss level for laptop computer disk drives. Our best estimate is a maximum ambient magnetic field strength of 25 to 50 Gauss for safe laptop computer operation.

This manual provides recommended guidelines for use of the rectifier monitoring system. It is the sole responsibility of the customer to assure safety of equipment and personnel when using this product.

4. SPECIFICATIONS

The specifications for the Rectifier Condition Evaluation Monitor are listed in Table 4.1.

TABLE 4.1
RECTIFIER CONDITION EVALUATION MONITOR SPECIFICATIONS

Physical		
Dimensions		Comments:
Data Acquisition Unit	22”W x 23”H x 13.75”D (559 x 584 x 349) mm	
Flexible Current Sensor	3.625 ID (92 mm)	Standard Size (other sizes are available)
Sensor cable length	4.5 ft. (1.37 m)	
Weight		
Data Acquisition Unit	55 lbs. (20.5 kg)	
Flexible Current Sensor	0.76 lbs. (0.28 kg)	3.625 ID Flexible Current Sensor
Interconnection Cable		
Length	33 ft (10 m)	Data Acquisition Unit(s) to Flexible Current Sensor
USB Cable Length	15 ft (5 m)	Computer to USB Extender Sender
Serial Data Cable Length (Type Category 5E)	150 ft (45.7 m)	USB Extender Sender to Data Acquisition Unit
USB Cable Length	15 ft (5 m)	Data Acquisition Unit #1 to Data Acquisition Unit #2 (240 Channel Systems)

Environmental		
Temperature		Comments:
Data Acquisition Unit	0°C to 50°C	
Flexible Current Sensor	-20°C to +150°C	
Humidity		
Data Acquisition Unit	85% RH non-condensing	
Flexible Current Sensor	85% RH non-condensing	

TABLE 4.1
RECTIFIER CONDITION EVALUATION MONITOR SPECIFICATIONS (CONTINUED)

Electrical		
AC Supply		Comments:
Voltage	90 – 135 Vac 175 – 264 Vac	Automatic Selection
Frequency	50/60 Hz	
Basic Accuracy	3%	Flexible Current Sensors
Measuring Range		
Flexible Current Sensor	0…2000A	
Data Acquisition Unit	10 to 100%	
Output		
Analog Output	1V/1kA	Waveform Connectors
Serial Data	USB Port	Laptop Computer

Safety		
Isolation		Comments:
Flexible Current Sensor	3000 VAC, 1 Minute @ 60 Hz	
Data Acquisition Unit Output to line	Installation Category III @ 300 Volts	

Other		
Visual Indicators		Comments:
Data Acquisition Unit	+24V LED MUX A0 – MUX A2 LEDs TEST MODE LED TEST A0 – TEST A1 LEDs	
Personal Daq/56 Update Rate	4 seconds for 120 channels	

5. TECHNICAL DESCRIPTION

5.1 GENERAL

The Data Acquisition Unit (DAU) contains one analog card rack with backplane, reset sync cards, and integrator cards. The Data Acquisition Unit also contains the Personal Daq/56 USB Data Acquisition Module, the USB Extender Receiver, and two power supplies. The Personal Daq/56 accepts a maximum of 120 device data channels. The Data Acquisition Unit #2 in a 240 Channel system does not contain an USB Extender Receiver.

5.2 BASIC THEORY OF OPERATION

Each current sensor is associated with the measurement channel for a specific rectifier element. The signal from each current sensor is conducted to the DAU via an individual 2-conductor cable and a wire pair within the interconnection cable.

The output from a current sensor is a voltage waveform corresponding to the instantaneous change of current in the rectifier device associated with that current sensor. Integrating the output signal of the current sensor returns it to the current waveform being conducted by the rectifier device. The current waveform is converted to a DC voltage proportional to the RMS value of the integrated signal.

The analog card rack contains multiplexer circuits to switch the DC voltage signals into the twenty analog input channels located in the Personal Daq/56. The digital I/O in the Personal Daq/56 controls the multiplexer. The multiplexing scheme can be described as a 6-leg by 20-channel matrix. One of six integrator channels ("legs") is addressed on all 20 integrator cards.

5.3 ANALOG CARD RACK

The analog card rack contains the following elements: one backplane, two reset sync cards, and twenty integrator cards. See Figure 5.1.

DAU Data I/O Connector Variations		
DAU Version	Data Port	USB Port
120 Channel	Installed	N/A
240 Channel DAU #1	Installed	USB “A”
240 Channel DAU #2	N/A	USB “B”

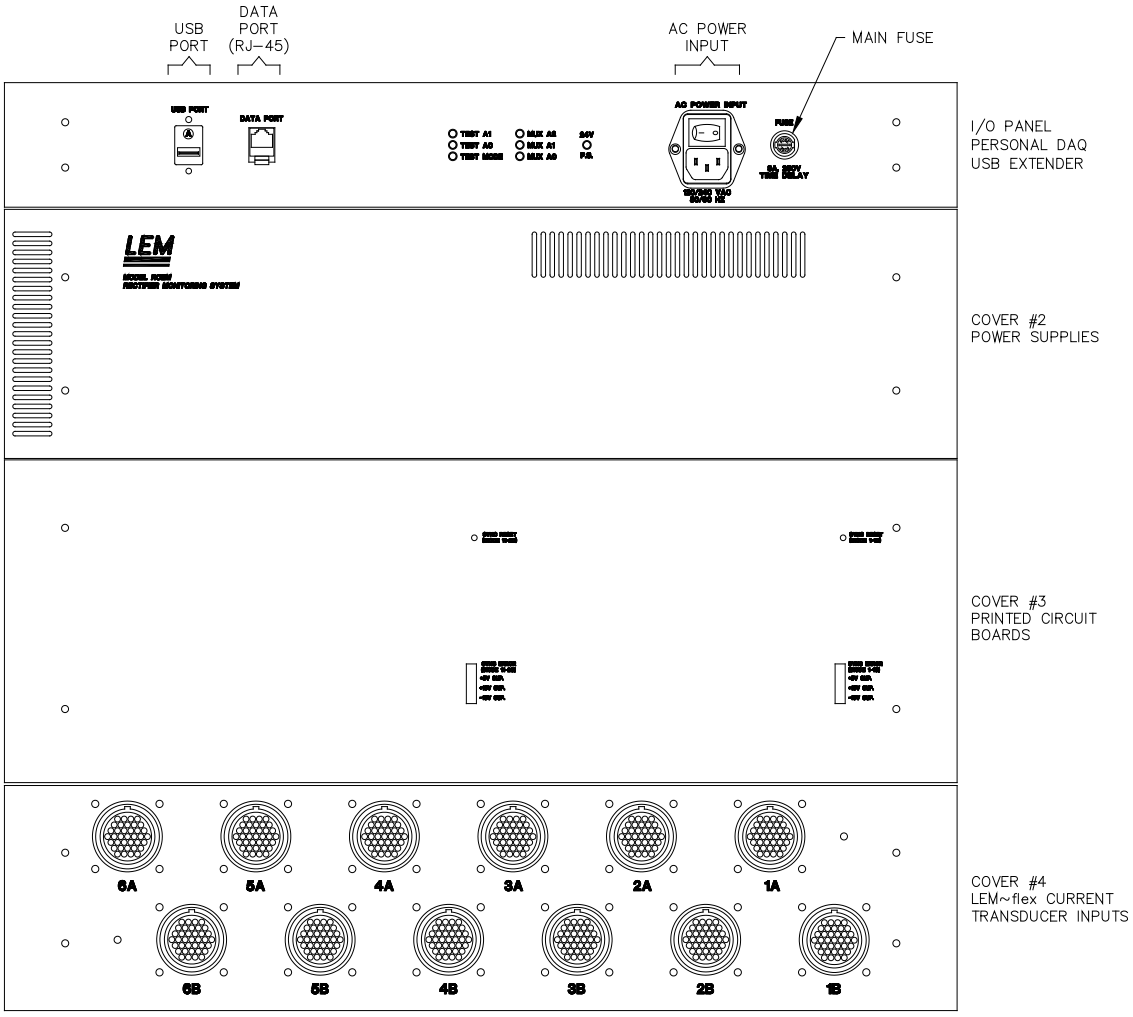

Figure 5.1
Analog Card Rack

5.4 BACKPLANE

The digital interface circuits to/from the Personal Daq/56 are located on the Data Acquisition Unit backplane. The backplane also contains the reset sync cards connectors, the integrator card connectors, the signal input connectors from the current sensors, and the power circuits.

The backplane also contains the ac zero-crossing detector circuit. This circuit supplies the ac zero-crossing timing pulse to the reset sync pulse generator and the test signal generator circuits located on the Reset Sync Cards.

5.5 POWER CIRCUITS

The power circuits in the Data Acquisition Unit consist of the ac power input circuit, the regulated quad output power supply, the +12V power supply, the + 5V power supply, and the dc power input circuits.

The ac power input circuit contains varistors used to clamp transient voltages and a filter module to reduce line-transmitted noise. The fuses are used to protect the power supply and the ac zero-crossing detector.

The regulated power supply has 4 output voltages. They are +5VDC, ±15VDC, and +24VDC. The regulated voltages all have a common ground circuit. The power supply is mounted on card rack side panel. This power supply may be accessed by removing Cover #2.

The power supply outputs are connected to the backplane. LC filters located on the backplane filter the regulated voltages. The +24VDC is connected to the digital interface module as well as powering the rectifier/test relays on the integrator cards.

The isolated +12V and the +5V power supplies are also mounted on the card rack side panel. The +12V power supply is used to power the Personal Daq/56 while the +5V power supply provides power to the USB Extender Receiver. All three power supplies have a universal ac power input circuit rated at 100-240VAC, 50/60Hz.

5.6 ANALOG INPUT CONNECTORS

There are twenty analog input connectors located to the bottom edge of the backplane. The current sensors are connected to these connectors via twelve circular connectors located on the analog input panel. The backplane connects the current sensor output signals to the integrator inputs. Each integrator card has an associated 12-position waveform output connector.

5.7 INTEGRATOR CARDS

Each integrator card provides electronic circuitry for six channels. Each integrator includes the following:

1. rectifier/test DPDT relays
2. active integrator circuits
3. RMS-to-dc converters
4. (1) 6-to-1 analog multiplexer

The circuits found on each integrator card are discussed below.

1.) Rectifier/Test DPDT Relay.

Each of the test signal DPDT relays is used to switch the input source for two integrator circuits. The normally closed relay contacts connect the integrator inputs to the current sensor signals. Energizing the ganged relay coils selects the test signal as the input source for all integrator circuits. A digital I/O channel in the Personal Daq/56 controls the relays.

2.) Active Integrator Circuits.

Each integrator card contains six active integrator circuits. Each integrator circuit uses a CMOS analog switch to reset the integrating capacitor. Integrator reset pulses are buffered by CMOS digital buffers.

Integrator resets are synchronized to the ac line supplying power to the DAU. Reset synchronization is established by the Reset Sync Cards during its

initialization sequence upon power-up. A “RCEM RESET” command from the spreadsheet program will also cause the integrator resets to synchronize to the ac line.

To work properly, each integrator must be reset when the associated rectifier device is not conducting current during the commutation cycle. In a full-wave, three leg rectifier, the reset pulse will occur at a different instant for each integrator on the integrator card. The six integrator channels on each integrator card are referred to as Leg 1, Leg 2, Leg 3, Leg 4, Leg 5, and Leg 6.

The integrator circuit outputs are scaled to 1V/1kA. The output of each integrator circuit is available at the 12-position waveform output connector located on the top edge of each integrator card. The integrator circuit outputs are also connected to the pc board edge connector. These outputs are used by the reset sync cards to generate the reset pulses. The final connection is to the RMS-to-dc converters. This is the output signal path.

3.) RMS-TO-DC Converter.

The RMS-to-dc converters are used to convert the device current waveform to a dc voltage. The outputs of the RMS-to-dc converters are connected to the 6-to-1 multiplexer.

4.) 6-to-1 Analog Multiplexer Circuit.

The multiplexer used is an eight input, one output CMOS analog multiplexer. Inputs S1 through S6 are connected to the six RMS-to-dc converter outputs. Inputs S7 and S8 are not used. The output of the 6-to-1 multiplexer is connected to a non-inverting amplifier with a gain of 5. This output is routed to the Personal Daq/56 via the backplane and a wiring harness.

5.8 RESET SYNC CARDS

This circuit generates the reset pulses required to control the analog integrator circuits. The device waveform signal from the integrator card is applied to a window comparator. The outputs of the window comparators are connected to a microcontroller. The microcontroller uses the ac zero-crossing signal from the backplane and the outputs from the window comparators to generate the reset signals.

The first Reset Sync Card generates the reset signals for the first ten Integrator Cards while the second Reset Sync Card generates the resets for the second group of ten Integrator Cards. The reset signals are available on connectors P23 and P24 located on the backplane. See Figure 5.2 for the Reset Pulse Connector Location and Figure 5.3 for Reset Pulse Signal Location.

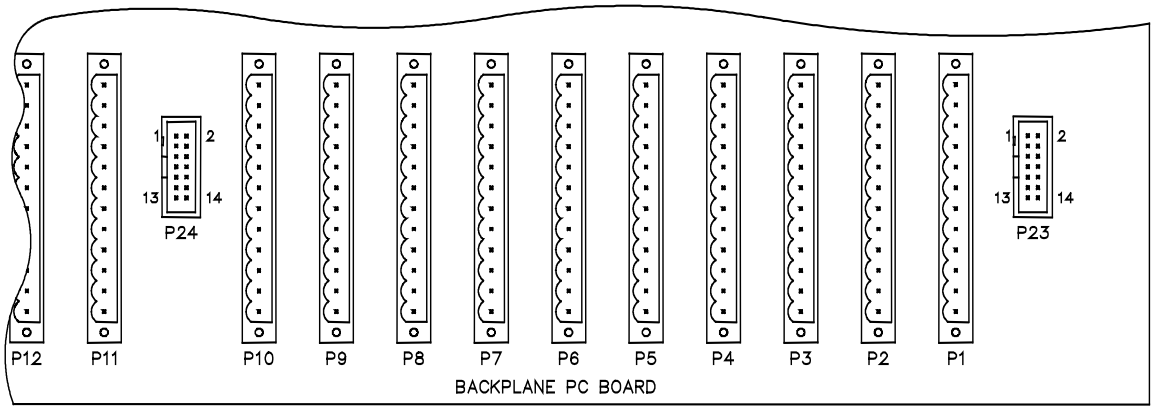

Figure 5.2
Reset Pulse Connector Location

	PIN NO.		
Reset Pulse 1	1	2	Common
Reset Pulse 2	3	4	Common
Reset Pulse 3	5	6	Common
Reset Pulse 4	7	8	Common
Reset Pulse 5	9	10	Common
Reset Pulse 6	11	12	Common
Zero-crossing	13	14	Common

Notes:
1) P23: Channels 1 – 10
2) P24: Channels 11 – 20

Figure 5.3
Reset Pulse Signal Location

5.9 TEST SIGNAL GENERATOR

The reset sync card also contains the test signal generator. A second microcontroller is used to generate the test pattern. This microcontroller also uses the ac zero-crossing circuit to generate the pattern. The timing signals from the microcontroller is connected to the signal generator consisting of op amps U11 and U14, analog switch U9, and a reference voltage produced by U12. The test signal waveform for the 571A test signal is shown in Figure 5.4.

