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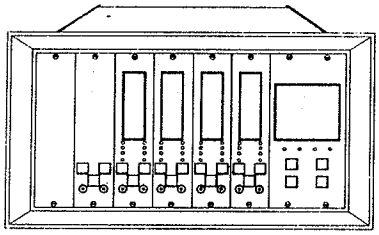
Find the *GE / Bently Nevada 3300/01-01* at our website: *Click HERE*

PART NO. 80175-01

3300/01 SYSTEM MONITOR

OPERATION MANUAL

BENTLY NEVADA



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NOTICE

READ THE FOLLOWING BEFORE INSTALLING OR OPERATING EQUIPMENT

Bently Nevada Corporation has attempted to identify areas of risk created by improper installation and/or operation of this product. These areas of information are noted as **WARNING** or **CAUTION** for your protection and for the safe and effective operation of this equipment. Read all instructions before installing or operating this product. Pay particular attention to those areas designated by the following symbols.

⚠ WARNING

High Voltage present Could cause shock, burns or death.

Do Not touch exposed wires or terminals.

CAUTION

Machine Protection Will Be Lost

SYMBOLS

Special symbols are used in the manual to illustrate specifics in the step by step processes. For example:



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FORWARD

This document is for control room personnel who operate the 3300 Monitoring System. The information includes description, disassembly instructions, performance tests, recommended spare parts, field changeable options, specifications and schematics. The procedures are presented in step-by-step graphic format.

RELATED DOCUMENTS

3300 System Overview, 80177
3300 System Installation Instructions, 80172
3300 System Troubleshooting, 80173
3300/10 Power Supply, 80174
Dynamic Data Manager System, 46390-01
Transient Data Manager User Guide, 79206-01
Allen Bradley Communications Interface Module 1770-KF2 User's Manual
Modicon Modbus Protocol Reference Guide PI-MBUS-300 REV B

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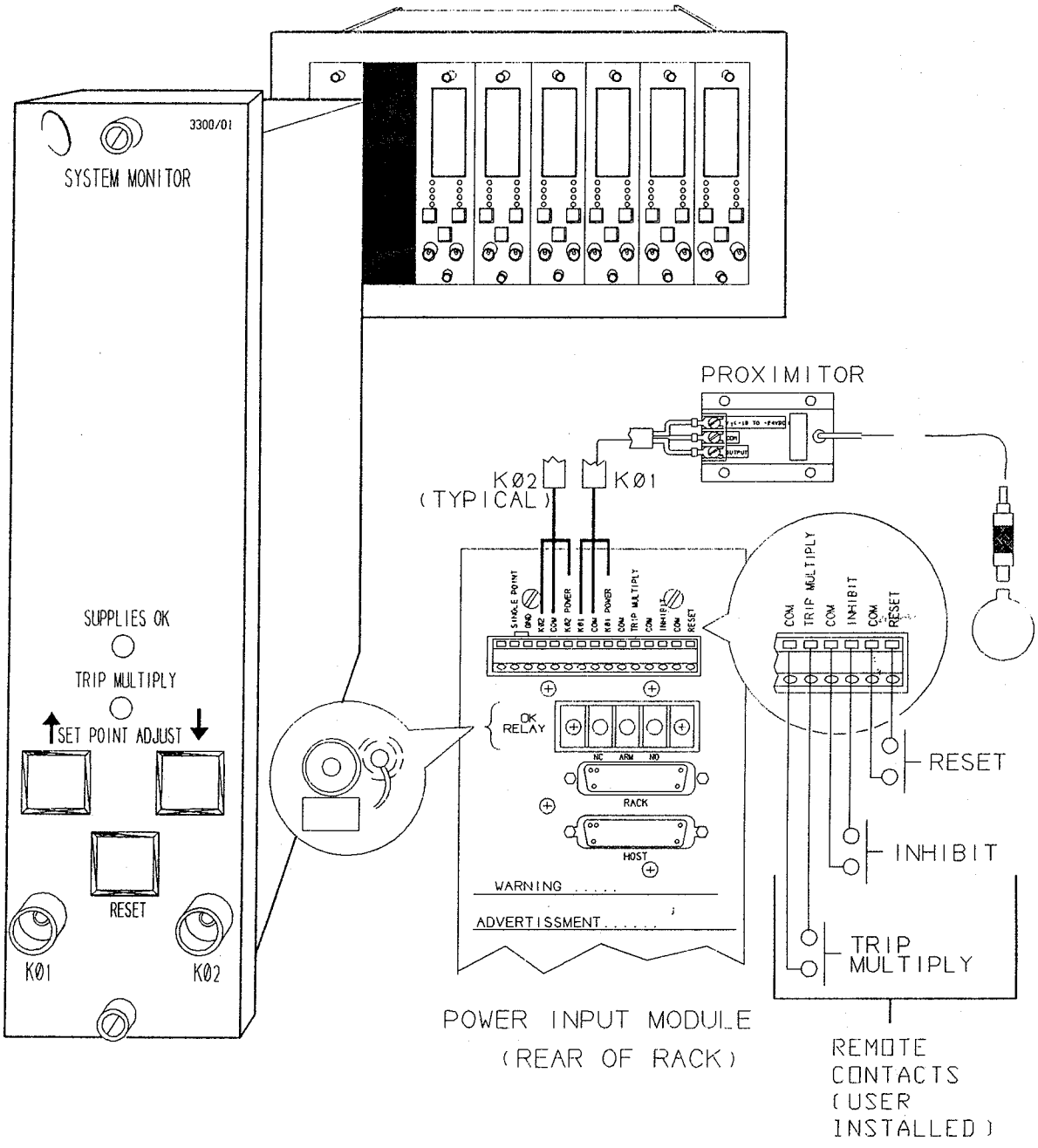
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1 SYSTEM MONITOR

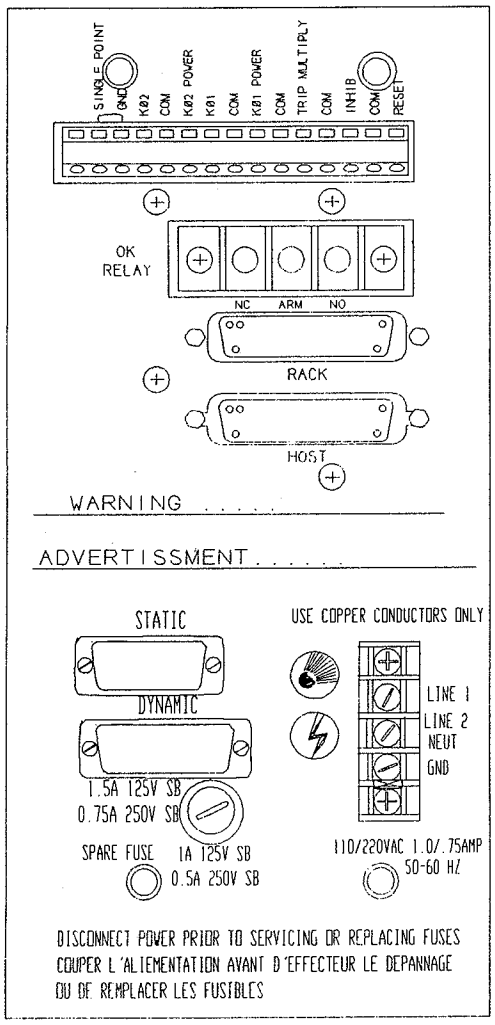


SEE [6] FOR CONNECTIONS TO COMMUNICATIONS PROCESSOR
SEE [14] FOR SERIAL INTERFACE CONNECTIONS

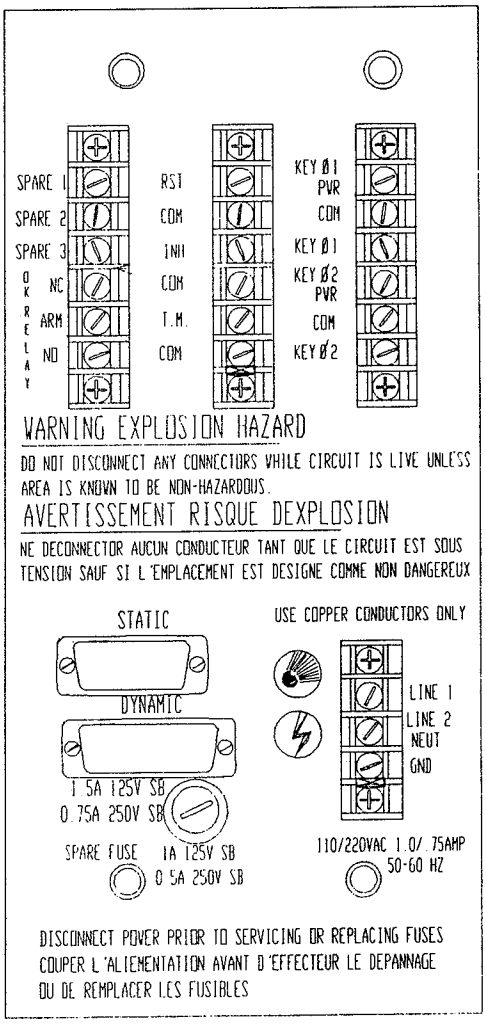
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1 SYSTEM MONITOR

Two types of Power Input Modules (PIM) can be used with the System Monitor. The PIM shown below on the left is supplied when the Serial Interface option is specified. It includes the two additional 25-pin serial connectors. The PIM on the right is the standard input module. Whenever the PIM is referenced pictorially in this document, the figure shown is the Serial Interface option PIM. In all these figures, the standard PIM may be substituted for the Serial Interface PIM. All connections to either PIM are the same, only the style of the connectors have been altered.



Serial Interface option PIM



Standard PIM

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2 MONITOR FUNCTIONS

SYSTEM POWER-UP INHIBIT

The System Monitor provides a Power-up Inhibit function that allows each monitor to inhibit its alarms during power-up, or whenever a system supply voltage falls below its operating level. After power-up, the inhibit function remains active for approximately 2 seconds. The inhibit function can also be activated by contact closure through terminals on the Power Input Module at the rear of the rack.

SUPPLY VOLTAGES OK

Seven LEDs located behind the front panel of the System Monitor are ON to indicate when supply voltages are functioning. The supply voltages are +VRH, +VRL, +7.5V, +5V REF, -7.5V, and -VT. A green LED on the front panel (SUPPLIES OK), when ON, indicates that all supply voltages are functional.

SYSTEM RESET

The System Monitor provides System Reset capability that is activated by either external contact closure through terminals on the Power Input Module, or by pressing the RESET switch on the front panel.

TRIP MULTIPLY

The System Monitor provides a trip multiply control that is activated by contact closure through terminals on the Power Input Module. When activated, trip multiply allows the alarm setpoints to be multiplied by a factor preset on monitors with Trip Multiply options installed. The Trip Multiply function is indicated by a red LED on the front panel.

STATIC DATA BUS BUFFER

The System Monitor multiplexes signals from the Communications Processor to select static data from the monitors. Static data signals from the monitor are buffered before being sent to the Communications Processor. If the Serial Interface option is installed, the position and data select signals from the Communications Processor are intercepted in the interface. If no Communications Processor is connected the Serial Interface takes over control of the position select and data select signals to gather data.

OK RELAY

The System Monitor drives an OK Relay that is located on the Power Input Module. The single-pole, double-throw (SPDT) relay is used to indicate that the 3300 rack is in an OK condition. The OK Relay is set normally energized. The OK Relay is deactivated either by the system power-up inhibit signal (from System Monitor), or by a not OK signal from the monitors.

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2 MONITOR FUNCTIONS

ALARM SETPOINT ADJUST

The System Monitor has two switches on the front panel that adjust alarm setpoint levels on each monitor. One switch is for upscale adjustments and the other is for downscale adjustments.

KEYPHASORS

The System Monitor receives input from two Keyphasor transducers through terminals on the power input module and buffers the input for use by the monitors. Buffered Keyphasor signals are also available from the coaxial connectors on the front panel. The System Monitor also provides short-circuit protected Keyphasor power.