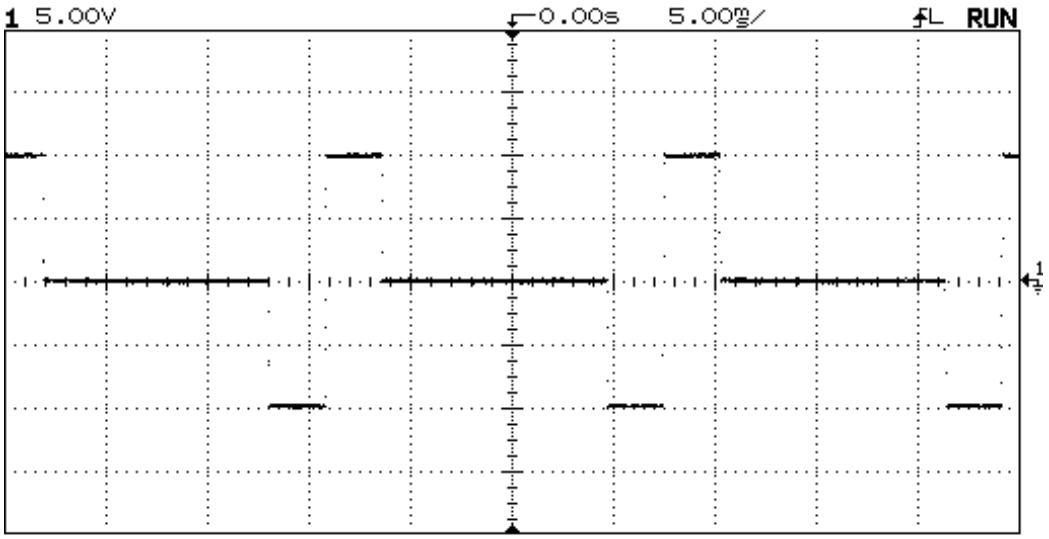

Figure 5.4
571A Test Signal Waveform

5.10 PERSONAL DAQ/56

The Personal Daq/56 is a self-contained USB data acquisition module with twenty analog input channels and 16 digital I/O channels. The Personal Daq/56 is located on the top end panel of the Data Acquisition Unit. See Figure 5.5.

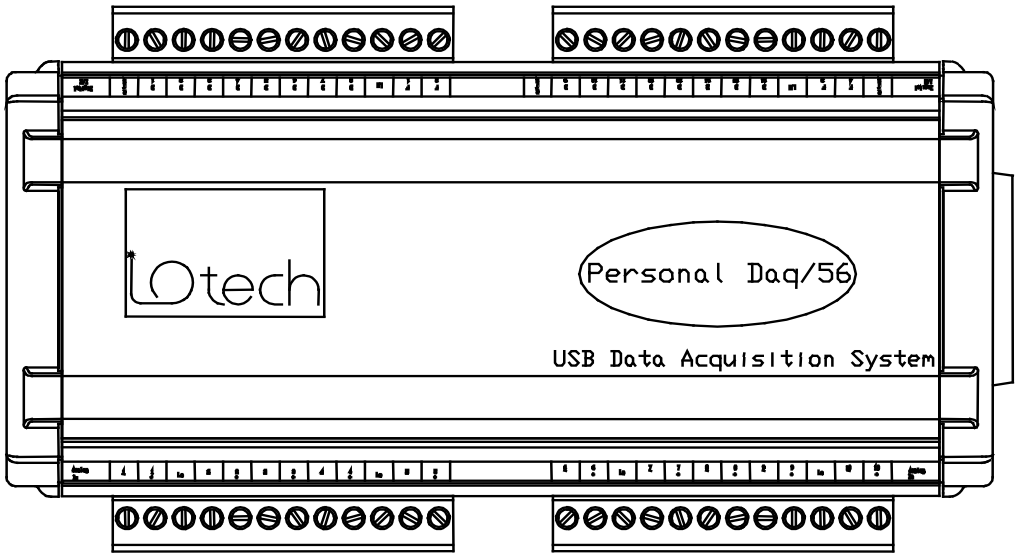

Figure 5.5
Personal Daq/56

5.11 USB EXTENDER RECEIVER

The USB specification severely limits the distance of an USB peripheral from the computer. The USB Extender allows that distance to be increased to a maximum distance of about 300 feet. The USB Extender Receiver is located near the Personal Daq/56 on the top end panel of the Data Acquisition Unit. See Figure 5.6. The receiver is powered by an isolated +5V power supply.

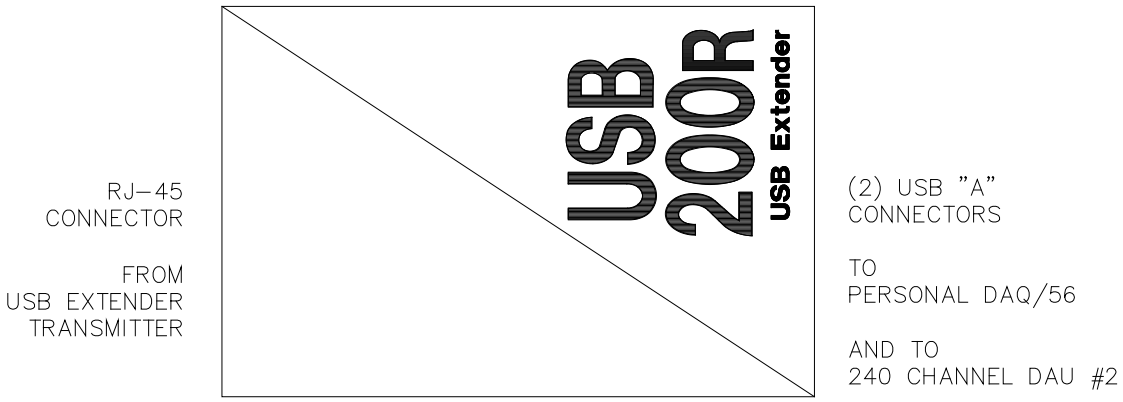

Figure 5.6
USB Extender Receiver

5.12 DIGITAL INTERFACE MODULE

The digital interface module connects the 5V digital outputs of the Personal Daq/56 to the 24V digital inputs required by the backplane. This module consists of an input terminal strip, an interface integrated circuit, and an output terminal strip. The module is located adjacent to the Personal Daq/56 Data Acquisition Module. See Figure 5.7.

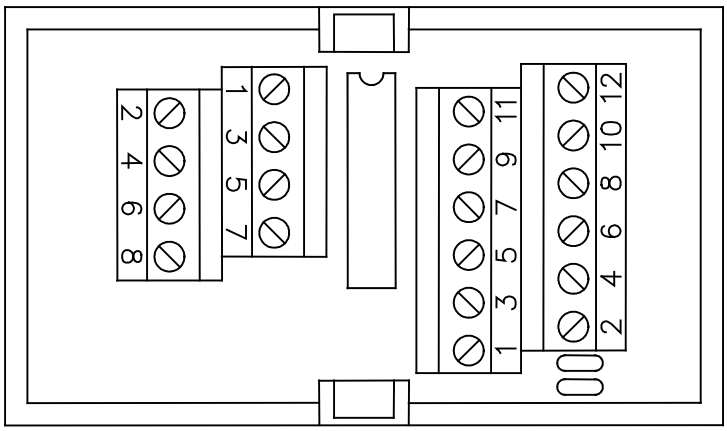

Figure 5.7
Digital Interface Module

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6. PREPARATION FOR USE

6.1 SYSTEM CHECKOUT AND PREPARATION

IMPORTANT
Make a system checkout when the equipment is received. When unpacking or handling the current sensor assemblies, treat them very gently; do not handle in such a manner as to place strain on the current sensors. The current sensors should ALWAYS be treated as delicate measurement instruments.

6.2 RECTIFIER SHUTDOWN

WARNING
Disconnect the input side of the rectifier from the AC power supply and disconnect the output side of the rectifier from the load, or use your approved disconnect procedure to ensure that no AC input is present and that cell-effect voltages from the electrochemical process are not present during installation of current sensors.

6.3 SENSOR MOUNTING AND CONNECTION CONSIDERATIONS

Once the rectifier has been safely taken off line, a current sensor may be safely placed around each device (or related fuse or pigtail as circumstances dictate).

6.4 INSTALLATION INSTRUCTIONS

Make sure the current sensors and their output cables are clean before installing them in the rectifier. If the current sensors and cables are not clean, the contaminants on them may provide a conductive path for a high-voltage breakdown. Section 6 describes how to check for such paths.

The Flexible Current Sensors are factory calibrated to DynAmp's standard Flexible Current Sensor circuit. All Flexible Current Sensors are interchangeable regardless of the physical size.

To install current sensors in a rectifier:

a.) Place current sensors on device paths in the proper direction (conventional plus-to-minus current flowing into the polarity dot). Proper Flexible Current Sensor mounting is shown in Figure 6.1.

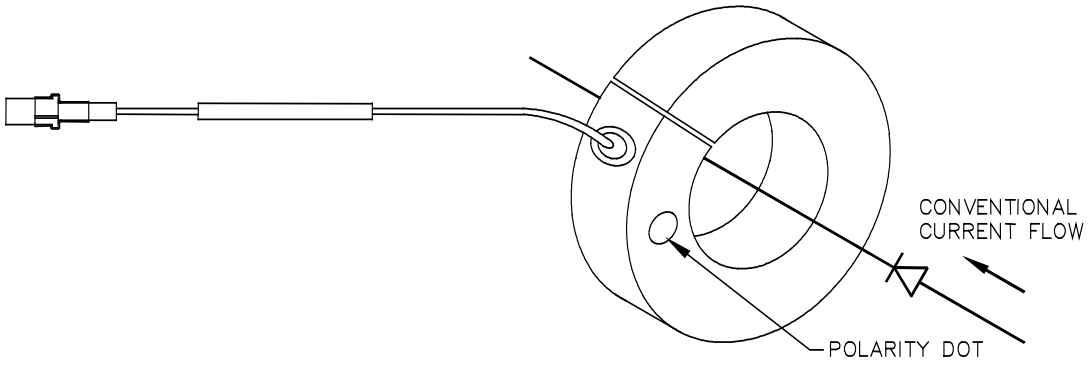

Figure 6.1
Flexible Current Sensor Installation Detail

b.) To install the Flexible Current Sensor, separate the Velcro fasteners and separate the ends. Then encircle the conductor and secure the Velcro fasteners.

c.) Connect each current sensor cable to mating half of extension cable (refer to the enclosed interconnection drawings). Table 6.1 through Table 6.7 summarizes the connections for various rectifier configurations on 120 channel systems and 240 channel systems. The cable connectors are keyed for proper polarity.

d.) Connect the Data Acquisition Unit to the appropriate ac power.

e.) Turn ON the Data Acquisition Unit using the power switch located on the I/O Panel.

f.) Put the rectifier back on-line and bring it up to load.

The RCEM may be tested, using its built-in test signal generator, during rectifier testing. Use the procedure in Appendix B.9 whenever the RCEM measurements indicate a problem in a rectifier, *before taking the rectifier off-line*. Use caution when disconnecting the current sensor cables, since hazardous voltages may exist when the current sensors are installed on live rectifier circuits.

TABLE 6.1
TRANSDUCER CONNECTIONS, 6-LEG RECTIFIER (20 DIODES MAX.)

Leg 1		Leg 2		Leg 3	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1A-1	1	2A-1	1	3A-1
↓	↓	↓	↓	↓	↓
10	1A-10	10	2A-10	10	3A-10
11	1B-1	11	2B-1	11	3B-1
↓	↓	↓	↓	↓	↓
20	1B-10	20	2B-10	20	3B-10
Leg 4		Leg 5		Leg 6	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4A-1	1	5A-1	1	6A-1
↓	↓	↓	↓	↓	↓
10	4A-10	10	5A-10	10	6A-10
11	4B-1	11	5B-1	11	6B-1
↓	↓	↓	↓	↓	↓
20	4B-10	20	5B-10	20	6B-10

Notes: 1) This chart applies to a 120 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connect to Data Acquisition Unit connectors 1A through 6B

TABLE 6.2
TRANSDUCER CONNECTIONS, 6-LEG RECTIFIER (40 DIODES MAX.)