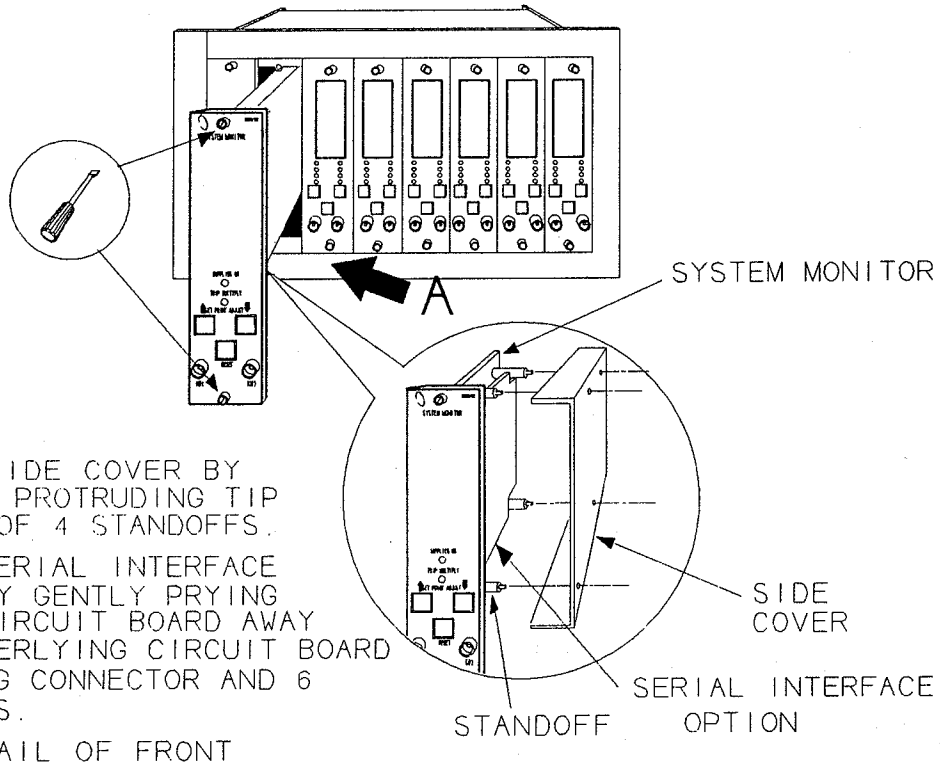
SERIAL INTERFACE OPTION

When installed in the System Monitor, the Serial Interface option provides a communications interface via defined protocols for the transmission of static data from the 3300 rack. The Serial Interface option can operate concurrently with a connected Data Manager Communications Processor.

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3 DISASSEMBLY PROCEDURES

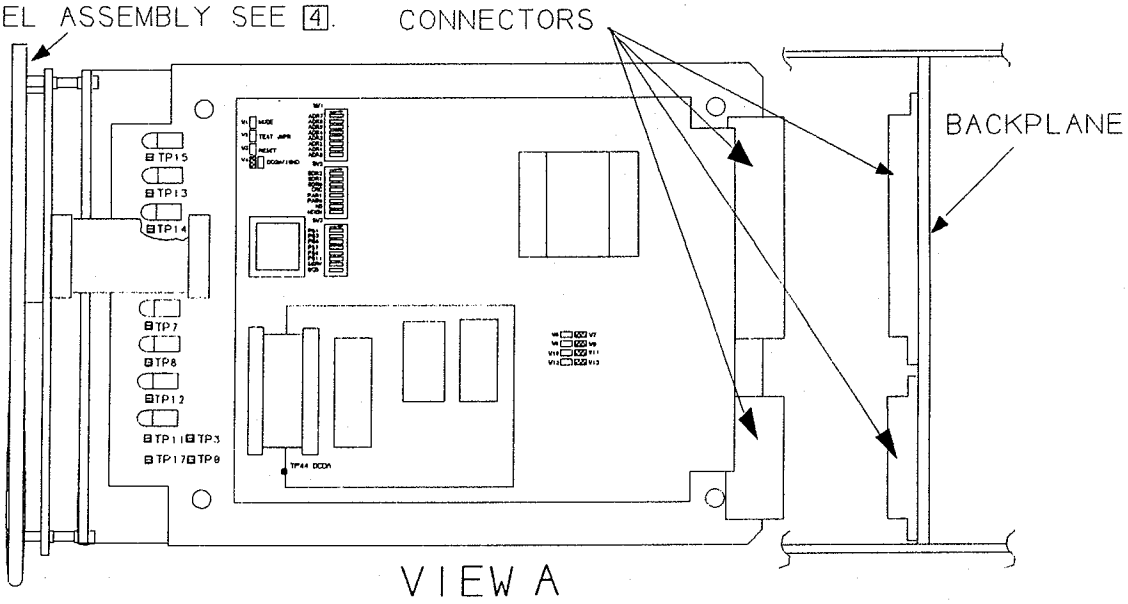
1. LOOSEN SCREWS AND PULL SYSTEM MONITOR OUT FROM RACK.



2. REMOVE SIDE COVER BY PINCHING PROTRUDING TIP ON EACH OF 4 STANDOFFS.

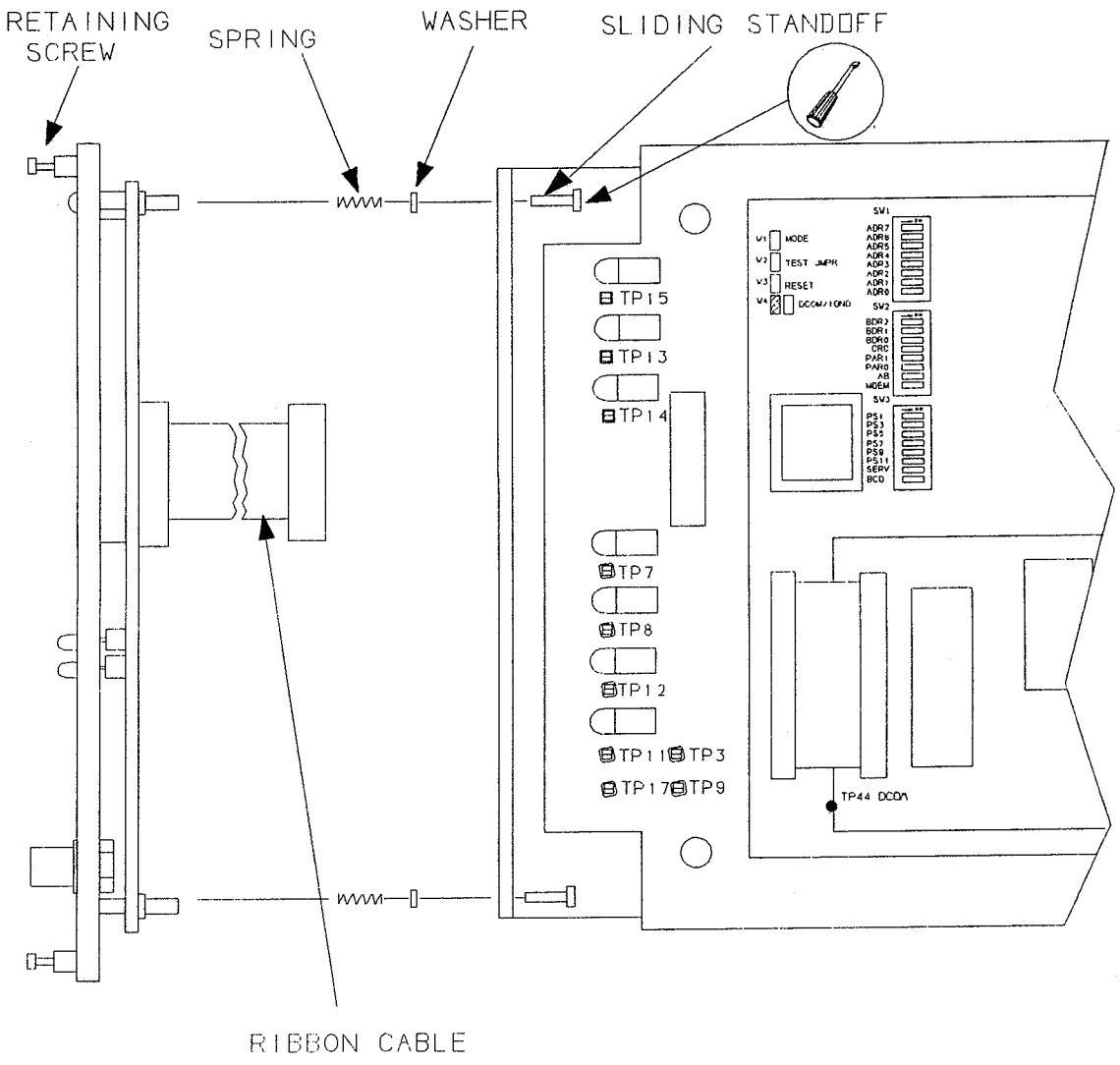
3. REMOVE SERIAL INTERFACE OPTION BY GENTLY PRYING OPTION CIRCUIT BOARD AWAY FROM UNDERLYING CIRCUIT BOARD AT MATING CONNECTOR AND 6 STANDOFFS.

FOR DETAIL OF FRONT PANEL ASSEMBLY SEE [4].



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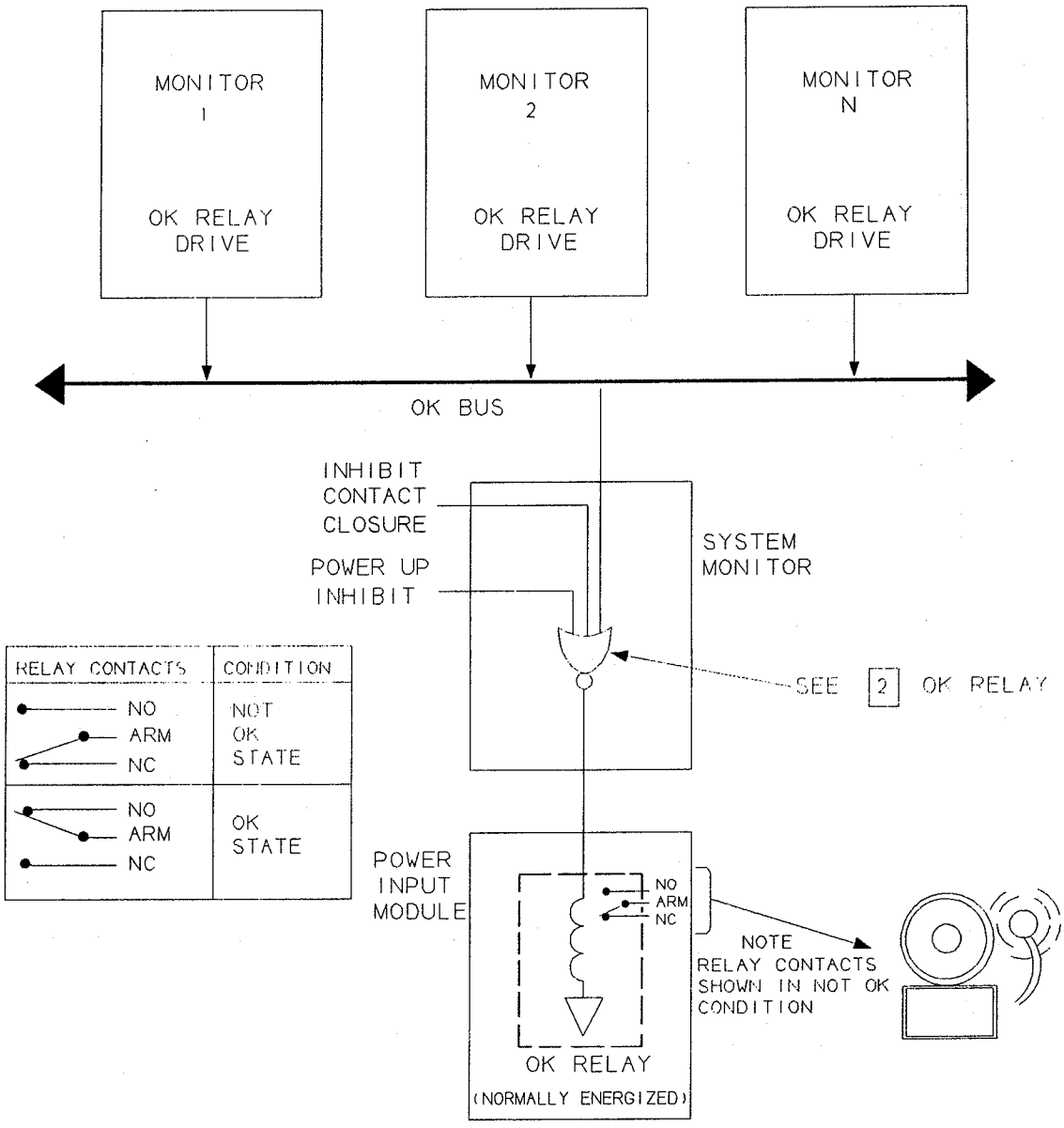
4 FRONT PANEL ASSEMBLY REMOVAL



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5 OK RELAY CONFIGURATION

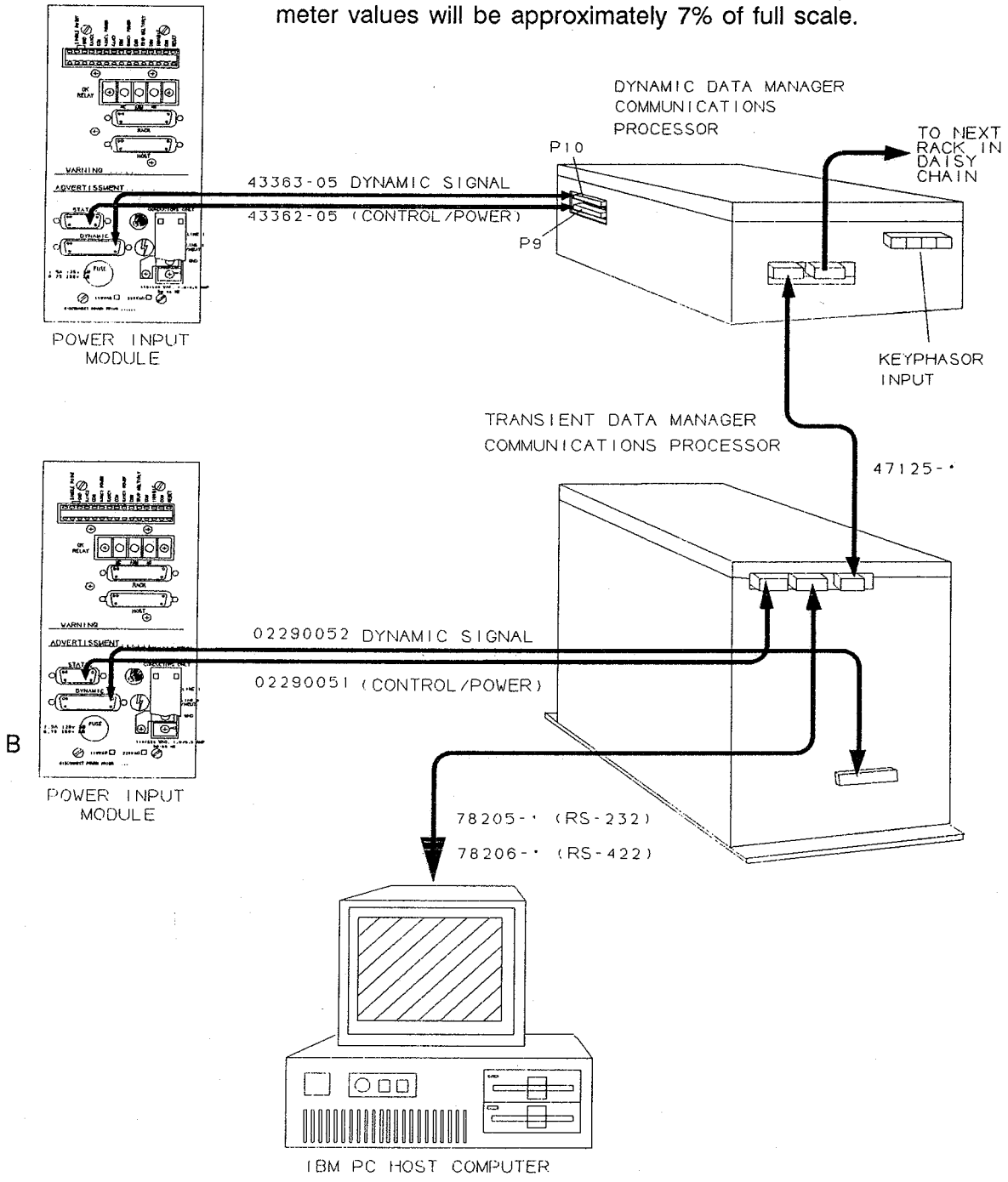
THE FOLLOWING DIAGRAM SHOWS THE FUNCTIONAL CONCEPT OF THE OK RELAY
FOR MORE DETAIL REFER TO SCHEMATIC (SEE 18)



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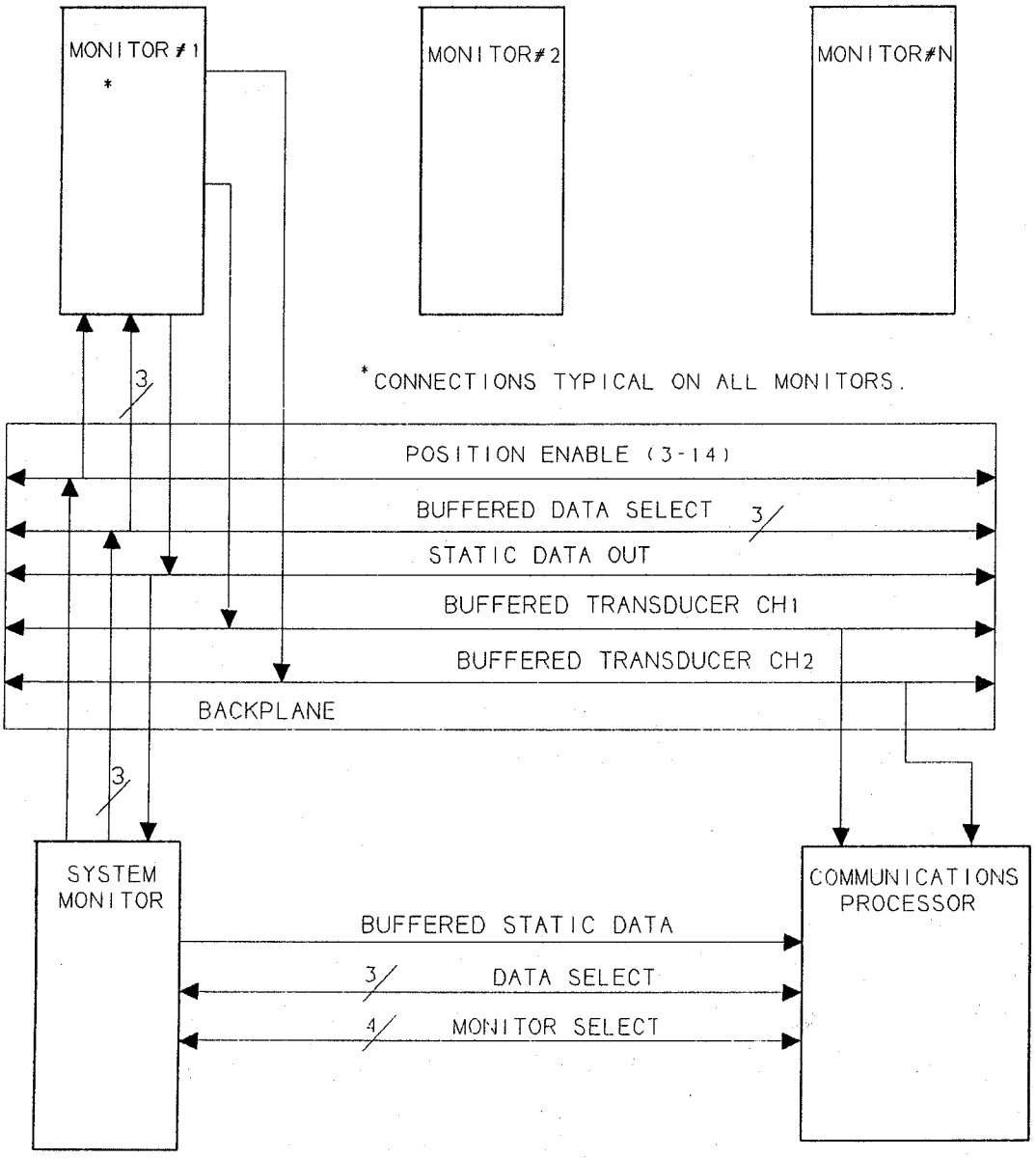
6 COMMUNICATIONS PROCESSOR INTERFACE

Communications processor systems used with 3300 systems should all operate from the same power source. If they do not and if the 3300 system power goes off, the computer screen will indicate system OK and displayed meter values will be approximately 7% of full scale.



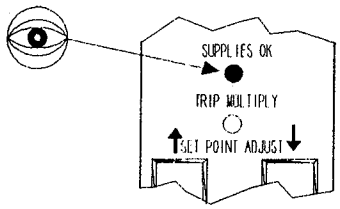
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6 COMMUNICATIONS PROCESSOR INTERFACE



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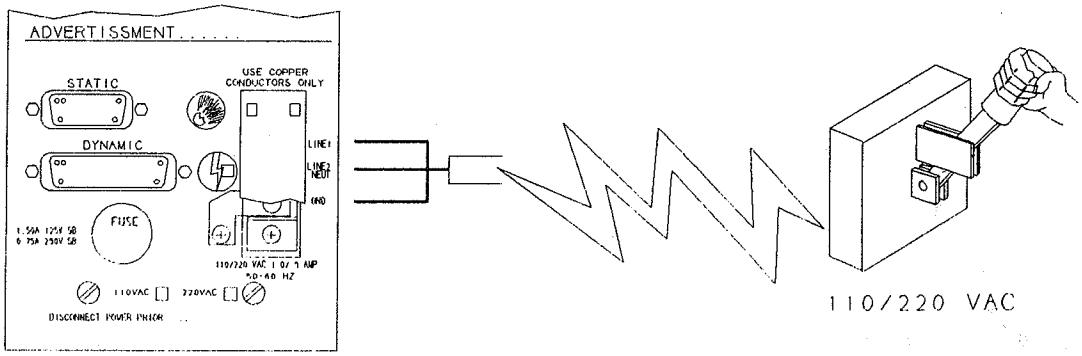
7 PERFORMANCE TESTING



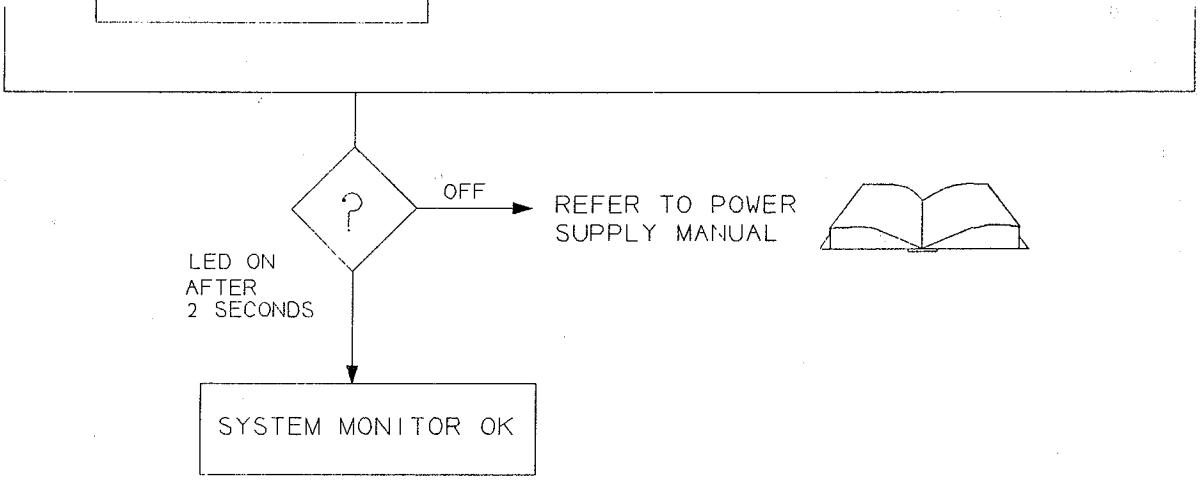
SYSTEM MONITOR

CAUTION

-V_T JUMPERS IN SYSTEM MONITOR AND POWER SUPPLY MUST BE SET TO SAME VOLTAGE (-18 VDC OR -24 VDC) OR **SUPPLIES OK** LED WILL NOT GO ON.