Leg 1		Leg 2		Leg 3	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1A-1	1	2A-1	1	3A-1
↓	↓	↓	↓	↓	↓
10	1A-10	10	2A-10	10	3A-10
11	1B-1	11	2B-1	11	3B-1
↓	↓	↓	↓	↓	↓
20	1B-10	20	2B-10	20	3B-10
21	1C-1	21	2C-1	21	3C-1
↓	↓	↓	↓	↓	↓
30	1C-10	30	2C-10	30	3C-10
31	1D-1	31	2D-1	31	3D-1
↓	↓	↓	↓	↓	↓
40	1D-10	40	2D-10	40	3D-10
Leg 4		Leg 5		Leg 6	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4A-1	1	5A-1	1	6A-1
↓	↓	↓	↓	↓	↓
10	4A-10	10	5A-10	10	6A-10
11	4B-1	11	5B-1	11	6B-1
↓	↓	↓	↓	↓	↓
20	4B-10	20	5B-10	20	6B-10
21	4C-1	21	5C-1	21	6C-1
↓	↓	↓	↓	↓	↓
30	4C-10	30	5C-10	30	6C-10
31	4D-1	31	5D-1	31	6D-1
↓	↓	↓	↓	↓	↓
40	4D-10	40	5D-10	40	6D-10

Notes:
1) This chart applies to a 240 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connect to Data Acquisition Unit #1 connectors 1A through 6B
4) Cables 1C through 6D connect to Data Acquisition Unit #2 connectors 1A through 6B

TABLE 6.3
TRANSDUCER CONNECTIONS, PARALLEL 6-LEG RECTIFIER (10 DIODES MAX)

Leg 1A		Leg 2A		Leg 3A	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	1A-1 ↓ 1A-10	1 ↓ 10	2A-1 ↓ 2A-10	1 ↓ 10	3A-1 ↓ 3A-10
Leg 4A		Leg 5A		Leg 6A	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	4A-1 ↓ 4A-10	1 ↓ 10	5A-1 ↓ 5A-10	1 ↓ 10	6A-1 ↓ 6A-10
Leg 1B		Leg 2B		Leg 3B	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	1B-1 ↓ 1B-10	1 ↓ 10	2B-1 ↓ 2B-10	1 ↓ 10	3B-1 ↓ 3B-10
Leg 4B		Leg 5B		Leg 6B	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	4B-1 ↓ 4B-10	1 ↓ 10	5B-1 ↓ 5B-10	1 ↓ 10	6B-1 ↓ 6B-10

Notes: 1) This chart applies to a 120 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connect to Data Acquisition Unit connectors 1A through 6B

TABLE 6.4
TRANSDUCER CONNECTIONS, PARALLEL 6-LEG RECTIFIER (20 DIODES MAX)

Leg 1A		Leg 2A		Leg 3A	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1A-1	1	2A-1	1	3A-1
↓	↓	↓	↓	↓	↓
10	1A-10	10	2A-10	10	3A-10
11	1B-1	11	2B-1	11	3B-1
↓	↓	↓	↓	↓	↓
20	1B-10	20	2B-10	20	3B-10
Leg 4A		Leg 5A		Leg 6A	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4A-1	1	5A-1	1	6A-1
↓	↓	↓	↓	↓	↓
10	4A-10	10	5A-10	10	6A-10
11	4B-1	11	5B-1	11	6B-1
↓	↓	↓	↓	↓	↓
20	4B-10	20	5B-10	20	6B-10
Leg 1B		Leg 2B		Leg 3B	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1C-1	1	2C-1	1	3C-1
↓	↓	↓	↓	↓	↓
10	1C-10	10	2C-10	10	3C-10
11	1D-1	11	2D-1	11	3D-1
↓	↓	↓	↓	↓	↓
20	1D-10	20	2D-10	20	3D-10
Leg 4B		Leg 5B		Leg 6B	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4C-1	1	5C-1	1	6C-1
↓	↓	↓	↓	↓	↓
10	4C-10	10	5C-10	10	6C-10
11	4D-1	11	5D-1	11	6D-1
↓	↓	↓	↓	↓	↓
20	4D-10	20	5D-10	20	6D-10

Notes:
1) This chart applies to a 240 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connect to Data Acquisition Unit #1 connectors 1A through 6B
4) Cables 1C through 6D connect to Data Acquisition Unit #2 connectors 1A through 6B

TABLE 6.5
TRANSDUCER CONNECTIONS, 12-LEG RECTIFIER (10 DIODES MAX.)

Leg 1		Leg 2		Leg 3	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	1A-1 ↓ 1A-10	1 ↓ 10	2A-1 ↓ 2A-10	1 ↓ 10	3A-1 ↓ 3A-10
Leg 4		Leg 5		Leg 6	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	4A-1 ↓ 4A-10	1 ↓ 10	5A-1 ↓ 5A-10	1 ↓ 10	6A-1 ↓ 6A-10
Leg 7		Leg 8		Leg 9	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	1B-1 ↓ 1B-10	1 ↓ 10	2B-1 ↓ 2B-10	1 ↓ 10	3B-1 ↓ 3B-10
Leg 10		Leg 11		Leg 12	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1 ↓ 10	4B-1 ↓ 4B-10	1 ↓ 10	5B-1 ↓ 5B-10	1 ↓ 10	6B-1 ↓ 6B-10

Notes: 1) This chart applies to a 120 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connects to Data Acquisition Unit connectors 1A through 6B

TABLE 6.6
TRANSDUCER CONNECTIONS, 12-LEG RECTIFIER (20 DIODES MAX.)

Leg 1		Leg 2		Leg 3	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1A-1	1	2A-1	1	3A-1
↓	↓	↓	↓	↓	↓
10	1A-10	10	2A-10	10	3A-10
11	1B-1	11	2B-1	11	3B-1
↓	↓	↓	↓	↓	↓
20	1B-10	20	2B-10	20	3B-10
Leg 4		Leg 5		Leg 6	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4A-1	1	5A-1	1	6A-1
↓	↓	↓	↓	↓	↓
10	4A-10	10	5A-10	10	6A-10
11	4B-1	11	5B-1	11	6B-1
↓	↓	↓	↓	↓	↓
20	4B-10	20	5B-10	20	6B-10
Leg 7		Leg 8		Leg 9	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1C-1	1	2C-1	1	3C-1
↓	↓	↓	↓	↓	↓
10	1C-10	10	2C-10	10	3C-10
11	1D-1	11	2D-1	11	3D-1
↓	↓	↓	↓	↓	↓
20	1D-10	20	2D-10	20	3D-10
Leg 10		Leg 11		Leg 12	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	4C-1	1	5C-1	1	6C-1
↓	↓	↓	↓	↓	↓
10	4C-10	10	5C-10	10	6C-10
11	4D-1	11	5D-1	11	6D-1
↓	↓	↓	↓	↓	↓
20	4D-10	20	5D-10	20	6D-10

Notes:
1) This chart applies to a 240 Channel RCEM
2) 1A-1 = Leg cable “1A”, Current Transducer connector “1”
3) Cables 1A through 6B connects to Data Acquisition Unit #1 connectors 1A through 6B
4) Cables 1C through 6D connects to Data Acquisition Unit #2 connectors 1A through 6B

TABLE 6.7
TRANSDUCER CONNECTIONS, 1-LEG OF A MULTI-LEG RECTIFIER

Leg "n"		Leg "n"		Leg "n"	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
1	1A-1	6	2A-1	11	3A-1
2	1A-2	7	2A-2	12	3A-2
3	1A-3	8	2A-3	13	3A-3
4	1A-4	9	2A-4	14	3A-4
5	1A-5	10	2A-5	15	3A-5
Leg "n"		Leg "n"		Leg "n"	
Diode No.	Cable No.	Diode No.	Cable No.	Diode No.	Cable No.
16	4A-1	21	5A-1	26	6A-1
17	4A-2	22	5A-2	27	6A-2
18	4A-3	23	5A-3	28	6A-3
19	4A-4	24	5A-4	29	6A-4
20	4A-5	25	5A-5	30	6A-5

Notes:
1) Rectifier must have at least 3 legs
2) This table shows connections for 30 diodes/leg
3) 1A-1 = Leg cable "1A", Current Transducer connector "1"
4) Cables 1A through 6A connects to Data Acquisition Unit connectors 1A through 6A

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7. MAINTENANCE AND TROUBLESHOOTING

7.1 CALIBRATION INTERVALS

DynAmp does not specify required intervals of calibration for its products.

The end user of the product is responsible for identifying the appropriate interval between calibrations. The intervals should be determined based on the following factors:

- Requirements of a Quality Management System
- Accuracy and permissible limits of errors
- Purpose and usage
- Experience with similar products
- Manufacturer's recommendations
- Stability of the product
- Past history
- Other characteristics of the product

Reference: "ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories" and Laboratory Accreditation Bureau "Guidance for Documenting and Implementing ISO/IEC 17025:2005 and Laboratory Guidance."

As a guideline, DynAmp recommends a 24-month interval of calibration for all permanently installed products and a 12-month interval of calibration for all products used in portable applications.

7.2 GENERAL

IMPORTANT
The RCEM electronics will not operate until the communications link is established with the laptop computer.

This section contains some specialized tests of the electronics and current sensors of the RCEM, as well as some preventive maintenance procedures. The output of the built-in signal generator provides a test signal for testing the overall operation of the RCEM as well as its accuracy.

7.3 VERIFYING PROPER OPERATION

Data acquired from the test signal generator should be within ±1.5% of the selected test signal level. If data acquired from the test signal generator is within specified accuracy, the

problem is not likely to be a DAU hardware problem. If data acquired from the test signal generator is not within specified accuracy, continue with the steps in this section.

7.4 FUSE REPLACEMENT

Replace DAU fuse(s) with the specified type and current rating. The main fuse is located on the I/O Panel. The ac zero-crossing fuse is located on the end of the analog card rack.

Disconnect power to the system before servicing or replacing fuses.

1. Turn the DAU power switch off.
2. Remove the fuseholder cap. You may use the blade of a small screwdriver, if desired.
3. Remove the blown fuse from the fuse clip PC board. Replace with MDL1 slow blow fuse. Be sure to insert the replacement fuse in the proper location for the appropriate line voltage.

7.5 STATIC PRECAUTIONS WHEN SERVICING

Qualified personnel only should perform servicing, following procedures described herein.

If troubleshooting indicates a need to replace a component on a printed circuit board or to replace the entire board, measures to prevent electrostatic discharge (ESD) damage must be taken, as follows:

a. ALWAYS wear a wrist strap connected to ground through a 1-megohm resistor when working on printed circuit boards.

b. Use a soldering iron with a grounded tip.

c. Use a non-static generating de-soldering pump (metallic) or solder removal braid.

d. Transport static sensitive components in static shielding bags or rails. A new printed circuit board should be treated as a static sensitive device. The fact that a part is installed on a board does not make the part static safe.

e. If possible, perform printed circuit board maintenance at a workstation that has a conductive covering that is grounded through a 1-megohm resistor. If a conductive tabletop cover is not available, a clean steel tabletop is an excellent substitute.

f. Keep plastic, vinyl, Styrofoam and other non-conductive materials away from printed circuit boards. They are good static generators that do not give up their charge easily.

g. Return goods to DynAmp in static safe packaging. This will limit further component damage from ESD.

CAUTION
Do not touch any printed circuit board unless you are wearing a grounded wrist strap, as circuit damage may occur.

7.6 VERIFYING PROPER INTEGRATOR RESET SYNCHRONIZATION

One possible source of incorrect device data is improper integrator reset synchronization. Check any suspect channels with an oscilloscope. The waveform should look similar to Figure 7.1

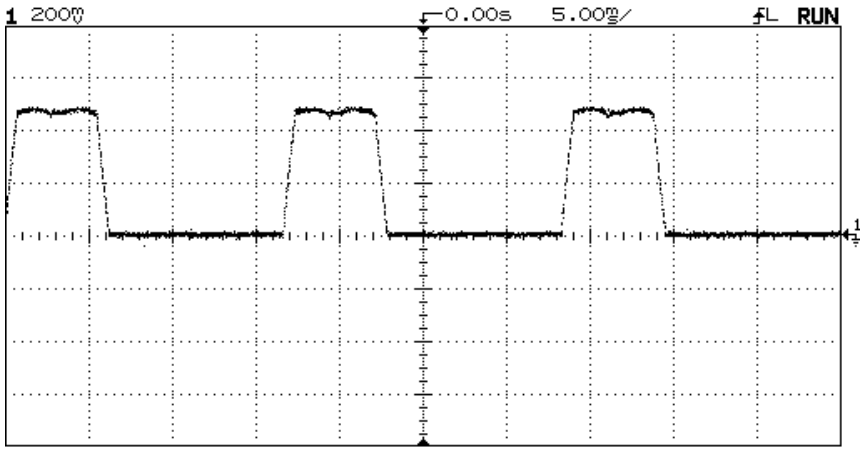

Figure 7.1
Device Current Waveform

The device current waveforms should be present anytime the rectifier is ON. Proper integrator reset synchronization is indicated by 0 volts when rectifier device is **not** conducting during the commutation cycle. That is, the device current "humps" should rise from, and return to a level of zero volts (no dc offset voltage present).

If a dc offset voltage is present in the device current waveform, the integrators are not being reset at the proper time. In this case, check the suspect integrator card as follows:

1. Make sure that all integrator cards are properly seated in the card rack.
2. Connect the oscilloscope to the questionable waveform test points. See Figure 7.2.
3. With the laptop computer connected to the Personal Daq/56, click on the “RCEM RESET” button on the spreadsheet.
4. If the problem persists, remove the integrator card, and substitute a known good integrator card. Be sure to observe static precautions.
5. Repeat steps 3 through 4.

7.7 ADJUSTING THE SIGNAL GENERATOR

To adjust the signal generator, refer to Figure 7.2 and proceed as follows:

a. Connect a DMM between TP1 (+) and TP2 (COM). Place switch **SW2 Position 2** in the **MANUAL** position (switch lever down).

b. Place switch **SW2 Position 1** in the **V-** position (switch lever down).

c. Adjust potentiometer **R54** for a reading of -10.000 Vdc.

d. Place switch **SW2 Position 1** in the **V+** position (switch lever up).

e. Adjust potentiometer **R55** for a reading of +10.000 Vdc.

f. Place switch **SW2 Position 2** in the **AUTO** position (switch lever up).

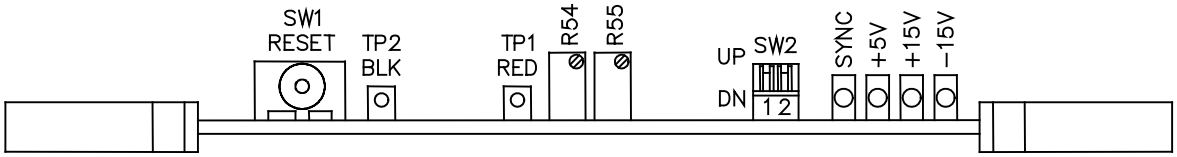

Figure 7.2
Reset Sync PC Board

7.8 ADJUSTING THE INTEGRATOR PC BOARDS

To adjust the Integrator PC Boards, refer to Figure 7.3 and proceed as follows:

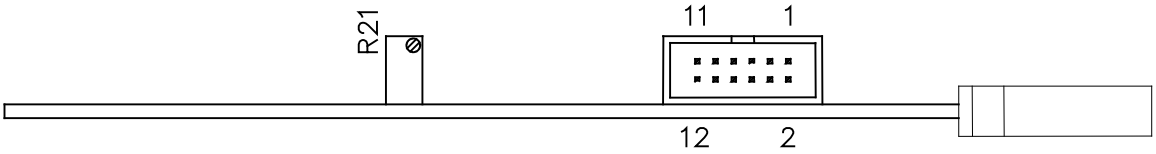

Figure 7.3
Integrator PC Board

1. Adjust the signal generator as described in the proceeding section. The accuracy of the Integrator PC Boards depends on the accuracy of the signal generator.
2. Activate the “Calibrate Worksheet” as described in Appendix B.14.
3. Adjust potentiometer R21 on the first Integrator PC Board while watching the average of Diode 1 on the “Calibrate Worksheet”. Adjust the potentiometer for a reading of 571 amps, ±1 amp.
4. Repeat for Integrator PC Boards 2 through 20 (“Calibrate Worksheet”, Diodes 2 through 20).

7.9 SENSOR TESTING (CONTINUITY METHOD)

The current sensor continuity test (described below) is made when the RCEM is first installed and will also prove useful in troubleshooting. The dielectric test, paragraph 7.9, is another useful preventive maintenance and diagnostic tool.