110/220 VAC



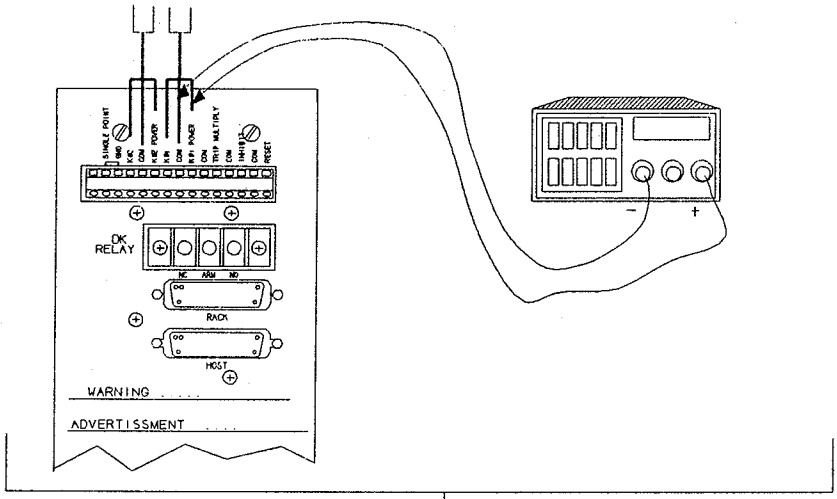
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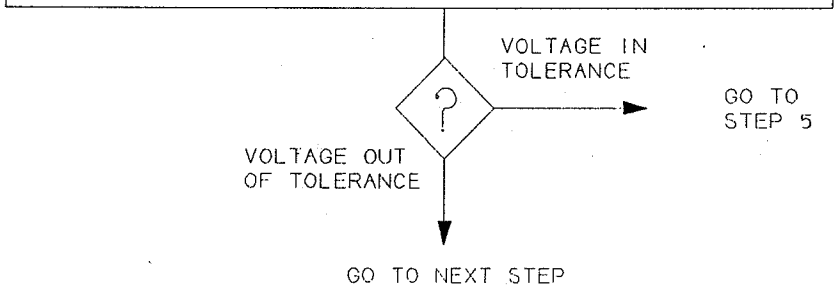
8 KEYPHASOR PERFORMANCE TEST

NOTES: 1. THE FOLLOWING PROCEDURE FOR TESTING KEYPHASOR 1 IS TYPICAL FOR TESTING KEYPHASOR 2.

2. MACHINE ASSOCIATED WITH KEYPHASOR UNDER TEST SHOULD BE RUNNING DURING THIS PROCEDURE. IF MACHINE IS NOT TURNING, SIMULATE RUNNING MACHINE INPUT FROM FUNCTION GENERATOR OR TK3 TEST KIT.

1. MEASURE KEYPHASOR 1 POWER AT POWER INPUT MODULE **KØ1 POWER** TERMINAL
   TOLERANCE IS -23.7 ± 0.5 VDC
   (-17.85 ± 0.45 VDC FOR 3000 PROXIMITOR)

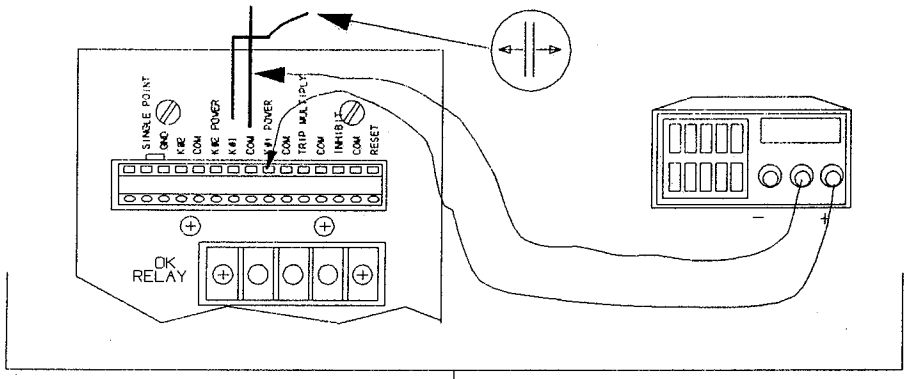




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8 KEYPHASOR PERFORMANCE TEST

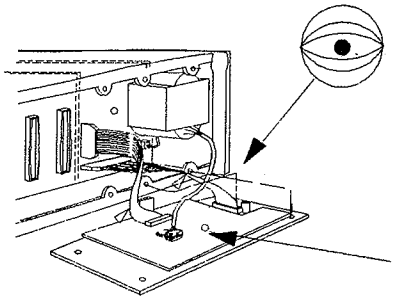
2. DISCONNECT WIRE FROM **KØ1 POWER** AND MEASURE VOLTAGE AT POWER INPUT MODULE TERMINAL. MEASUREMENT SHOULD MEET TOLERANCE SPECIFIED IN STEP 1.



VOLTAGE IN TOLERANCE → GO TO STEP 4

VOLTAGE OUT OF TOLERANCE

3. LOOSEN SCREWS AND PULL POWER INPUT MODULE OUT FROM REAR OF RACK. EXAMINE CABLING AND CONNECTIONS BETWEEN MODULE AND RACK.



⚠ WARNING

HIGH VOLTAGE LEVELS ARE PRESENT THAT COULD CAUSE SERIOUS INJURY.

POWER INPUT MODULE

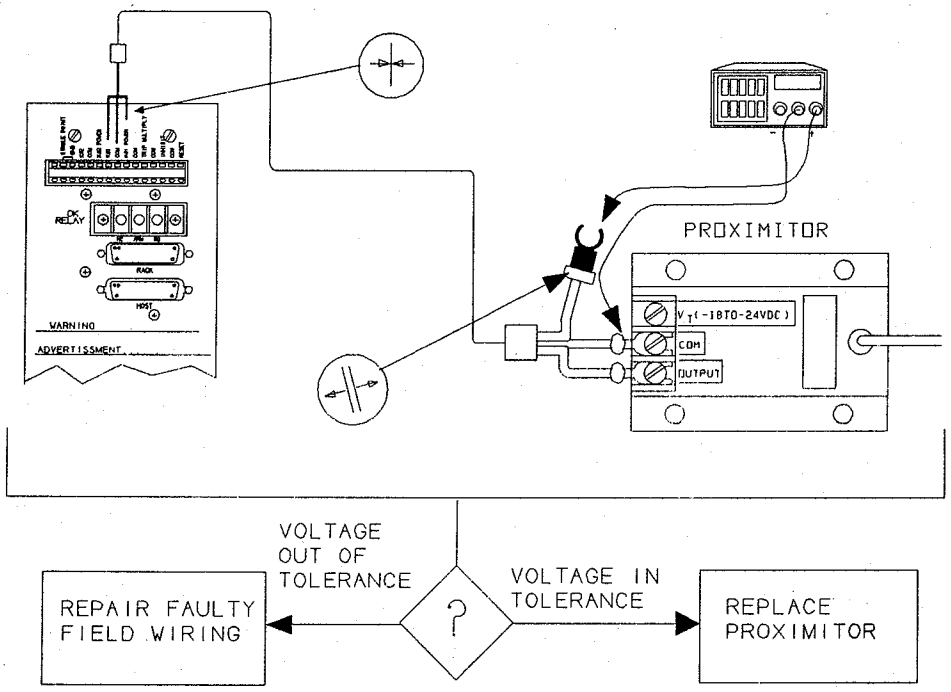
CABLING DEFECTIVE → REPAIR/REPLACE CABLE OR CONNECTION

CABLING OK → REPLACE SYSTEM MONITOR

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8 KEYPHASOR PERFORMANCE TEST

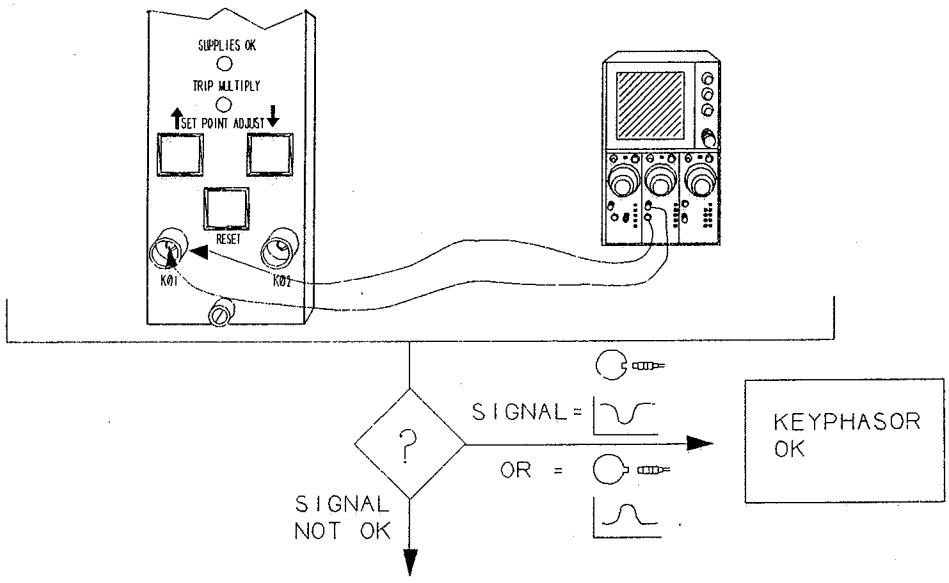
4. RECONNECT WIRE AT **K01 POWER** TERMINAL. DISCONNECT WIRE AT **-VT** (-18 VDC OR -24 VDC) TERMINAL OF PROXIMITOR AND MEASURE VOLTAGE AT WIRE. VOLTAGE SHOULD MEET TOLERANCE LISTED IN STEP 1.



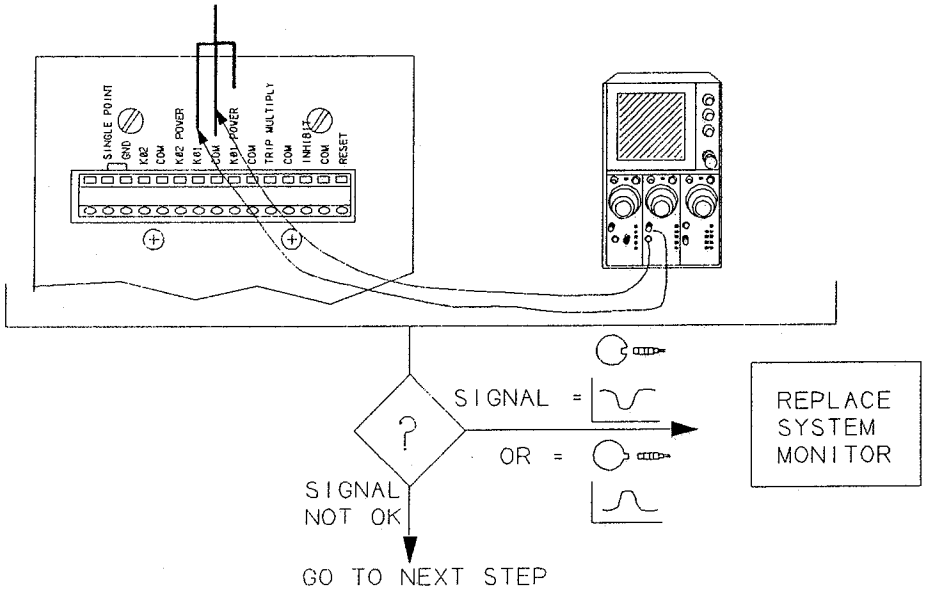
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8 KEYPHASOR PERFORMANCE TEST