1. Make sure that the rectifier system in which the current sensors are connected is off-line (not powered).
2. Disconnect the input connectors “1A” through “6B” on the I/O Panel of the DAU. Measure the continuity of each current sensor with a DMM.

Current Sensor	Pins
1	16 & 13
2	10 & 4
3	17 & 8
4	23 & 9
5	24 & 14
6	29 & 15
7	34 & 21
8	30 & 22
9	17 & 18
10	19 & 20

3. Replace any defective current sensor(s) and repeat the test.

7.10 SENSOR DIELECTRIC TESTING - WINDINGS TO SURFACE

Dielectric withstand-voltage tests of the current sensors can be useful in preventive maintenance and troubleshooting of the RCEM.

WARNING

DANGER HIGH VOLTAGE exists while performing Hipot tests. Qualified trained personnel should perform Hipot tests. Refer to test equipment users guide for equipment operating instructions.

CAUTION

1. Hipot testing produces ozone gas through electrolysis that in high concentrated levels (0.12 PPM) can be toxic as a strong irritant through inhalation. The presence of high concentrated levels of ozone gas will be noticeable by a strong pungent odor.

2. All Hipot tests should be performed in an open area with air movement to disperse ozone gas. The use of a portable fan may be necessary to disperse concentrated levels of ozone gas.

3. All Hipot Testing should be halted if a high level of ozone gas is suspected until the Safety Director has reviewed the application.

Place current sensor in test ground plane (metal container containing loose hardware). Submerge current sensor below loose hardware. Use metallic hardware, preferably ball bearings (no sharp edges). Keep the output cable outside the test ground plane. See Figure 6.4 for a typical Hi-Pot Test Setup.

Short current sensor connector pins 1 and 2 together. Connect Hipot between connector pins and metal container. Gradually apply 3000 Vac and maintain for 1 minute.

As the high-voltage source, we suggest the use of a commercial high-potential tester such as the Junior Hy-Pot from Associated Research, Inc. (8221 N. Kimball Ave., Skokie, IL). Connect the test apparatus to the ac terminals of the tester and set the tester's AC/DC switch to the AC position.

Note that the tester has two neon lamp indicators - BREAKDOWN and LEAKAGE. Once the connections are made, slowly increase the voltage output of the tester and look for an indication from the lamps. It should be possible to run the voltage up to 3000 Vac without breakdown occurring. If a LEAKAGE indication is obtained before this point, it may be necessary to adjust the threshold of the tester's leakage test circuit (by means of a potentiometer on the tester). Capacitive effects cause (Leakage.) A breakdown will be indicated by the tester's BREAKDOWN lamp.

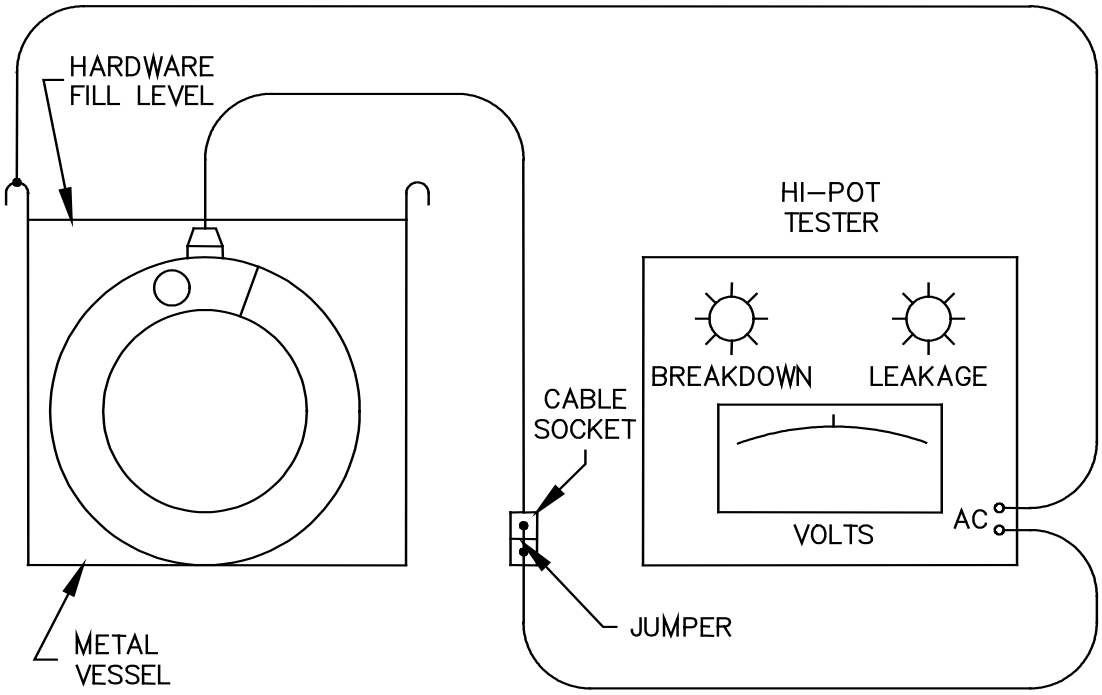

Figure 7.4
Hi-Pot Test Setup

7.11 CONNECTOR CONTAMINATION (INTEGRATOR CARDS)

In the process of daily operation or during vibration in shipment, the DAU integrator card connectors may get contaminated. This may also happen from airborne contaminants that may enter the DAU from normal factory use. This action may cause abnormal operation of the RCEM.

NOTE
ADHERE TO ALL STATIC PROTECTION WARNINGS IN SECTION 7.5!

The cure for this symptom is simple. Turn off the DAU using the power switch. Remove the protective cover on the DAU analog card rack. This is done by removing four screws. Remove the integrator cards from the DAU. Clean the connector pins on the integrator cards and the connectors inside the DAU. Suitable solvent would be isopropyl alcohol (99% pure, no glycerin added), trichlorethylene, or any other DynAmp, LLC approved connector cleaner. Reinstall all integrator cards in the appropriate slots. Reinstall the front cover and reapply ac to the unit.

7.12 RESET SYNC ERROR OR INCORRECT DATA

If a Reset Sync error occurs, this means that the DAU is not synchronized to the rectifier. Incorrect data will result if the DAU is not properly synchronized. When the DAU is turned on, it automatically goes through its synchronization routine. In order for the DAU to synchronize properly, the rectifier needs to be conducting current when the DAU is powered up. The value of this current should be approximately 100 amps per device or greater. If the DAU is powered up and the rectifier is not in the above stated condition, the DAU may not establish correct reset pulse locations. The DAU will automatically adjust the reset pulse locations when the rectifier is conducting adequate current. However, all reset pulses may not be in the optimum location. A scanner reset will assure optimum reset pulse location.

The “RCEM RESET” command button will also cause the Data Acquisition Unit to synchronize to the rectifier. This may be accomplished by turning the DAU power off then on, or by clicking on the “RCEM RESET” command button located on the laptop computer spreadsheet.

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8. SERVICE, PARTS, AND DOCUMENTATION

8.1 SERVICE ASSISTANCE

For further assistance, contact DynAmp Customer Support at:

Americas:

Telephone: +1 614.871.6900 Fax: +1 614.871.6910

8:00 AM to 5:00 PM USA Eastern Time

From first Sunday in November to second Sunday in March – 13:00 GMT to 22:00 GMT

From second Sunday in March to first Sunday in November – 12:00 GMT to 21:00 GMT

Europe:

Telephone: +41 22.706.1446 Fax: +41 22.706.1311

8:30 AM to 5:00 PM Central European Time

From last Sunday in October to last Sunday in March – 7:30 GMT to 16:00 GMT

From last Sunday in March to last Sunday in October – 6:30 GMT to 15:00 GMT

After Hours Critical Service Emergency:

Telephone: +1 614.871.6906

5:00 PM to 8:00 AM USA Eastern Time

From first Sunday in November to second Sunday in March – 22:00 GMT to 13:00 GMT

From second Sunday in March to first Sunday in November – 21:00 GMT to 12:00 GMT

Central e-mail:

help@dynamp.com

DynAmp web:

www.dynamp.com

8.2 SPARE PARTS ORDERS - ROUTINE OR EMERGENCY

Requests for spare parts, either in an emergency or for a routine order, should be directed to "Inside Sales" at DynAmp during normal hours, if possible, or via any method shown above for off-hours. When contacting us, please present as much information as possible - the related equipment Model Number and Serial Number; the required part name and its DynAmp item number (and other identifying or vendor number(s); and your time needs. An approved Purchase Order Number should be given with your order.

8.3 SPARE PARTS

The following table lists recommended quantities of spare parts for the RCEM. As spares are used, replacements should be ordered to insure continuous operation of the equipment.

TABLE 8.1
SPARE PARTS LIST

DESCRIPTION	ITEM NO.	QUAN
Fuses, 0.125A, 250V, MDA-1/8 (5 per box)	3529	1 box
Fuses, 3A, 250V, MDA-3 (5 per box)	12591	1 box
COP, 3.625 ID Flexible	14063	5
PCB Assembly, RCEM Integrator	42687	2
PCB Assembly, RCEM Reset Sync	44521	1
Cable Assembly, BNC Male-to-Male 5 Ft	42814	2
Adapter, BNC Female to 0.025 x 0.025 Socket	42815	2

Disconnect power to the system before servicing or replacing fuses.

9. DRAWING LIST

9.1 REQUIRED DRAWINGS

The drawings in table 8.1 are to be considered as part of (although not necessarily included in) this manual. Drawings should be kept with the manual at all times.

TABLE 9.1
DRAWING LIST

DRAWING TITLE	NUMBER
Interconnection Diagram: RCEM 120 Channel COP (6-Pulse)	02D108554
Interconnection Diagram: RCEM 120 Channel COP (12-Pulse)	02D108555
Outline and Mounting: RCEM DAU 120 Channel	02D108504
Outline and Mounting: COP 3.625 ID Flexible	02B104835
PCB Assembly: RCEM Backplane	26D108297
PCB Assembly: RCEM Integrator	26C108299
PCB Assembly: RCEM Reset Sync	26B108301
PCB Assembly: RCEM Digital Interface 5V/24V	26B108487
Schematic: RCEM System 120 Channel	05D108502

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APPENDIX A:
ANSI RECTIFIER CIRCUITS