5. CHECK KEYPHASOR OUTPUT SIGNAL AT SYSTEM MONITOR FRONT PANEL KØ1 COAXIAL CONNECTOR.



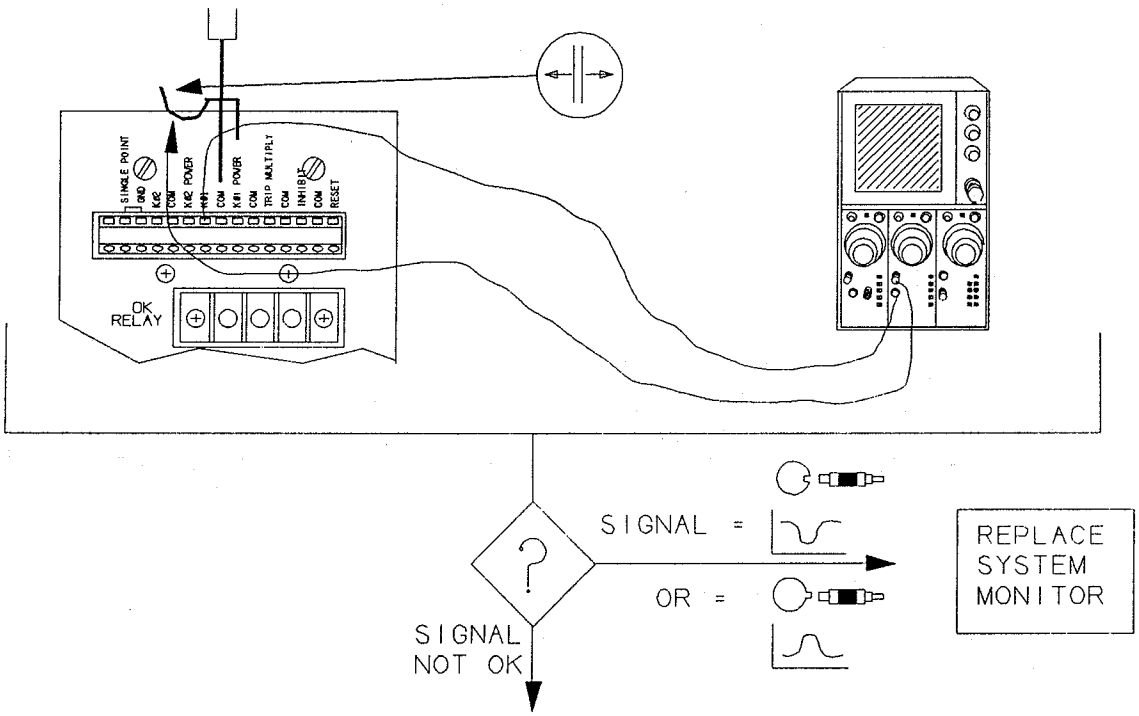
6. CHECK KEYPHASOR SIGNAL AT POWER INPUT MODULE KØ1 TERMINAL



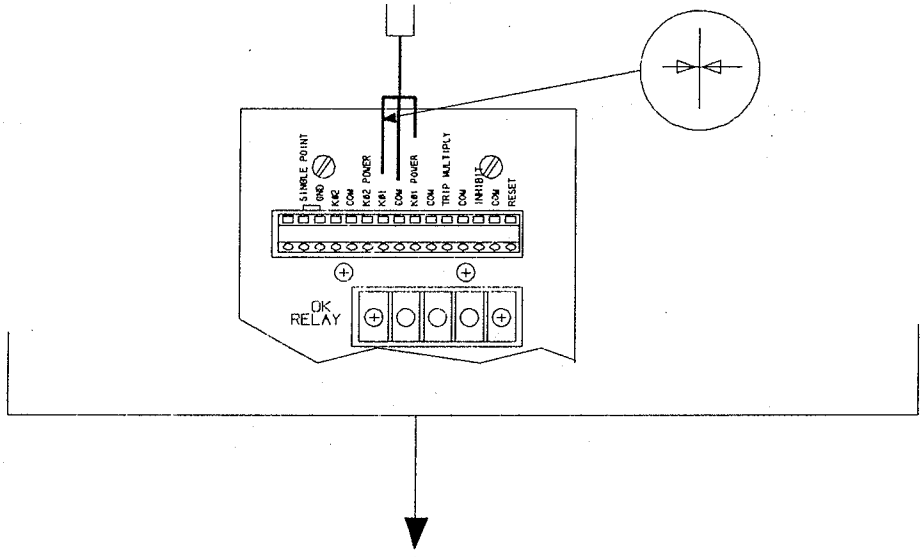
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8 KEYPHASOR PERFORMANCE TEST

7. DISCONNECT WIRE AT POWER INPUT MODULE KØ1 TERMINAL AND CHECK WIRE FOR KEYPHASOR SIGNAL.



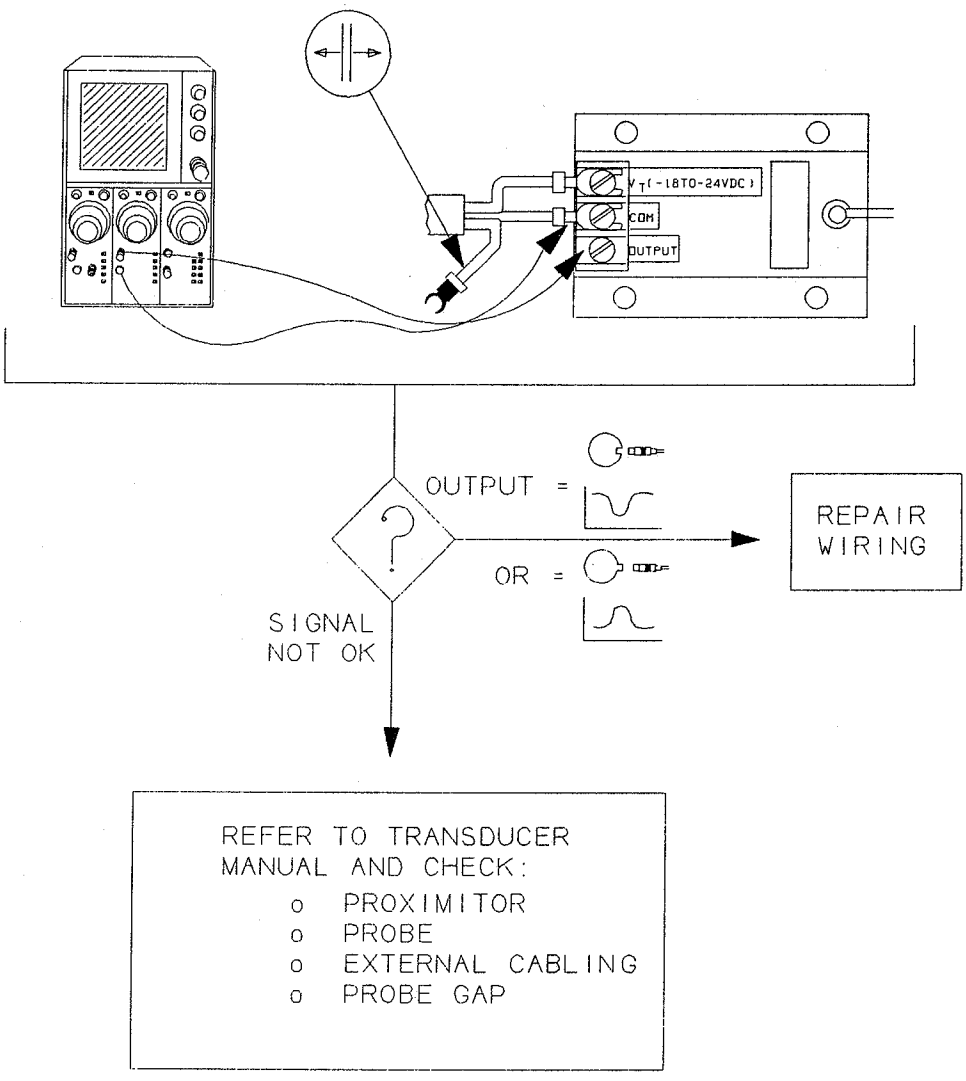
8. RECONNECT WIRE TO POWER INPUT MODULE KØ1 TERMINAL.



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8 KEYPHASOR PERFORMANCE TEST

9. DISCONNECT WIRE AT PROXIMITOR **OUTPUT** TERMINAL AND CHECK SIGNAL AT **OUTPUT** TERMINAL.



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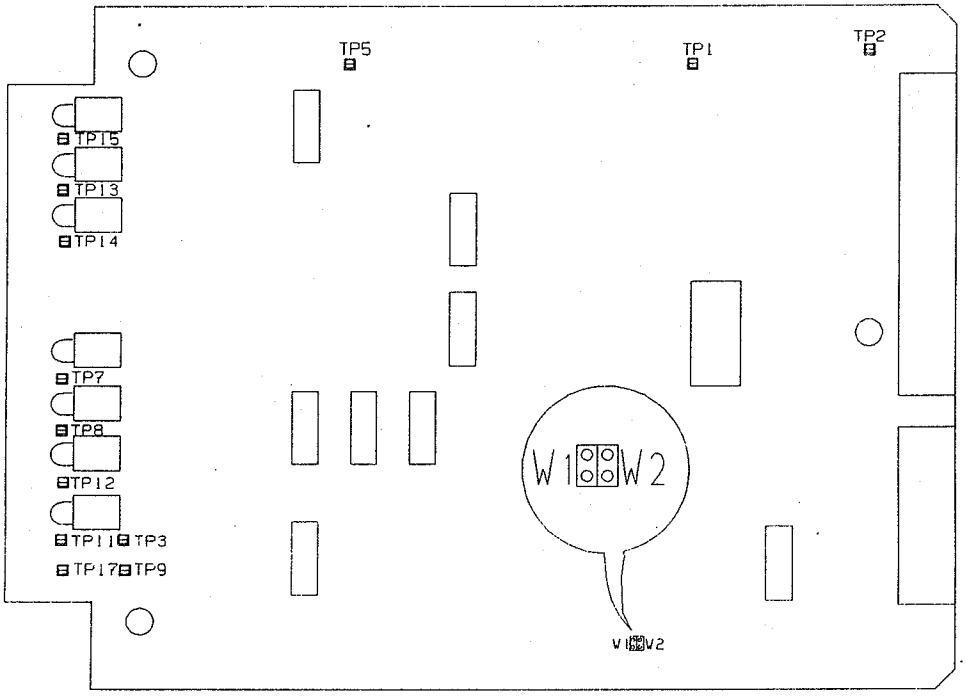
9 $-V_T$ JUMPER CONFIGURATION

TO CHANGE TRANSDUCER VOLTAGE ($-V_T$) ON SYSTEM MONITOR. DISENGAGE FROM RACK (SEE [3]) AND SET JUMPER AS FOLLOWS:

VOLTAGE $-V_T$	JUMPER
-24 VDC	W1
-18 VDC	W2

NOTE

THIS VOLTAGE OPTION MUST CONFORM WITH $-V_T$ SET IN POWER SUPPLY FOR SUPPLIES OK LED TO OPERATE.



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10 RECOMMENDED SPARE PARTS

DESCRIPTION	PART NUMBER
System Monitor	3300/01-XX XX = 01 without Serial Interface XX = 02 with Serial Interface
System Monitor PWA	84030-01
Serial Interface PWA	83989-01
System Monitor front panel	78452-01

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11 SPECIFICATIONS

INPUT SUPPLY

No external loads, normal operation mode, 25°C

Supply	Voltage
+VRH	22.55 ± 6.05 Vdc
+VRL	11.22 ± 3.09 Vdc
+7.5V	7.5 ± 0.1 Vdc
+5V	5.00 ± 0.05 Vdc
+5V REF	5.00 ± 0.009 Vdc
-7.5V	-7.5 ± 0.1 Vdc
-VT (-24V Option)	-23.75 ± 0.45 Vdc
-VT (-18V Option)	-17.9 ± 0.4 Vdc

SYSTEM POWER-UP INHIBIT

Delay	2.1 ± 1 seconds

CONTACT CLOSURE RATING

Contacts for System Reset, Inhibit, and Trip Multiply

Active	<100Ω

KEYPHASOR

Output Voltage (-24V Option)	-23.2V to -24.2V, Short-circuit Protected
Output Voltage (-18V Option)	-17.4V to -18.3V, Short-circuit Protected

ENVIRONMENTAL

Operating Temperature	+32°F to +149°F (0°C to +65°C)
Storage Temperature	-40°F to +185°F (-40°C to +85°C)
Humidity	95%, noncondensing

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12 SERIAL INTERFACE OVERVIEW

PROTOCOLS

The 3300 Serial Interface option gives the 3300 system communication capability using either RS-232C or RS-422A connections. The interface implements two standard protocols which are switch selectable on the interface. The protocols are Modicon Modbus and Allen Bradley full duplex (DF1). Each protocol possesses its own unique characteristics but the data which is transferred over each interface link is similar. That data consists of each monitor's current values and status values.