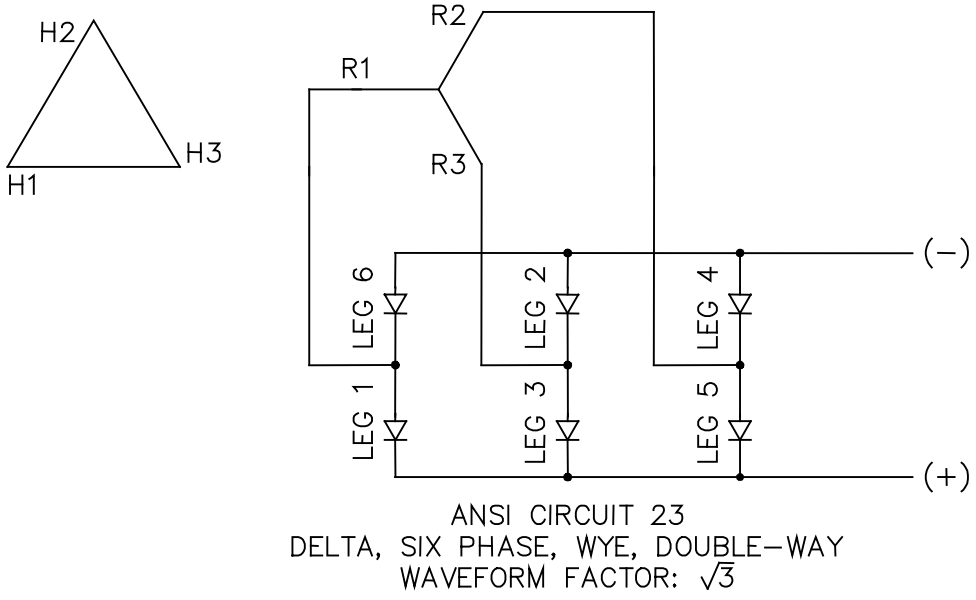


Figure A.1
ANSI Rectifier Circuit 23

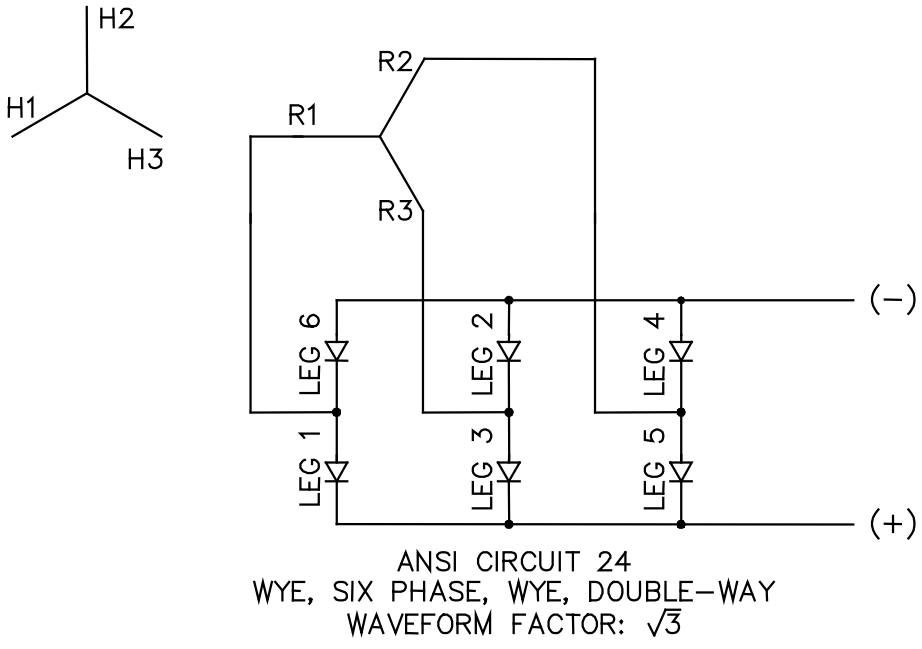


Figure A.2
ANSI Rectifier Circuit 24

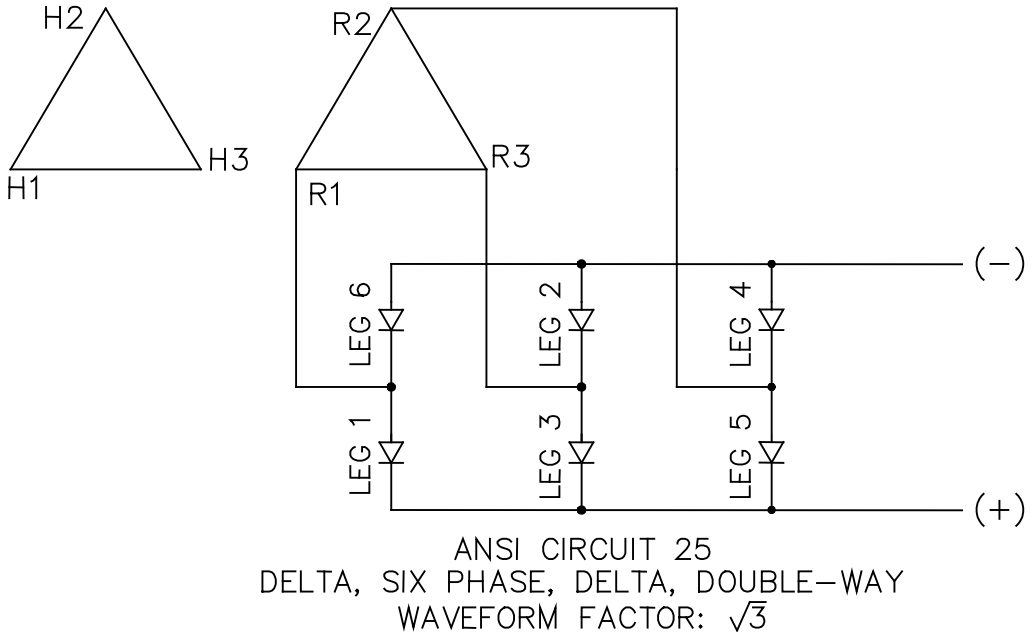


Figure A.3
ANSI Rectifier Circuit 25

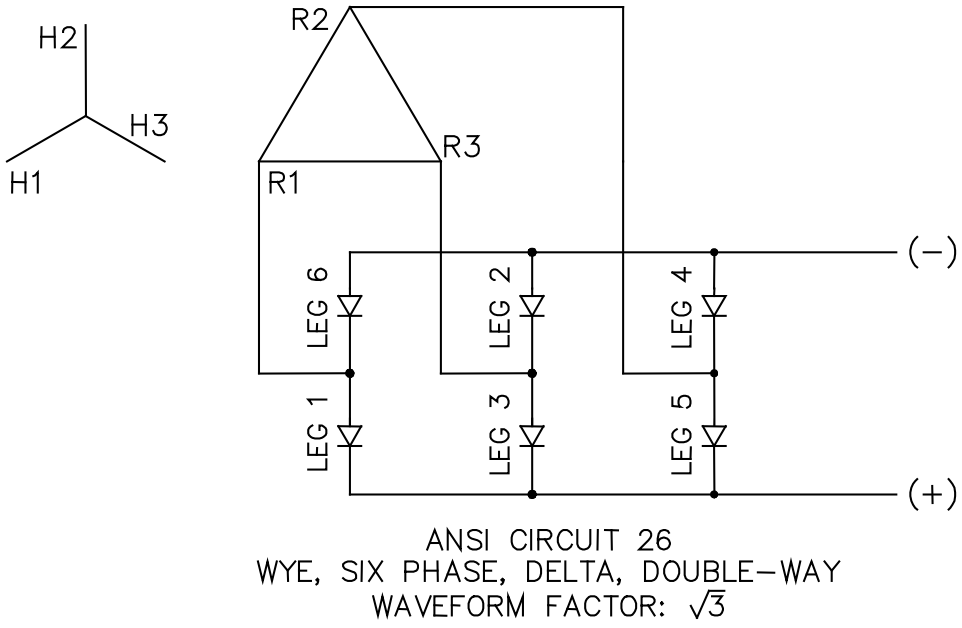


Figure A.4
ANSI Rectifier Circuit 26

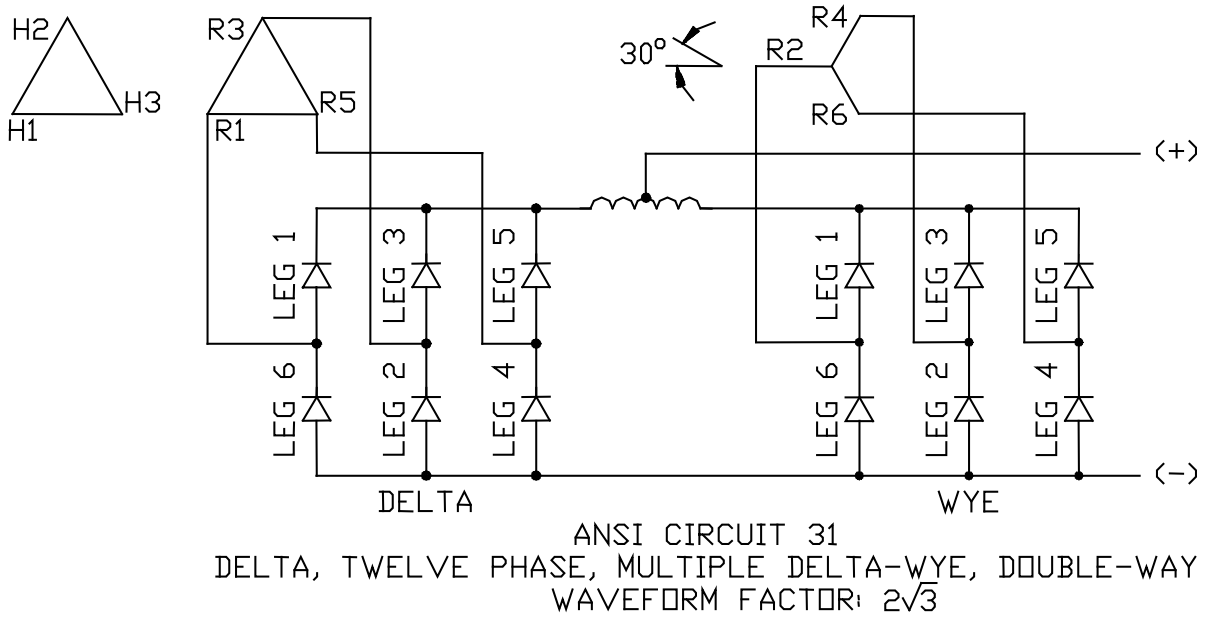


Figure A.5
ANSI Rectifier Circuit 31

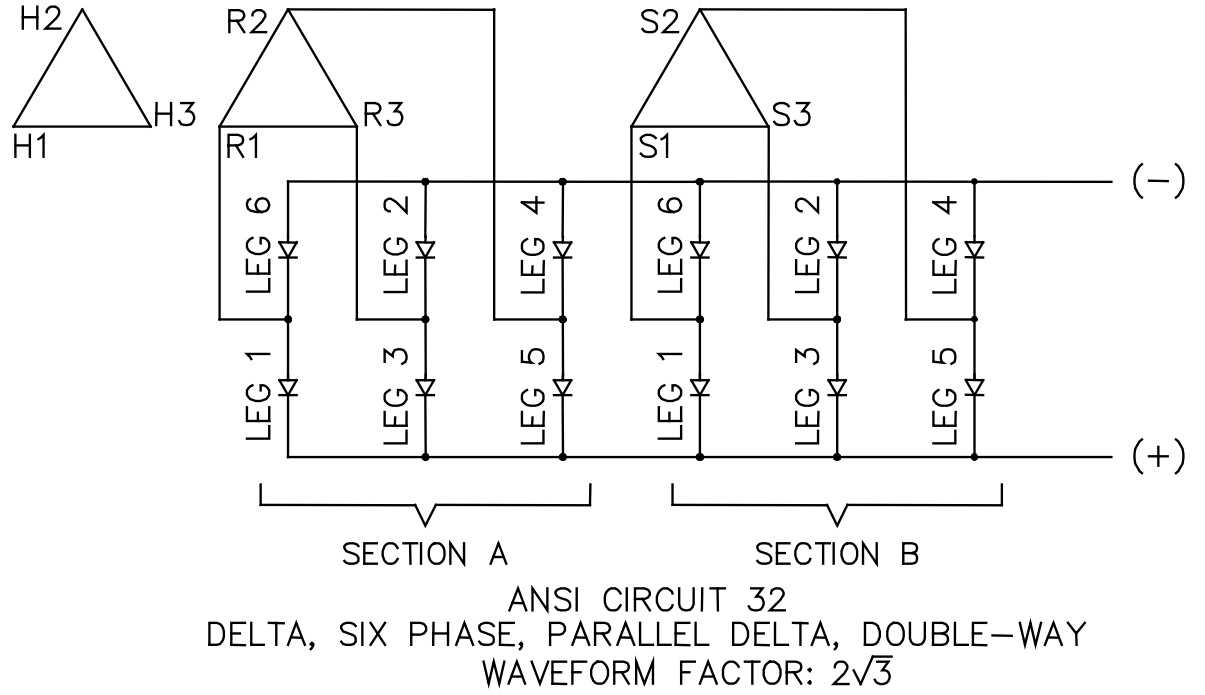
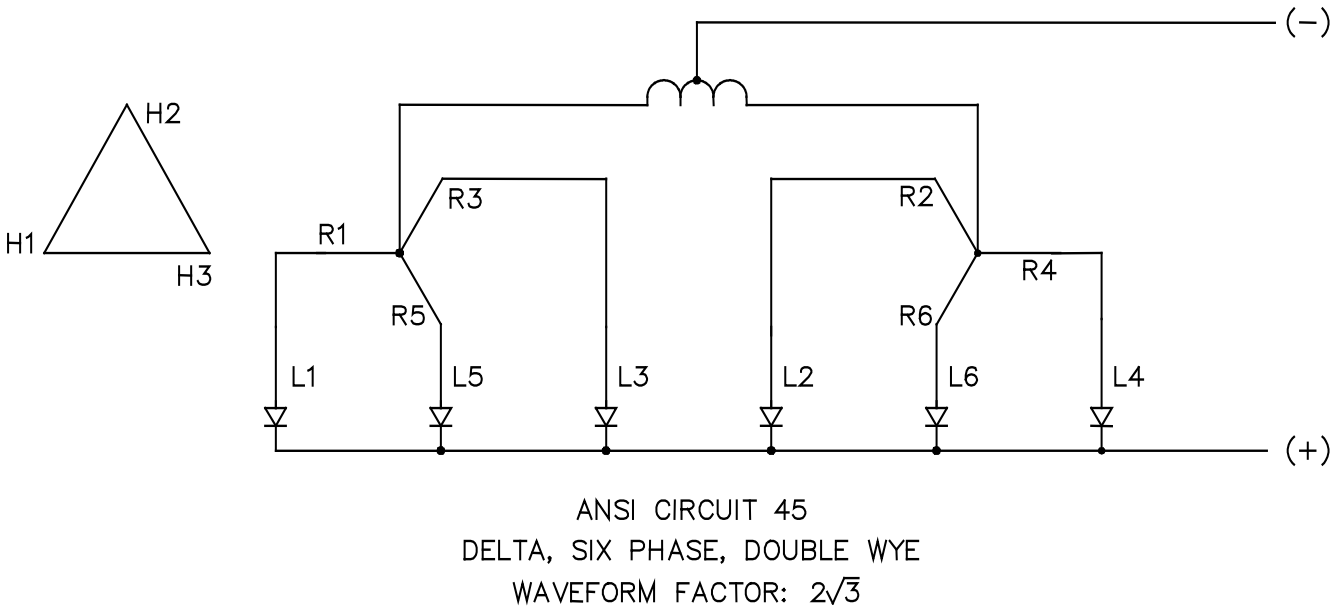
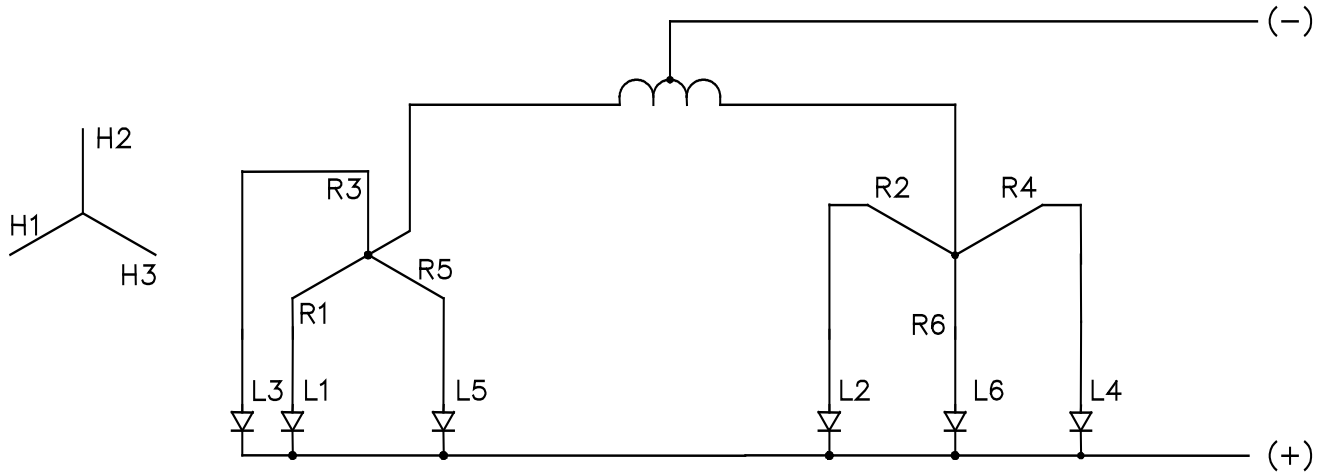