DIFFERENCES FROM BASIC SYSTEM MONITOR

The interface option installs in the system monitor slot and rides on top of the System Monitor main circuit board. With the interface installed, the original functions of the System Monitor remain unaltered. To supply the communications signals, the 3300 system backplane has an additional 32-pin din connector located immediately below the 64-pin din backplane connector. This connection supplies the communications signals to and from the Power Input Module (PIM). The PIM provides the required communications connectors.

SELECTION SWITCHES

Selection switches on the Serial Interface allow the setting of the device address and baud rate. In addition such selections as message checking mode (cyclic redundancy check or block character check), parity and stop bit selection, modem controls enable, and protocol mode can be set. To identify the positions of any 6-channel monitors in the rack, 6 switches are provided. Each switch identifies an odd slot position which corresponds to the left side slot into which a 6-channel monitor is placed.

SCAN METHOD

The Serial Interface uses the Data Manager Communications Processor (CP) backplane controls and multiplexed analog data signal to receive information from the 3300 monitors. If there is no Communications Processor connected to the 3300 rack, the Serial Interface generates the required backplane control signals to scan the rack. The Serial Interface will then scan as if the rack is a full 14 position rack. If there is a Communications Processor present, then the Serial Interface gathers data in synchronism with the Communications Processor. In this case, the Serial Interface gathers data only from the points which are configured in the Data Manager software.

The scanning of the rack is constantly active in the Serial Interface. Data obtained from the scanning process is deposited in a data base maintained within the interface. When a request for data is received via a protocol message from an external device, the requested data is retrieved from the data base, formatted and returned to the requesting device in a message response. Allen Bradley and Modbus protocols have different message formats for requests and responses. For a complete

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12 SERIAL INTERFACE OVERVIEW

discussion of the message content and other related protocol details refer to the documents listed in the forward of this manual.

The Serial Interface is designed to operate concurrently with either Transient Data Manager (TDM) or Dynamic Data Manager (DDM).

OTHER INTERFACES

The two protocols implemented by the Serial Interface, Modicon Modbus and Allen Bradley full duplex, are used by many other manufacturers in communications interfaces into their Distributed Control Systems (DCS). This manual describes two known interface connections into Honeywell and Allen Bradley systems. Similar connections can be made into other DCSs that support either of these two protocols. Consult the factory for details on interface requirements for other DCSs.

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13 SERIAL INTERFACE SETUP

Proper operation of the Serial Interface requires that the switch and jumper settings be set appropriate for both the configuration of the 3300 rack(s) and the style of communications between the host device and the Serial Interface. Once these settings and the proper cable connections are made, the interface can receive command messages and return response messages to a host device. Refer to the section 16, entitled Protocol Specifications, for information on how to specify the data (direct or status values) within a protocol message command. The locations (addresses) of the desired data are dependent on the configuration of the 3300 rack and the type of protocol used. Host devices which communicate with the Serial Interface each have their own unique characteristics regarding how the user is allowed to specify command messages. Refer to the host documentation to see how the data fields within the protocol command messages are specified. Use the information provided in section 16 to determine the protocol addresses of the 3300 rack data. These addresses, along with a size or byte count field in the command message from the host, control what data is returned in a reply message from the Serial Interface.

Note

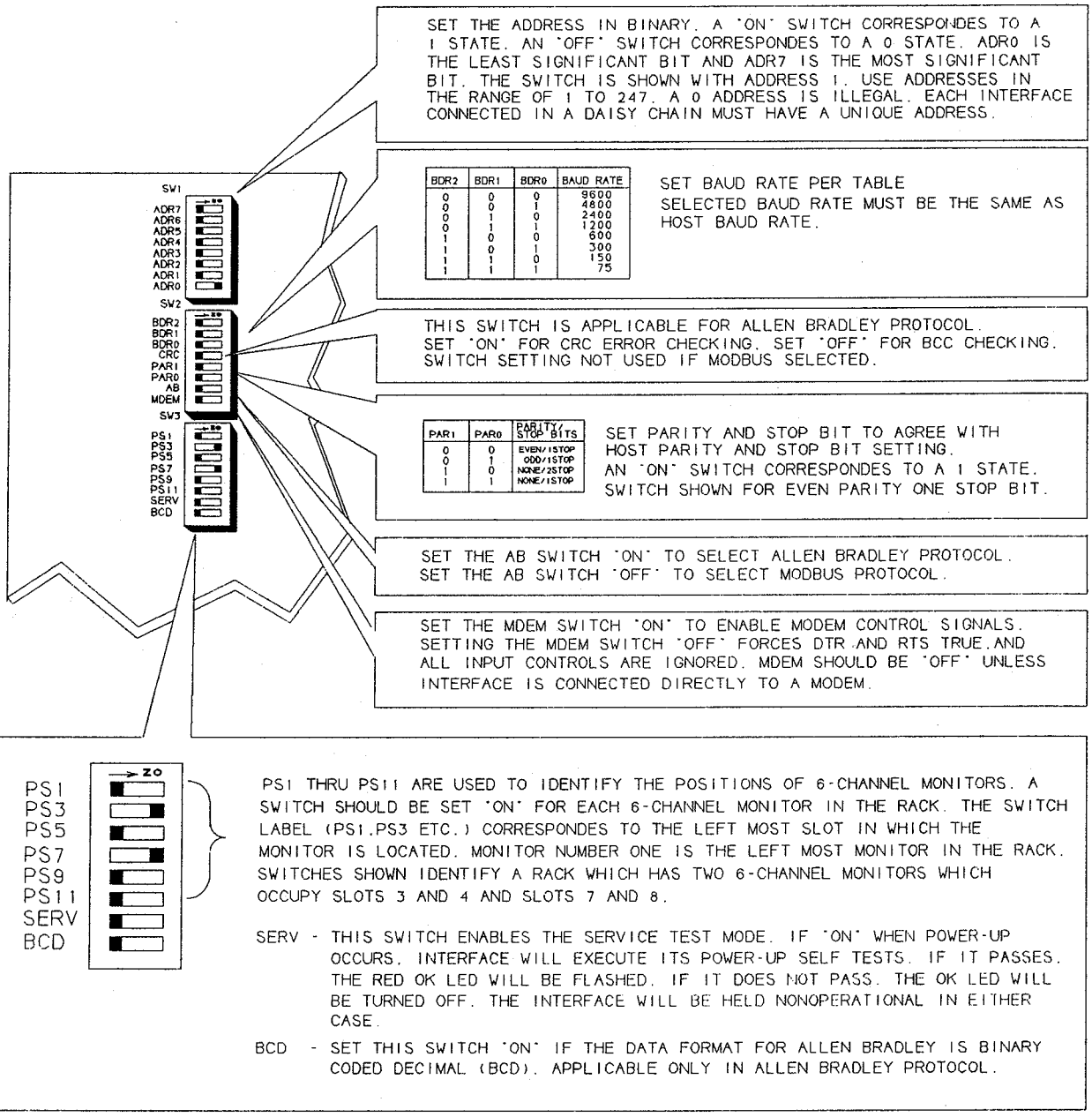
The exact message formats for the protocols used by this interface are not described in this document. References to certain fields within these messages, for example ADDR and SIZE, are made in some examples as an aid to understanding the example. It is presumed that the reader understands the message formats in those cases. If the reader is not familiar with the protocol requirements, he is referred to the documents listed in the forward. In general, the host user interface should allow specification of data addresses without dealing directly with the message formats themselves.

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13 SERIAL INTERFACE SETUP

SWITCH SETTINGS

Three 8-position switch assemblies are located in the upper left corner of the Serial Interface option PWA.

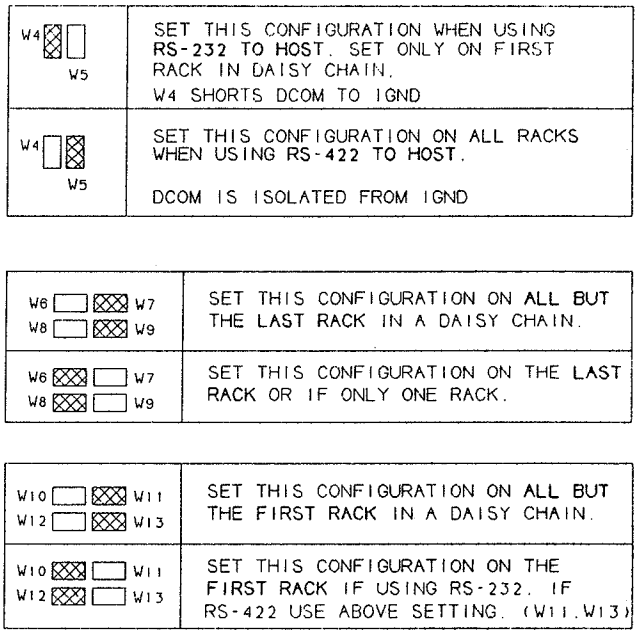


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13 SERIAL INTERFACE SETUP

JUMPER SETTINGS

Several jumpers are located on the Serial Interface option PWA. Use the figure at the right to help determine the required jumper settings for your configuration. The W4/W5 combination allows the shorting together of digital common and isolated ground. These two ground systems should be connected together on any interface that uses the RS-232C standard. They should be disconnected on all interfaces that use RS-422A to the host or next rack. Note that the Serial Interface allows a selection of RS-232C or RS-422A to the host but is always RS-422A to the next rack. Therefore, all interconnected racks past the first rack in a daisy chain should have the shorting bar set on W5, (DCOM disconnected from IGND). The first rack in a daisy chain should short W4 if the connection to the host is RS-232C. Short W5 if the connection to the host is RS-422A.



The jumpers W6 through W13 are used to terminate unused RS-422A receivers. This is necessary to prevent noise, coupled in the cable or picked up on the connector inputs, from causing level transitions in the interface. All unused RS-422A receivers should be terminated. Be sure to examine your interconnections carefully. After terminating a receiver, make sure it is never again connected through a cable to a driver in another daisy chained interface. Overheating and damage to the driver will occur. As a precaution, remove all terminating jumpers when changing the cabling configuration of an existing system. When finished, reset termination jumpers.

W4 - Connects digital common to isolated ground
W5 - Disconnects digital common from isolated ground

W6,W8 - Terminates RS-422A receivers from next rack
W7,W9 - Unterminates RS-422A receivers from next rack

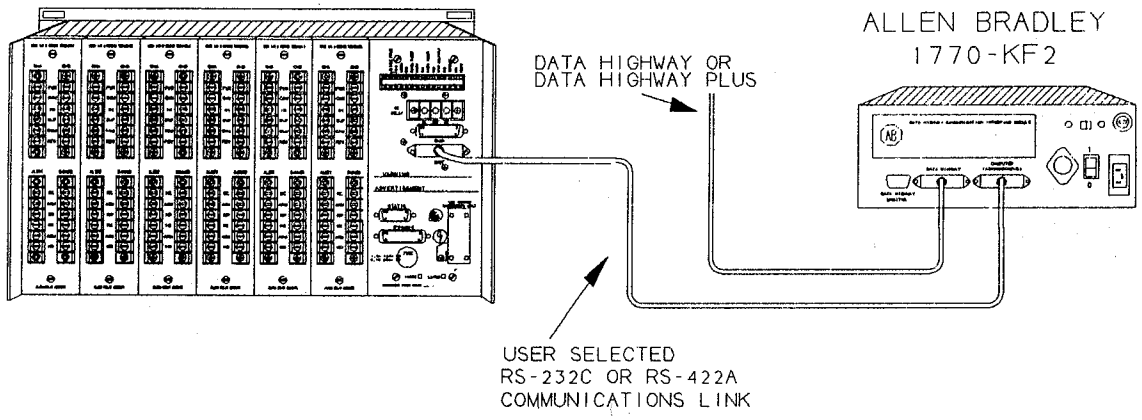
W10,W12 - Terminates RS-422A receivers from host
W11,W13 - Unterminates RS-422A receivers from host

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14 CABLING

CABLE CONNECTION TO ALLEN BRADLEY 1770-KF2 COMMUNICATIONS MODULE

The 1770-KF2 is a stand-alone communication interface which provides a RS-232C or RS-422A link between asynchronous devices and an Allen Bradley Data Highway or Data Highway Plus communications network.



With the KF2 module, either RS-232C or RS-422A may be used. If RS-232C is selected, connections between the KF2 and the PIM should be made with cable part number 84916. If RS-422 is specified, use cable part number 84917. Connect the cable to the **HOST** connector on the PIM. Set W4 through W13 jumpers on the interface appropriate for the communications standard selected.