Figure A.6
ANSI Rectifier Circuit 32



ANSI CIRCUIT 45
DELTA, SIX PHASE, DOUBLE WYE
WAVEFORM FACTOR: $2\sqrt{3}$

Figure A.7
ANSI Rectifier Circuit 45



ANSI CIRCUIT 46
WYE, SIX PHASE, DOUBLE WYE
WAVEFORM FACTOR: $2\sqrt{3}$

Figure A.8
ANSI Rectifier Circuit 46

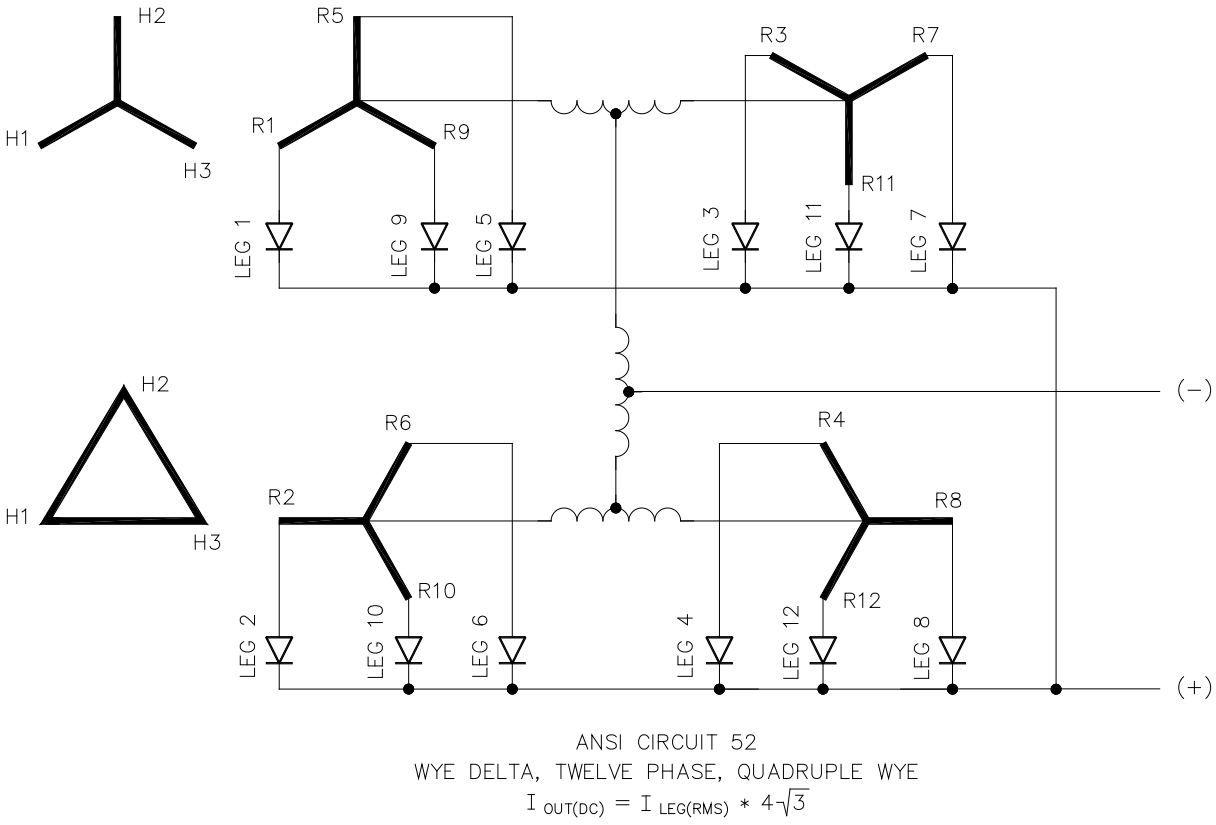


Figure A.9
ANSI Rectifier Circuit 52

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APPENDIX B: SOFTWARE

B.1 PROVIDED SOFTWARE

All software and drivers associated with this product are supplied on CD-ROMs. The contents of the DynAmp CD-ROM are as follows:

- DynAmp spreadsheet(s)
- Personal Daq/56 configuration file: “RCEM.cfg”
- A copy of this manual “043526x.pdf” (x = manual revision)
- Applicable manuals addendums

The Personal Daq/56 software is supplied on the manufacturer’s CD-ROM.

The above software is already installed on the laptop computer supplied with the product. However, in case of a problem, please follow the instructions below for reinstalling the software.

B.2 MINIMUM REQUIREMENTS FOR LAPTOP COMPUTER

The following is a list of the minimum requirements for the laptop computer:

1. Windows 2000 operating system. Software is compatible with Vista (32 bit) and Windows 7 (32 bit).
2. Microsoft Office Small Business
3. USB High-power Compliant Port
4. USB Mass Storage Device
5. CD-ROM Drive
6. Universal AC Adapter with an IEC 60320 International Standardized Appliance Connector

Note: All power saving modes of operation must be disabled.

B.3 SOFTWARE INSTALLATION

Place Personal Daq/56 CD-ROM in the drive and using “Windows Explorer”, double click on “Setup.exe” in the “PdaqView\Disk1” subdirectory. This will start the iotech installation program. Continue with the installation by accepting all the default values.

The iotech drivers are typically installed in a directory called “Program Files\pDaqView”. The drivers require an authorization number for proper operation. Use the following steps to enter the authorization number:

1. Start the “PdaqView.exe” program. This program should be located in the “c:\Program Files\pDaqView\Applications” directory.
2. Click on the “Authorization” option in the “Files” menu.
3. Enter the authorization number.
4. Click on the “Apply Code” button.
5. Exit the “PdaqView.exe” program.

The pDaqView drivers communicate with the Personal Daq/56 via the laptop’s USB port.

The customized spreadsheet file(s) provided on the DynAmp CD-ROM should be copied to the “Program Files\pDaqView” directory and the “RCEM.cfg” file should be copied to the “Program Files\pDaqView\Applications” directory. Finally, a shortcut to each spreadsheet should be created on the “Desktop” for easy access. The spreadsheet requires Microsoft Excel to operate properly.

B.4 STARTING THE DATA ACQUISITION PROGRAM

Notes
The current waveforms through the diodes must be stable to the mains or sync errors will occur. The USB cable(s) should be connected to the RCEM and disconnected from the computer.

Caution
Keep the computer as far as possible away from magnetic fields or damage to the computer hard drive may occur.

Use the following procedure to start the data acquisition program:

1. The DAU power should be on.
2. Turn the laptop computer power ON. Allow the computer to boot to the desktop screen.
3. Connect the USB cable(s) to the computer. All LEDs (except +24V) should turn off.
4. Click on the RCEM spreadsheet icon. Allow the spreadsheet to load. If the program inquires whether you want macros enabled, select “Enable Macros”.
5. If a message box appears with the following message: ”Personal Daq is not running. Do you wish to start the Personal Daq?”, click on the “No” button.
6. The RCEM Data Acquisition program is now ready to run.

B.5 SPREADSHEET DESCRIPTION

A customized Excel spreadsheet is provided for interfacing with the Personal Daq/56 from the laptop computer. The spreadsheet allows the monitoring of the diode currents, and provides visual indicators of all the alarm conditions. It also allows the RCEM system to be operated in test mode to assist in troubleshooting problems with the system.

The “Display” worksheet’s general layout is shown in Figure B.1. Figures B.2 through B.4 are other examples of a typical worksheet layout. The following list is a description of the individual fields on the worksheet:

1.) UNIT NUMBER: This is the identification number of the rectifier under test.

2.) RECTIFIER CURRENT: The calculated dc current output of the rectifier. (Average leg total current times the waveform factor)

3.) DIODE: The diode number. There is a maximum of 20 diodes in each rectifier leg.

4.) CURRENT: Indicates diode current in rms amperes.

5.) % DEV: The percent deviation of the diode current from the average leg current.

6.) TOTAL: The sum of the leg diode currents in rms amperes.

7.) AVERAGE: The average of the leg diode currents in rms amperes.

8.) DATE: The date of the last rectifier data acquisition.

9.) TIME: The time of the last rectifier data acquisition.

10.) HI: The percentage (%) above the average of the leg diode currents that will cause high diode currents to be flagged. The cell containing the high diode current will change to a red background color.

11.) LO: The percentage (%) below the average of the leg diode currents that will cause low diode currents to be flagged. The cell containing the low diode current will change to a blue background color.

12.) WAVEFORM FACTOR: Worksheet cell containing the value used to calculate the “Rectifier Current”. See Appendix A for the correct waveform factor to use. This value varies with the ANSI rectifier circuit number.

13.) ANSI RECTIFIER CIRCUIT: Worksheet cell containing the active ANSI Rectifier Circuit number.

14.) LEVEL: Worksheet cell containing the checkback value of the active test signal level. “OFF” will be displayed when the “TEST MODE” is not active.

15.) ACQUIRE DATA: Command button used to initiate a rectifier data acquisition. One data set will be acquired each time the button is actuated. The worksheet will be updated to the data acquired.

16.) RCEM RESET: Command button used to reset the microcontrollers on the Reset Sync PC Boards. This will cause the integrator reset pulses to synchronize to the diode current waveforms.

17.) TEST MODE: Command button used to switch the data source to the internal test signal generator. Radio buttons selects the test signal level.

18.) SAVE AS: Command button used to save the rectifier data set to a disk file and to restore the original spreadsheet.

19.) SCAN: The SCAN mode of operation continuously acquires and displays rectifier data sets at the acquisition scan rate of approximately 4 seconds.

a. START: Command button that initiates the SCAN mode of operation.

b. STOP: Command button that terminates the SCAN mode of operation. of operation.

20.) DEVICES/LEG: Command button used to enter the number of rectifying devices/leg.

Note: This command button may not be preset on some RCEM spreadsheets.

21.) ANSI RECTIFIER CIRCUIT: Selection box used to select the appropriate ANSI Rectifier Circuit Number.

B.6 PROGRAMMING THE NUMER OF DEVICES/LEG

Use the following procedure to program the number or devices/leg:

1. Click on the “DEVICES/LEG” command button.
2. Enter the number of devices/leg into the Input Box.
3. Click on the Input Box “Ok” button. The “Display” and “Calibrate” worksheets will be configured to the number of devices/leg entered.
4. Click on the Input Box “Cancel” button to exit the command without changing the number of devices/leg.

B.7 SELECTING THE ANSI RECTIFIER CIRCUIT NUMBER

Use the following procedure to select the ANSI Rectifier Circuit Number:

1. Click on the desired ANSI Rectifier Circuit Number checkbox.
2. The “Waveform Factor:” cell will update to the waveform factor for the selected ANSI Rectifier Circuit.
3. The “ANSI Rectifier Circuit:” cell will display the selected ANSI Rectifier Circuit Number.

NOTE
If you click on an ANSI Rectifier Circuit Number that is already selected, the checkmark will disappear. However, the “ANSI Rectifier Circuit:” cell will continue to display the correct ANSI Rectifier Circuit Number.

B.8 ACQUIRING A RECTIFIER DATA SET

Use the following procedure to setup and acquire the rectifier data:

1. Enter the rectifier unit number in the “Unit Number:” field.
2. Enter the waveform factor in the “Waveform Factor:” field. See Appendix A for the correct waveform factor to use. This value varies with the ANSI rectifier circuit number but regardless of the waveform factor used, the diode currents will be correct.
3. Click on the “ACQUIRE DATA” command button to acquire or refresh the rectifier data.

B.9 SAVING THE RECTIFIER DATA TO A FILE

Use the following procedure to save the rectifier data to a file:

1. Click on the “SAVE AS” command button on the spreadsheet.
2. Select the folder in which the data will be stored from the “Save in:” option box.
3. Enter the filename in the “File name:” option box.
4. Click on the “Save” button.

Note: The rectifier data cannot be saved to a disk file from the “SCAN” mode. You must exit the “SCAN” mode before saving the rectifier data.

B.10 ACTIVATING THE TEST MODE OF OPERATION

Use the following procedure to activate the test mode of operation:

1. Click on the desired test level radio button.
2. Click on the “TEST MODE” command button. If you are near the DAU, you should hear the test signal relays energize.
3. Check the “Level:” field to confirm the correct test signal level.
4. Acquire the test data by clicking the “ACQUIRE DATA” command button or start the “SCAN” mode to view the test data.
5. Click on the “TEST MODE” command button to leave the test mode of operation. The “Level:” field will change to “OFF” to indicate “TEST MODE” is not active.

B.11 STARTING THE SCAN MODE OF OPERATION

Uses the following procedures to setup and start the rectifier data scan:

a. Enter the rectifier unit number in the “Unit Number:” field.
b. Enter the waveform factor in the “Waveform Factor:” field. See Appendix A for the correct waveform factor to use. This value varies with the ANSI rectifier circuit number but regardless of the waveform factor used, the diode currents will be correct.

c. Click on the SCAN “START” button. The cursor will change to an hourglass and data will be acquired and displayed continuously at the scan rate.

CAUTION
Do not turn RCEM DAU power off when SCAN mode is active. The computer may lose communications with the RCEM DAU. See “*Recovering from DAQ Errors*” below to correct problem.

B.12 STOPPING THE SCAN MODE OF OPERATION

Uses the following procedures to stop the rectifier data scan:

1. Move the hourglass shaped cursor over the SCAN “STOP” command button.
2. Click on the SCAN “STOP” command button.
3. The rectifier data scanning will stop and the cursor shape will change.
4. The keyboard key combination of “CNTRL+SHIFT+S” will also end the SCAN mode of operation.

B.13 VIEWING THE DIODE CURRENT BAR GRAPHS

See Figure B.5 for a typical diode current bar graph. Use the following procedure to view the diode current bar graphs:

a. Start the SCAN Mode of operation.
b. Move the hourglass shaped cursor over the desired leg worksheet tab.
c. Click on the selected leg worksheet tab.
d. Click on the “Display” worksheet tab to switch back to the “Display” screen.

B.14 RECOVERING FROM DAQ ERRORS

Use the following procedure to recover from the error:

1. Disconnect the USB cable. All LEDs except the “24V P.S.” LED should turn off.
2. Click to clear the DAQ Error Message Box.
3. Click to clear the Visual Basic Error Message Box.
4. Exit from the Excel spreadsheet.
5. Reconnect the USB cable.
6. Restart Excel spreadsheet. If the program inquires whether you want macros enabled, select “Enable Macros”.
7. A message box will appear with the following message: ”Personal Daq is not running. Do you wish to start the Personal Daq?”
8. Click on the “No” button.

B.15 CALIBRATE WORKSHEET

A special worksheet is provided for use in calibrating the RCEM. See Figure B.6. The diode data are displayed in rows and the legs in columns. Each row corresponds to an Integrator PC Board. The average of the diode currents in each row is calculated and displayed. Use the following procedure to activate the Calibrate Worksheet:

a. Move the cursor over the Calibrate worksheet tab.

b. Click on the Calibrate worksheet tab.

c. Click on the “Calibrate” START command button. The cursor will change to an hourglass.

d. Calibrate the Integrator PC Boards according to the procedure in Section 7.8.

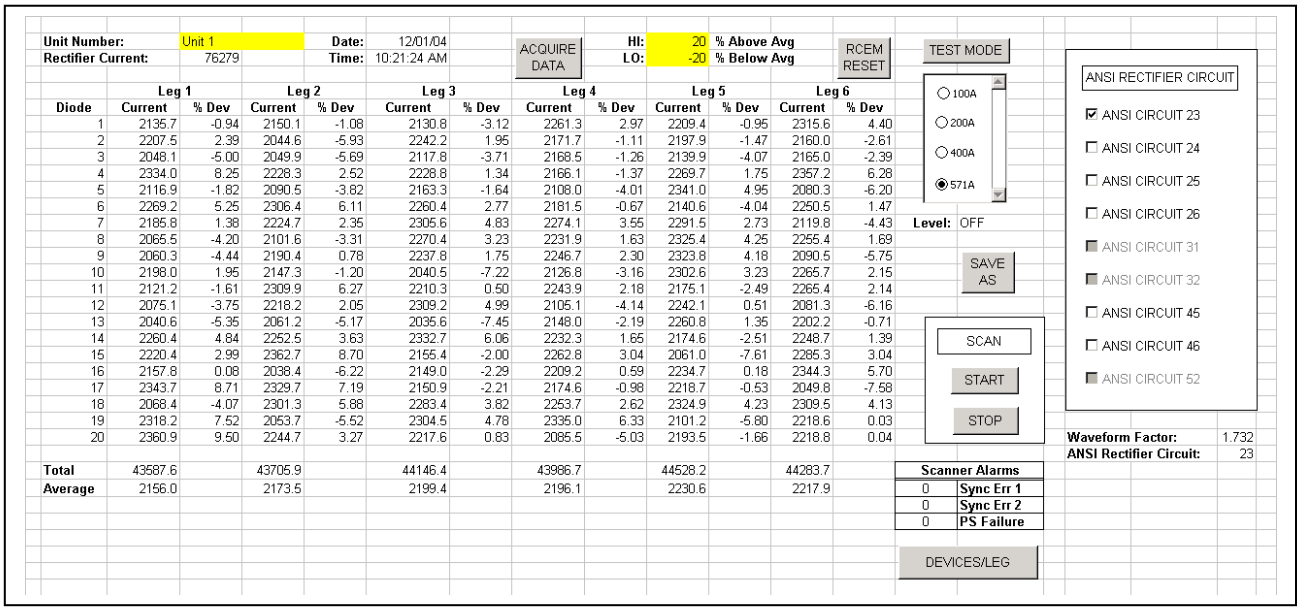
e. Click on the “Calibrate” STOP command button to end the Calibrate mode of operation.

f. Click on the “Display” worksheet tab to return to the Display screen.

B.16 PRECAUTIONS

In order to ensure proper operation, please follow the following precautions:

1. When the spreadsheet is first opened, the radio button selections in the test signal level check box may not correspond to the actual selections used by the Personal Daq/56.
2. The spreadsheet should normally be left in protected mode to avoid accidentally overwriting equations and links. Cells that allow user input are highlighted in yellow. No other cells should be modified to ensure proper operation.
3. A virus protection feature in Excel allows disabling all macros from being executed automatically. However, in order for the provided spreadsheet to operate properly, macros must be enabled.
4. When entering new values in the spreadsheet, such as Lo alarm value, the entry operation into the cell must be completed by pressing the “Return” or “Enter” keys before the new values can be updated into the Personal Daq/56.



Unit Number:	Unit 1		**Date:**	12/01/04		ACQUIRE DATA	**HI:**	20	**% Above Avg**		RCEM RESET	TEST MODE
Rectifier Current:	76279		**Time:**	10:21:24 AM			**LO:**	-20	**% Below Avg**			○ 100A ○ 200A ○ 400A ◉ 571A
	Leg 1		**Leg 2**		**Leg 3**		**Leg 4**		**Leg 5**		**Leg 6**	**Level:** OFF
Diode	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**
1	2135.7	-0.94	2150.1	-1.08	2130.8	-3.12	2261.3	2.97	2209.4	-0.95	2315.6	4.40
2	2207.5	2.39	2044.6	-5.93	2242.2	1.95	2171.7	-1.11	2197.9	-1.47	2160.0	-2.61
3	2048.1	-5.00	2049.9	-5.69	2117.8	-3.71	2168.5	-1.26	2139.9	-4.07	2165.0	-2.39
4	2334.0	8.25	2228.3	2.52	2228.8	1.34	2166.1	-1.37	2269.7	1.75	2357.2	6.28
5	2116.9	-1.82	2090.5	-3.82	2163.3	-1.64	2108.0	-4.01	2341.0	4.95	2080.3	-6.20
6	2269.2	5.25	2306.4	6.11	2260.4	2.77	2181.5	-0.67	2140.6	-4.04	2250.5	1.47
7	2185.8	1.38	2224.7	2.35	2305.6	4.83	2274.1	3.55	2291.5	2.73	2119.8	-4.43
8	2065.5	-4.20	2101.6	-3.31	2270.4	3.23	2231.9	1.63	2325.4	4.25	2255.4	1.69
9	2060.3	-4.44	2190.4	0.78	2237.8	1.75	2246.7	2.30	2323.8	4.18	2090.5	-5.75
10	2198.0	1.95	2147.3	-1.20	2040.5	-7.22	2126.8	-3.16	2302.6	3.23	2265.7	2.15
11	2121.2	-1.61	2309.9	6.27	2210.3	0.50	2243.9	2.18	2175.1	-2.49	2265.4	2.14
12	2075.1	-3.75	2218.2	2.05	2309.2	4.99	2105.1	-4.14	2242.1	0.51	2081.3	-6.16
13	2040.6	-5.35	2061.2	-5.17	2035.6	-7.45	2148.0	-2.19	2260.8	1.35	2202.2	-0.71
14	2260.4	4.84	2252.5	3.63	2332.7	6.06	2232.3	1.65	2174.6	-2.51	2248.7	1.39
15	2220.4	2.99	2362.7	8.70	2155.4	-2.00	2262.8	3.04	2061.0	-7.61	2285.3	3.04
16	2157.8	0.08	2038.4	-6.22	2149.0	-2.29	2209.2	0.59	2234.7	0.18	2344.3	5.70
17	2343.7	8.71	2329.7	7.19	2150.9	-2.21	2174.6	-0.98	2218.7	-0.53	2049.8	-7.58
18	2068.4	-4.07	2301.3	5.88	2283.4	3.82	2253.7	2.62	2324.9	4.23	2309.5	4.13
19	2318.2	7.52	2053.7	-5.52	2304.5	4.78	2335.0	6.33	2101.2	-5.80	2218.6	0.03
20	2360.9	9.50	2244.7	3.27	2217.6	0.83	2085.5	-5.03	2193.5	-1.66	2218.8	0.04
Total	43587.6		43705.9		44146.4		43986.7		44528.2		44283.7	
Average	2156.0		2173.5		2199.4		2196.1		2230.6		2217.9	

SAVE AS | SCAN | START | STOP | DEVICES/LEG

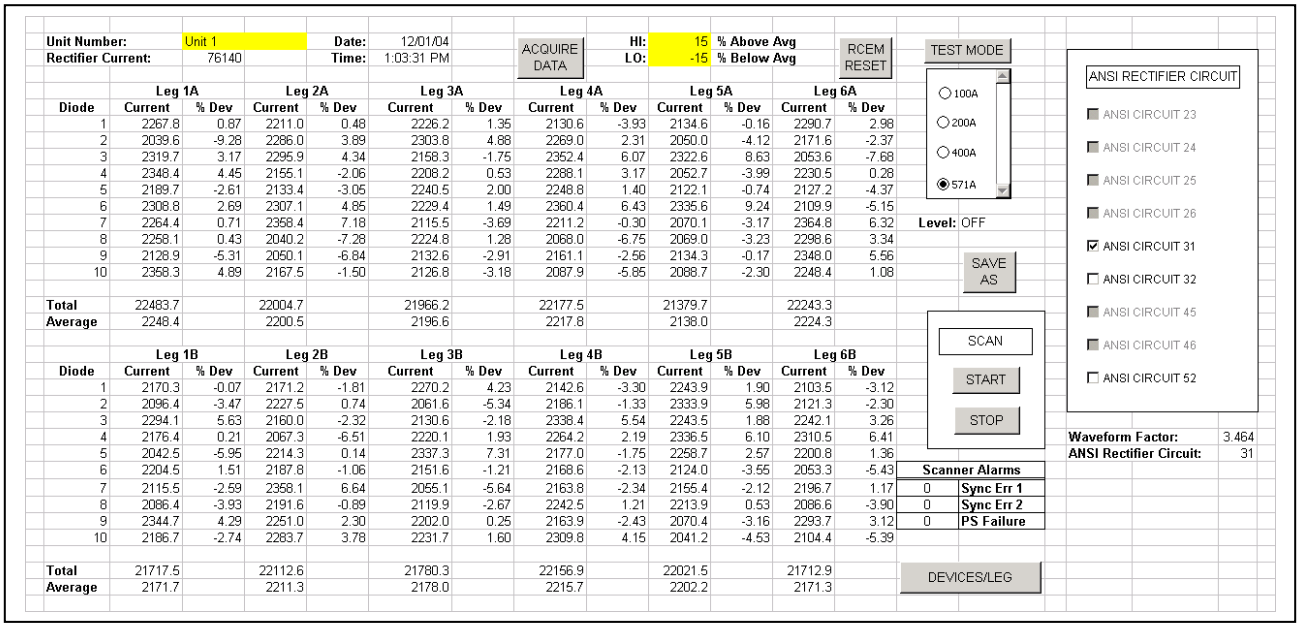
Scanner Alarms	
0	**Sync Err 1**
0	**Sync Err 2**
0	**PS Failure**

ANSI RECTIFIER CIRCUIT

- ☑ ANSI CIRCUIT 23
- ☐ ANSI CIRCUIT 24
- ☐ ANSI CIRCUIT 25
- ☐ ANSI CIRCUIT 26
- ☐ ANSI CIRCUIT 31
- ☐ ANSI CIRCUIT 32
- ☐ ANSI CIRCUIT 45
- ☐ ANSI CIRCUIT 46
- ☐ ANSI CIRCUIT 52

Waveform Factor:	1.732
ANSI Rectifier Circuit:	23

Figure B.1
6Leg120Ch Spreadsheet



Unit Number:	Unit 1		**Date:**	12/01/04		ACQUIRE DATA	**HI:**	15	**% Above Avg**		RCEM RESET	TEST MODE
Rectifier Current:	76140		**Time:**	1:03:31 PM			**LO:**	-15	**% Below Avg**			○ 100A ○ 200A ○ 400A ◉ 571A
	Leg 1A		**Leg 2A**		**Leg 3A**		**Leg 4A**		**Leg 5A**		**Leg 6A**	**Level:** OFF
Diode	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**
1	2267.8	0.87	2211.0	0.48	2226.2	1.35	2130.6	-3.93	2134.6	-0.16	2290.7	2.98
2	2039.6	-9.28	2286.0	3.89	2303.8	4.88	2269.0	2.31	2050.0	-4.12	2171.6	-2.37
3	2319.7	3.17	2295.9	4.34	2158.3	-1.75	2352.4	6.07	2322.6	8.63	2053.6	-7.68
4	2348.4	4.45	2155.1	-2.06	2208.2	0.53	2288.1	3.17	2052.7	-3.99	2230.5	0.28
5	2189.7	-2.61	2133.4	-3.05	2240.5	2.00	2248.8	1.40	2122.1	-0.74	2127.2	-4.37
6	2308.8	2.69	2307.1	4.85	2229.4	1.49	2360.4	6.43	2335.6	9.24	2109.9	-5.15
7	2264.4	0.71	2358.4	7.18	2115.5	-3.69	2211.2	-0.30	2070.1	-3.17	2364.8	6.32
8	2258.1	0.43	2040.2	-7.28	2224.8	1.28	2068.0	-6.75	2069.0	-3.23	2298.6	3.34
9	2128.9	-5.31	2050.1	-6.84	2132.6	-2.91	2161.1	-2.56	2134.3	-0.17	2348.0	5.56
10	2358.3	4.89	2167.5	-1.50	2126.8	-3.18	2087.9	-5.85	2088.7	-2.30	2248.4	1.08
Total	22483.7		22004.7		21966.2		22177.5		21379.7		22243.3	
Average	2248.4		2200.5		2196.6		2217.8		2138.0		2224.3	
	Leg 1B		**Leg 2B**		**Leg 3B**		**Leg 4B**		**Leg 5B**		**Leg 6B**	
Diode	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**	**Current**	**% Dev**
1	2170.3	-0.07	2171.2	-1.81	2270.2	4.23	2142.6	-3.30	2243.9	1.90	2103.5	-3.12
2	2096.4	-3.47	2227.5	0.74	2061.6	-5.34	2186.1	-1.33	2333.9	5.98	2121.3	-2.30
3	2294.1	5.63	2160.0	-2.32	2130.6	-2.18	2338.4	5.54	2243.5	1.88	2242.1	3.26
4	2176.4	0.21	2067.3	-6.51	2220.1	1.93	2264.2	2.19	2336.5	6.10	2310.5	6.41
5	2042.5	-5.95	2214.3	0.14	2337.3	7.31	2177.0	-1.75	2258.7	2.57	2200.8	1.36
6	2204.5	1.51	2187.8	-1.06	2151.6	-1.21	2168.6	-2.13	2124.0	-3.55	2053.3	-5.43
7	2115.5	-2.59	2358.1	6.64	2055.1	-5.64	2163.8	-2.34	2155.4	-2.12	2196.7	1.17
8	2086.4	-3.93	2191.6	-0.89	2119.9	-2.67	2242.5	1.21	2213.9	0.53	2086.6	-3.90
9	2344.7	4.29	2251.0	2.30	2202.0	0.25	2163.9	-2.43	2070.4	-3.16	2293.7	3.12
10	2186.7	-2.74	2283.7	3.78	2231.7	1.60	2309.8	4.15	2041.2	-4.53	2104.4	-5.39
Total	21717.5		22112.6		21780.3		22156.9		22021.5		21712.9	
Average	2171.7		2211.3		2178.0		2215.7		2202.2		2171.3	