Maximum cable length for RS-232C is 100 feet. Maximum cable length for RS-422A is 4000 feet. Use the RS-422A interface whenever possible.

Note

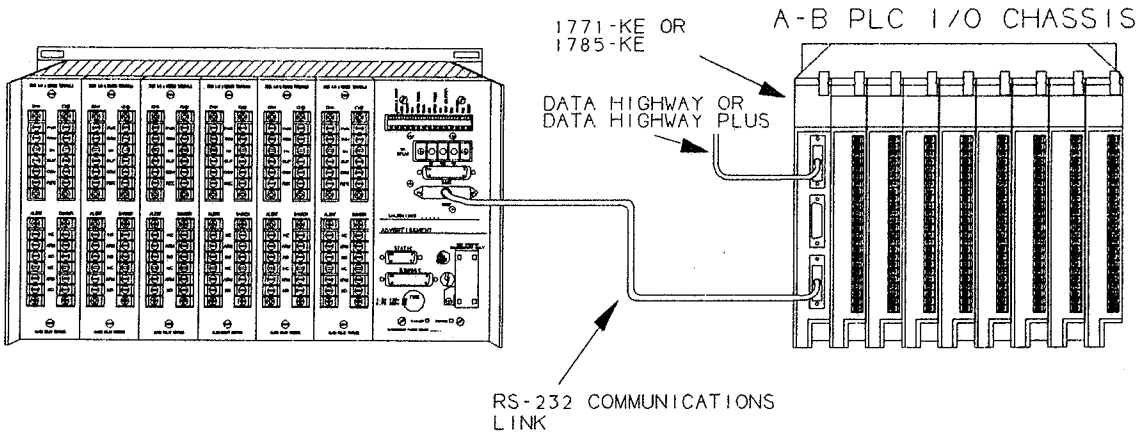
Since Allen Bradley protocol is full duplex, only one 3300 rack may be connected per KF2 module.

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14 CABLING

CABLE CONNECTION TO ALLEN BRADLEY 1771-KE OR 1785-KE COMMUNICATIONS MODULES

Both the 1771-KE and the 1785-KE are designed to be installed in an I/O chassis. A 1771-KE provides an interface between a RS-232C communication link and an Allen Bradley Data Highway Communication link. A 1785-KE provides an interface between a RS-232C communication link and an Allen Bradley Data Highway Plus communication link.



Make the cable connection between the Allen Bradley module and the PIM using a cable part number 85343. Connect the cable to the **HOST** connector on the PIM. The 85343 cable is available in lengths of 10, 25, 50 or 100 feet. When distances beyond 100 feet are required, a common method used is to employ a pair of modems in the communications link. The connection to the modem should be made with a standard 25-pin male/female computer cable.

Be sure to set the jumpers W4 through W13 prior to connecting link cables.

Note

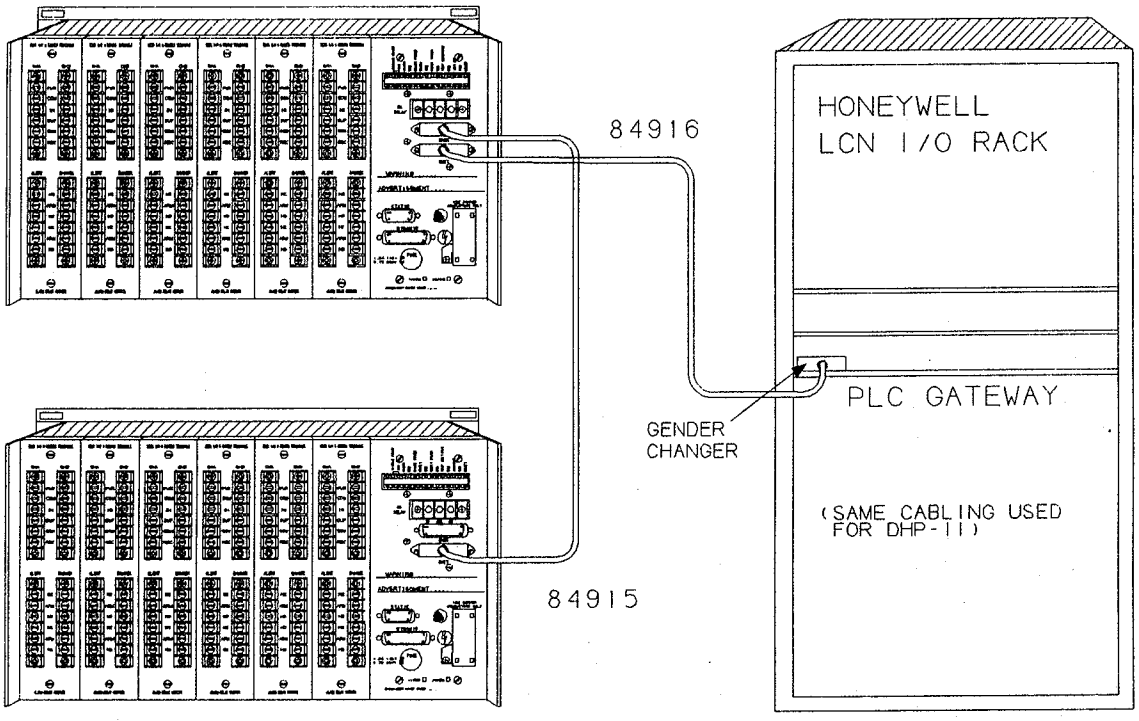
Since Allen Bradley protocol is full duplex, only one 3300 rack may be connected per KE module.

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14 CABLING

CABLE CONNECTION TO HONEYWELL PLC GATEWAY (PLCG) OR HONEYWELL DATA HIGHWAY PORT (DHP-II)

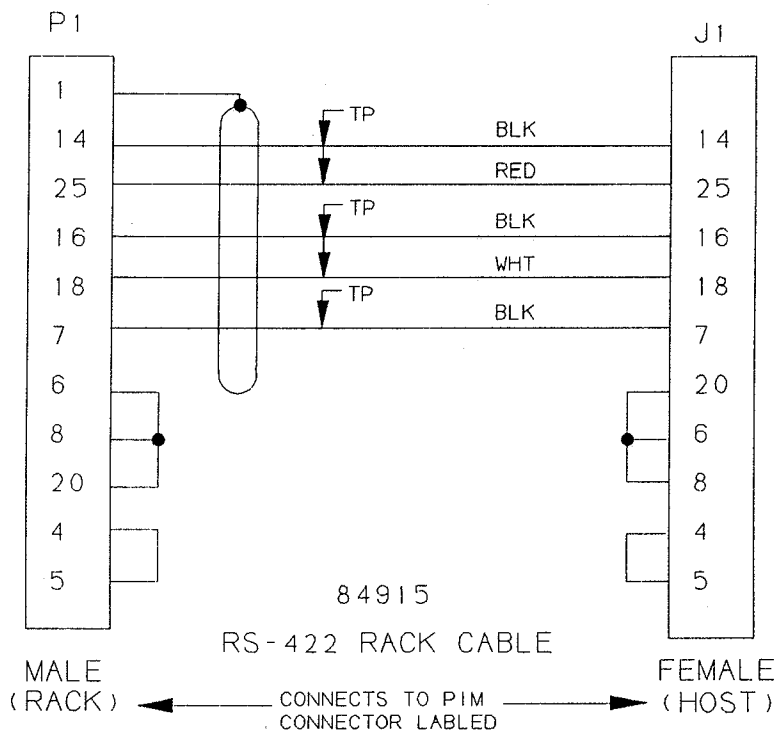
The Honeywell PLCG provides an interface between RS-232C devices using Modicon Modbus protocol and the TDC 3000 Local Control Network (LCN). The DHP-II provides a similar interface to the Honeywell Data Highway.

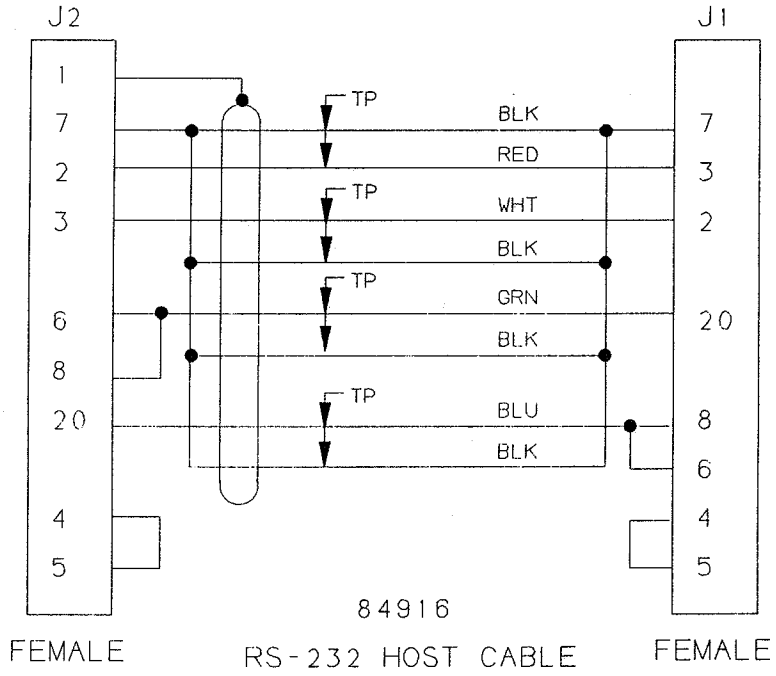


The connection between the Honeywell interface and the PIM uses a cable part number 84916. Connect the cable to the **HOST** connector on the PIM. This cable is limited to 100 feet. Since the Modbus protocol is master/slave, multiple 3300 racks may be connected in a daisy chain. Daisy chained racks are interconnected by attaching the male end of a 84915 cable to the **RACK** connector on the first rack and then connecting the female end of the cable to the **HOST** connector of the other rack. Since rack-to-rack communication uses the RS-422A standard, it can support cable distances up to 4000 feet between racks.

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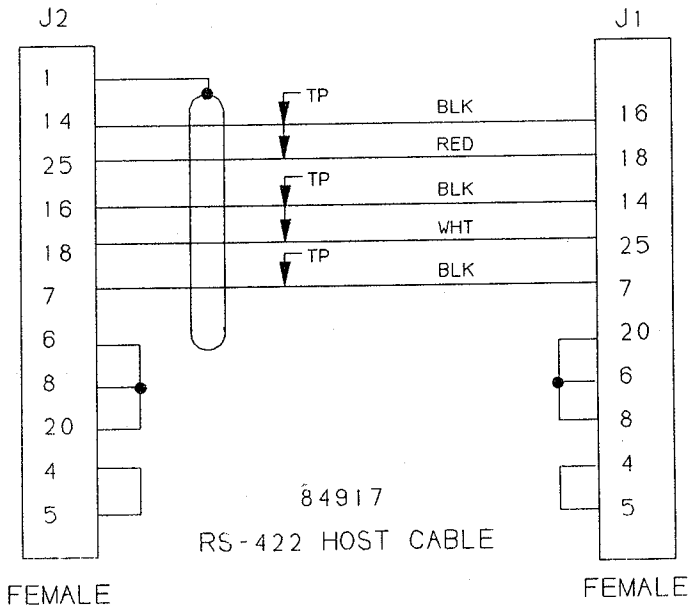
15 CABLE DIAGRAMS

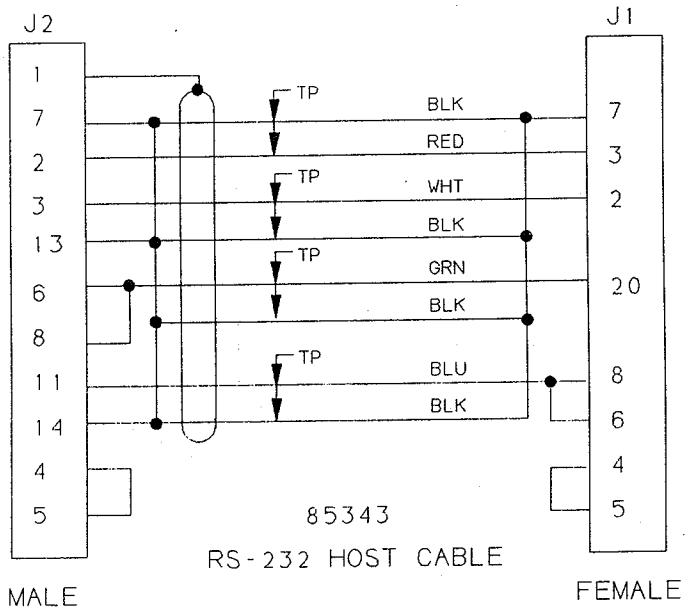




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15 CABLE DIAGRAMS





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16 PROTOCOL SPECIFICATIONS

ALLEN BRADLEY PROTOCOL MESSAGE TYPES

For a complete description of the Allen Bradley message formats refer to the Allen Bradley protocol document listed in the forward.