SAVE AS | SCAN | START | STOP | DEVICES/LEG

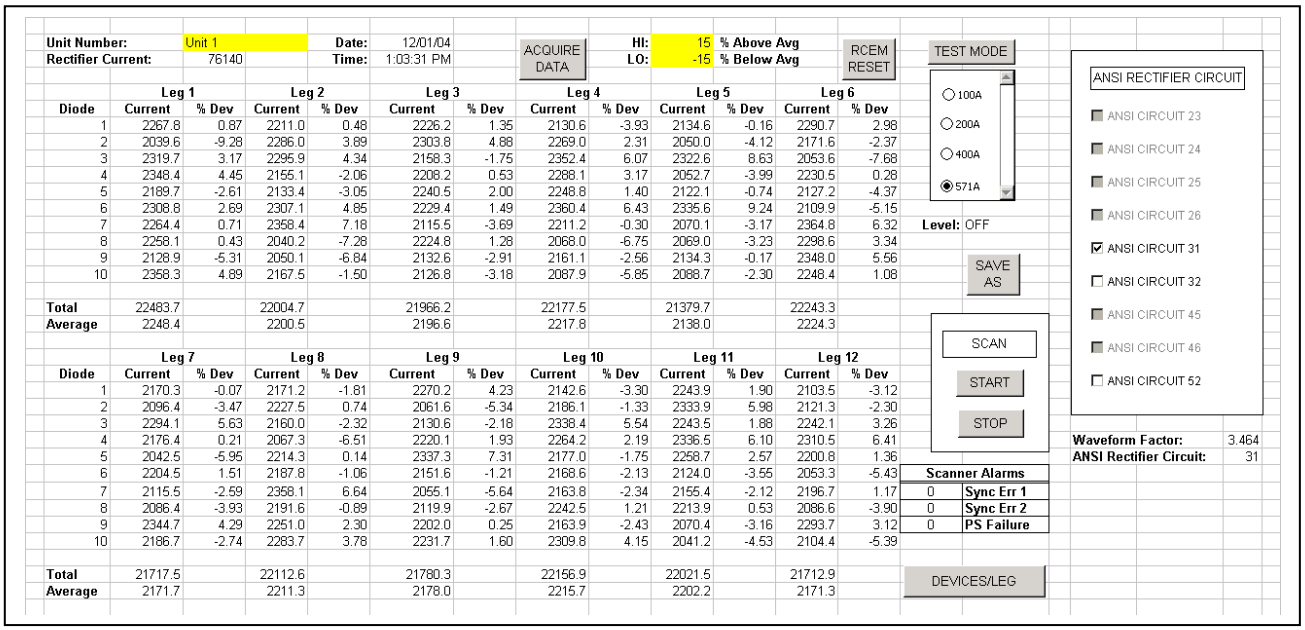
Scanner Alarms	
0	**Sync Err 1**
0	**Sync Err 2**
0	**PS Failure**

ANSI RECTIFIER CIRCUIT

- ☐ ANSI CIRCUIT 23
- ☐ ANSI CIRCUIT 24
- ☐ ANSI CIRCUIT 25
- ☐ ANSI CIRCUIT 26
- ☑ ANSI CIRCUIT 31
- ☐ ANSI CIRCUIT 32
- ☐ ANSI CIRCUIT 45
- ☐ ANSI CIRCUIT 46
- ☐ ANSI CIRCUIT 52

Waveform Factor:	3.464
ANSI Rectifier Circuit:	31

Figure B.2
M6Leg120Ch Spreadsheet



Unit Number:	Unit 1	Date:	12/01/04	ACQUIRE DATA	HI:	15	% Above Avg	RCEM RESET	TEST MODE
Rectifier Current:	76140	Time:	1:03:31 PM		LO:	-15	% Below Avg		○ 100A ○ 200A ○ 400A ◉ 571A

	Leg 1		Leg 2		Leg 3		Leg 4		Leg 5		Leg 6	
Diode	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev
1	2267.8	0.87	2211.0	0.48	2226.2	1.35	2130.6	-3.93	2134.6	-0.16	2290.7	2.98
2	2039.6	-9.28	2286.0	3.89	2303.8	4.88	2269.0	2.31	2050.0	-4.12	2171.6	-2.37
3	2319.7	3.17	2295.9	4.34	2158.3	-1.75	2352.4	6.07	2322.6	8.63	2053.6	-7.68
4	2348.4	4.45	2155.1	-2.06	2208.2	0.53	2288.1	3.17	2052.7	-3.99	2230.5	0.28
5	2189.7	-2.61	2133.4	-3.05	2240.5	2.00	2248.8	1.40	2122.1	-0.74	2127.2	-4.37
6	2308.8	2.69	2307.1	4.85	2229.4	1.49	2360.4	6.43	2335.6	9.24	2109.9	-5.15
7	2264.4	0.71	2358.4	7.18	2115.5	-3.69	2211.2	-0.30	2070.1	-3.17	2364.8	6.32
8	2258.1	0.43	2040.2	-7.28	2224.8	1.28	2068.0	-6.75	2069.0	-3.23	2298.6	3.34
9	2128.9	-5.31	2050.1	-6.84	2132.6	-2.91	2161.1	-2.56	2134.3	-0.17	2348.0	5.56
10	2358.3	4.89	2167.5	-1.50	2126.8	-3.18	2087.9	-5.85	2088.7	-2.30	2248.4	1.08
Total	22483.7		22004.7		21966.2		22177.5		21379.7		22243.3	
Average	2248.4		2200.5		2196.6		2217.8		2138.0		2224.3	

	Leg 7		Leg 8		Leg 9		Leg 10		Leg 11		Leg 12	
Diode	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev	Current	% Dev
1	2170.3	-0.07	2171.2	-1.81	2270.2	4.23	2142.6	-3.30	2243.9	1.90	2103.5	-3.12
2	2096.4	-3.47	2227.5	0.74	2061.6	-5.34	2186.1	-1.33	2333.9	5.98	2121.3	-2.30
3	2294.1	5.63	2160.0	-2.32	2130.6	-2.18	2338.4	5.54	2243.5	1.88	2242.1	3.26
4	2176.4	0.21	2067.3	-6.51	2220.1	1.93	2264.2	2.19	2336.5	6.10	2310.5	6.41
5	2042.5	-5.95	2214.3	0.14	2337.3	7.31	2177.0	-1.75	2258.7	2.57	2200.8	1.36
6	2204.5	1.51	2187.8	-1.06	2151.6	-1.21	2168.6	-2.13	2124.0	-3.55	2053.3	-5.43
7	2115.5	-2.59	2358.1	6.64	2055.1	-5.64	2163.8	-2.34	2155.4	-2.12	2196.7	1.17
8	2086.4	-3.93	2191.6	-0.89	2119.9	-2.67	2242.5	1.21	2213.9	0.53	2086.6	-3.90
9	2344.7	4.29	2251.0	2.30	2202.0	0.25	2163.9	-2.43	2070.4	-3.16	2293.7	3.12
10	2186.7	-2.74	2283.7	3.78	2231.7	1.60	2309.8	4.15	2041.2	-4.53	2104.4	-5.39
Total	21717.5		22112.6		21780.3		22156.9		22021.5		21712.9	
Average	2171.7		2211.3		2178.0		2215.7		2202.2		2171.3	

Level: OFF

SAVE AS

SCAN START STOP

Scanner Alarms	
0	Sync Err 1
0	Sync Err 2
0	PS Failure

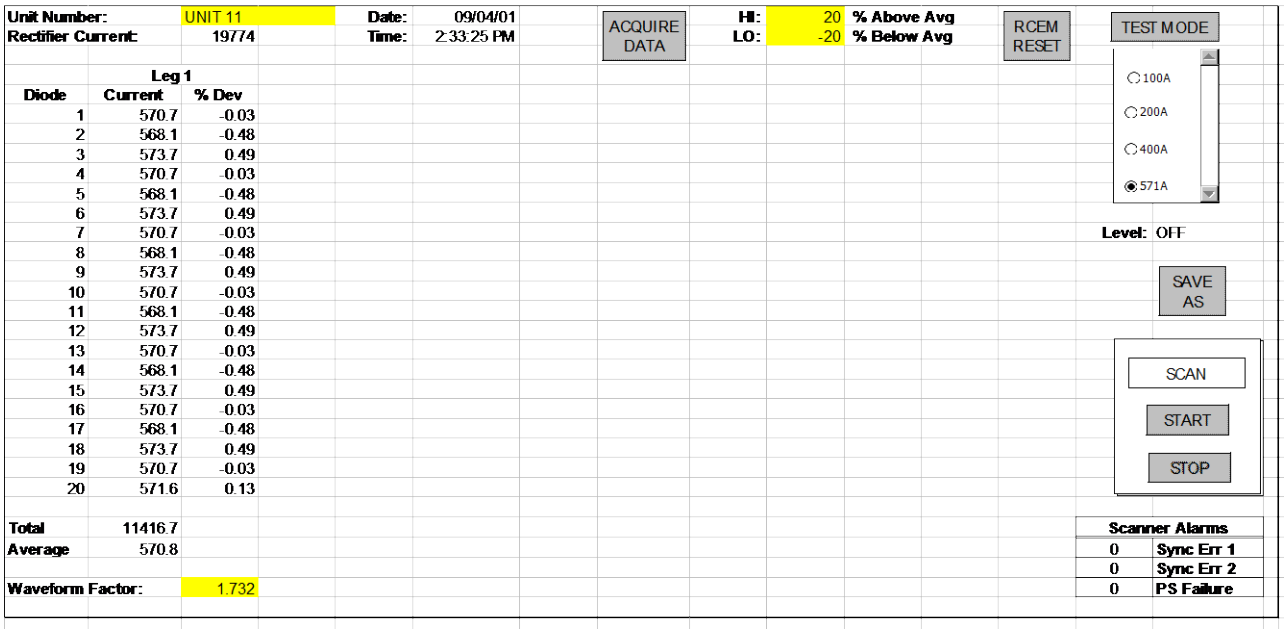
DEVICES/LEG

ANSI RECTIFIER CIRCUIT

- ☐ ANSI CIRCUIT 23
- ☐ ANSI CIRCUIT 24
- ☐ ANSI CIRCUIT 25
- ☐ ANSI CIRCUIT 26
- ☑ ANSI CIRCUIT 31
- ☐ ANSI CIRCUIT 32
- ☐ ANSI CIRCUIT 45
- ☐ ANSI CIRCUIT 46
- ☐ ANSI CIRCUIT 52

Waveform Factor:	3.464
ANSI Rectifier Circuit:	31

Figure B.3
12Leg120Ch Spreadsheet



Unit Number:	UNIT 11	Date:	09/04/01	ACQUIRE DATA	HI:	20	% Above Avg	RCEM RESET	TEST MODE
Rectifier Current:	19774	Time:	2:33:25 PM		LO:	-20	% Below Avg		○ 100A ○ 200A ○ 400A ◉ 571A

	Leg 1	
Diode	Current	% Dev
1	570.7	-0.03
2	568.1	-0.48
3	573.7	0.49
4	570.7	-0.03
5	568.1	-0.48
6	573.7	0.49
7	570.7	-0.03
8	568.1	-0.48
9	573.7	0.49
10	570.7	-0.03
11	568.1	-0.48
12	573.7	0.49
13	570.7	-0.03
14	568.1	-0.48
15	573.7	0.49
16	570.7	-0.03
17	568.1	-0.48
18	573.7	0.49
19	570.7	-0.03
20	571.6	0.13
Total	11416.7	
Average	570.8	
Waveform Factor:	1.732	

Level: OFF

SAVE AS

SCAN START STOP

Scanner Alarms	
0	Sync Err 1
0	Sync Err 2
0	PS Failure

Figure B.4
1Leg-20ch Spreadsheet

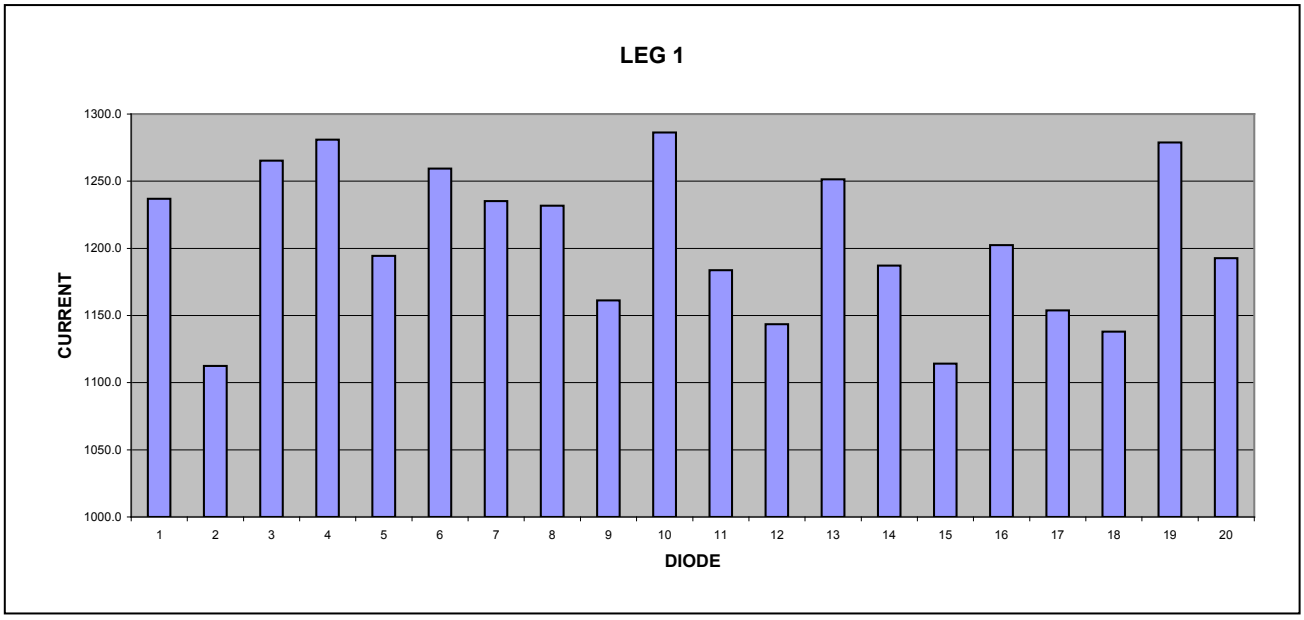


Figure B.5
Leg 1 Bar Chart

Diode	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6		Average
1	566.1	566.5	569.1	566.8	565.3	571.4		567.5
2	572.8	571.5	574.7	566.2	567.5	573.0		571.0
3	570.5	569.4	567.0	573.3	575.9	571.3		571.2
4	566.3	573.9	569.9	570.6	570.9	567.7		569.9
5	569.1	566.4	572.0	567.2	575.9	566.4		569.5
6	570.4	568.4	575.3	573.9	568.4	573.0		571.5
7	568.2	566.3	565.6	569.0	574.3	568.7		568.7
8	568.0	570.8	568.2	569.2	565.8	570.8		568.8
9	567.6	575.2	572.0	573.9	575.9	569.1		572.3
10	571.5	566.2	572.5	570.0	576.3	566.6		570.5
11	575.8	572.4	569.3	567.0	570.8	567.8		570.5
12	576.6	566.8	565.6	569.2	571.5	575.8		570.9
13	571.4	569.9	575.0	574.7	573.0	573.5		572.9
14	576.7	569.2	570.9	570.0	573.2	567.3		571.2
15	570.1	571.5	574.6	571.5	570.2	571.1		571.5
16	567.9	572.4	570.9	573.1	575.4	569.5		571.5
17	568.7	568.6	567.0	571.3	567.8	572.0		569.3
18	569.4	575.3	570.7	567.5	573.1	573.8		571.6
19	572.3	574.2	567.1	574.5	567.6	576.2		572.0
20	566.0	566.0	574.3	569.6	570.6	566.7		568.9

CALIBRATE

START

STOP

Scanner Alarms	
0	Sync Err 1
0	Sync Err 2
0	PS Failure

Figure B.6.
Calibrate Worksheet