The messages that may be transmitted and received by the Serial Interface will be selected from the Allen Bradley basic command set. They are

Command Name	Command Code	Function Code
Diagnostic Counters Reset	6	7
Diagnostic Read	6	1
Diagnostic Status	6	3
Diagnostic Loop	6	0
Unprotected Read	1	

DIAGNOSTIC COUNTERS RESET

This command resets to zero all diagnostic counters in the interface. (See diagnostic read below.)

DIAGNOSTIC READ

During operation of the interface, the firmware will keep track of several events. When a particular event occurs, a counter associated with that event will be incremented. These counters can be read by issuing a diagnostic read command. The Allen Bradley interface module must be configured to pass on all diagnostic messages or the Serial Interface will not receive the command. Counters are 16 bit counters and all will wrap around to zero when they overflow.

The counters that will be implemented by the Serial Interface are

1. 16-bit counter of the number of times a communications error occurred in a received message.
2. 16-bit counter of the number of times the backplane data was rejected because the Communications Processor control signals were unstable.
3. 16-bit counter of the number of times a scan overflow occurs. This is detected when a change in the backplane mux lines occur while the interface is waiting for the last mux

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change to settle.

4. 16-bit counter of the number of times a communications overrun has occurred.

The counters will be returned in the response message in the above order. The request message will set the ADDR field to 0 and the SIZE field to 8.

DIAGNOSTIC STATUS

This command reads the current revision letters of the firmware of the Serial Interface. Two bytes are returned in the response message in the following order.

Major Rev Number	This is the major version number of the Serial Interface firmware. Each change to the firmware that results in a requirements change will result in an update to this number.
Minor Rev Number	Each change to the Serial Interface firmware that is for the purpose of correcting programming errors or defects will result in an update to this number. Minor revision number changes should be backward compatible.

DIAGNOSTIC LOOP

You can use this command to check the integrity of transmissions over the communications link. The command message can transmit up to 65 bytes of data to the interface. The interface will reply to this command by transmitting the same data back to the originating station.

UNPROTECTED READ

This command reads words of data from interface memory. Use it to read direct and status values from the interface.

The information in the following pages will show how to specify the direct and status values in an unprotected read command.

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16 PROTOCOL SPECIFICATIONS

ALLEN BRADLEY PROTOCOL DATA ADDRESSING

The Serial Interface uses fixed protocol addresses for the starting locations of rack data. These addresses are not the physical addresses of the data in the interface memory. They are the addresses used in the protocol messages to access data which is available from the interface. The protocol starting addresses are

Data Type	Rack Starting Address
DIRECT VALUES MONITOR STATUS	8 (10 Octal) 48 (60 Octal)

Note 1

For addressing purposes, a 2-channel double-wide monitor looks like a 2-channel single-wide monitor in the left slot followed by an empty right slot. A single channel monitor will be treated as a dual channel monitor with an invalid data value for channel 2.

Note 2

At the message level, Allen Bradley protocol refers to addresses as byte addresses whereas Serial Interface addresses are word based (2 bytes). Therefore, the address that is placed into the protocol message is the word address multiplied by two. Byte addresses will always be even. Also the byte count at the message level is the word count multiplied by two.

DIRECT VALUES

Direct values occupy contiguous protocol addresses. The starting address for the direct values is address 8. This is the address of the first direct value of the first monitor location in the rack. The first monitor (slot 1) is the left most monitor just to the right of the System Monitor. The entire rack's direct values are found sequentially in adjacent addresses. Each monitor will have two direct values associated with it unless it is a 6-channel monitor. In that case, it will have 6 direct values. The presence of 6-channel monitors will be indicated by the SW3 switch on the Serial Interface circuit board. Channel direct values are ordered first channel to last channel. Once the

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configuration of the rack is known, then the exact locations of all the rack's direct values can be specified. A simple formula which can be used to calculate the starting address of monitor direct values is

Starting address = 8 + 2(monitor slot number - 1) + 2(number of 6-channel temperature monitors to the left of the selected monitor)

Use the Unprotected Read Command (command code 1) to access the direct values for the rack.

Example 1:

Read the direct values from a 3300 rack which contains 4 dual vibration monitors installed in slots 1, 2, 3 and 4.

The message request should be an unprotected read command specifying 8 data words (16 bytes) starting at word address 8. The Allen Bradley command format will have the ADDR field set to 16 and the SIZE field set to 16. See note 2 above.

Example 2:

Read the direct values from a 3300 rack which has dual vibration monitors installed into monitor positions 1 and 2 and a 6-channel temperature monitor in monitor position 5.

The data that we want consists of 10 values contained in nonsequential locations starting at word address 8. To retrieve the data most efficiently we should request the first 14 words which will include the values for the empty monitor positions 3 and 4. The host should then throw out the invalid data from monitor slots 3 and 4. The Allen Bradley command format will have the ADDR field set to 16 and the SIZE field set to 28. See note 2 above.

Example 3:

Read the temperatures values from a 6-channel temperature monitor in slot 5 of a 3300 rack. This rack also has a 6-channel temperature monitor in slot 1 and 2 dual vibration monitors in slots 3 and 4.

The starting word address for the temperature monitor in slot 5 is 18. This is the

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temperature for channel 1. Channels 2 through 6 follow at addresses 19 through 23. The Allen Bradley command format will have the ADDR field set to 36 and the SIZE field set to 12. See note 2 above.

Note

In all the examples, addresses are given in decimal. In programming Allen Bradley devices conversion to octal may be necessary.

MONITOR STATUS

The monitor status indicators will be returned as 16-bit words with a value of 1 or 0. Each monitor will have these three status words associated with it: Alert, Danger and not OK. Individual channel status is not available. If any channel of a monitor is in alert, then the monitor status is Alert.

The monitor status words will be ordered Alert, Danger, not OK and occupy contiguous protocol addresses starting at word address 48 (60 octal). To read the monitor statuses use the Unprotected Read Command (command code 1).

A simple formula for computing the starting address for any monitor's status values is

Starting address = 48 + 3(number of monitors to left of the selected monitor, including empty slots)

Use the Unprotected Read Command (command code 1) to access the monitor status values for the rack.

Note

In all the examples, addresses are given in decimal. In programming Allen Bradley devices conversion to octal may be necessary.

Example 1:

Read monitor status from a 3300 rack which has a vibration monitor in slot 1 and a 6-channel temperature monitor in slot 3.

The unprotected read command should request 9 status words (18 bytes) starting at word address 48. The status from the nonexistent monitor in slot 2 should be ignored by the

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host. The Allen Bradley command format will have the ADDR field set to 96 and the SIZE field set to 18. See note 2 at beginning of Allen Bradley Protocol Data Addressing.

Example 2:

Read monitor status from a 6-channel monitor in slot 7. The rack also has a 6-channel temperature monitor in slot 1, with slots 3, 4, 5 and 6 empty.

Starting address = 48 + 3(5) = 63. The unprotected read command should request 3 status words (6 bytes) starting at address 63 (77 octal). Address 63 contains the monitor's Alert status, address 64 the Danger status, and address 65 the not OK status. The Allen Bradley command format will have the ADDR field set to 126 and the SIZE field set to 6. See note 2 at beginning of Allen Bradley Protocol Data Addressing.

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16 PROTOCOL SPECIFICATIONS

ALLEN BRADLEY PROTOCOL DATA FORMAT

Internally the Serial Interface converts the backplane multiplexed static data signal into a digital value using an 8-bit analog-to-digital convertor. When an analog data request message is received on Allen Bradley full duplex protocol, this 8-bit value is shifted left four bits to represent a 12-bit value. If the BCD switch is set ON on SW3, then this 12-bit value is converted to a four place binary coded decimal number and placed in the message response. The least significant digit is always zero. If the BCD switch is OFF, the 12-bit binary number is returned in the message.

Since the maximum value the 8-bit convertor can have is 255, then the maximum 12-bit value is 255(16) = 4080. The least significant four bits of the 12-bit binary word are always zero.

ALLEN BRADLEY PROTOCOL MESSAGE RESPONSE TIMES

The following specifications define the typical measured response times for messages. The response time is the time from the end of the last received message to the beginning of the subsequent response message. It does not include message transmission times.

Message	Response Time (msec)
ACK or NAK	2
BCD	7 *
Binary	6 *

* full 36 word read

ALLEN BRADLEY PROTOCOL IMBEDDED RESPONSES

The Serial Interface implements imbedded responses with Allen Bradley protocol. It will accept imbedded responses within incoming messages and it may insert imbedded responses in outgoing messages.

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16 PROTOCOL SPECIFICATIONS

ALLEN BRADLEY PROTOCOL EXCEPTION RESPONSES

Error codes will be returned in the response message when the interface receives a message with an illegal function, address, or data range. Error codes returned in the message are Allen Bradley type REMOTE error codes.

Error Code	Error Condition
10	This error is sent from the interface if the command message was incorrect. This includes the command code, subcommand code, and size of the command or the requested size
50	An attempt to access an illegal address in the interface has aborted message execution.

Example:

An unprotected read is attempted from address 44 which is an illegal address for a direct data request. The reply message returns the error code 50.

The maximum number of valid direct data addresses is 36. First valid address is 8, last valid address is 43.

Status data addresses start at 48. The maximum number of valid status addresses is 36 (3 status values for each of 12 monitors). The last valid status address is 83.

Data requests outside of these ranges will either result in an error code 10 or error code 50 message response. Error code 10 will occur if the starting address is valid but the number of values requested results in a data address outside the valid range. Error code 50 occurs if the starting address is outside the valid address range.

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16 PROTOCOL SPECIFICATIONS

MODBUS PROTOCOL MESSAGE TYPES

A Serial Interface in a Modbus protocol connection will behave as a slave only. The mode of transmission is RTU. The messages that will be allowed to be received and transmitted by the Serial Interface are as follows:

Message	Function Code
Read Input Status	2
Read Input Register	4
Loopback/Maintenance	8
Report Slave ID	17

Note

All input point and input register addresses referenced in this document are zero based. Modicon programmable controller (PC) locations are one based. The address references in this manual relate directly to the modbus message format. If local host programming uses Modicon PC addresses the appropriate base conversion from one to zero must be kept in mind. For example: Input point address 0 = Modicon PC point 10001; Input register address 0 = Modicon PC register 30001. Refer to the Modicon Modbus protocol document listed in the forward for a complete review of Modicon PC formats.

READ INPUT STATUS

This command reads monitor status values from the interface.

READ INPUT REGISTER

This command reads monitor direct values from the interface.

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16 PROTOCOL SPECIFICATIONS

LOOPBACK/MAINTENANCE

This message allows multiple functions depending on the diagnostic code which is imbedded in the request message.

Diagnostic Code	Meaning
0	Return query data (2 bytes)
2	Return diagnostic register
10	Clear counters and diagnostic register
11	Return message count
12	Return communications error count
13	Return exception count
18	Return character overrun count

Counters and diagnostic register are cleared only by power-up or diagnostic code 10. All counters count modulo 65535.

REPORT SLAVE ID

This function is used to obtain the current firmware revision from the Serial Interface. Two bytes are returned in the response message in the following order.

Major Rev Number — This is the major version number of the Serial Interface firmware. Each change to the firmware that results in a requirements change will result in an update to this number.

Minor Rev Number — Each change to the Serial Interface firmware that is for the purpose of correcting programming errors or defects will result in an update to this number. Minor revision number changes should be backward compatible.

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16 PROTOCOL SPECIFICATIONS

MODBUS PROTOCOL DATA ADDRESSING

The Serial Interface uses fixed protocol addresses for the starting locations of rack data. These addresses are not the physical addresses of the data in the interface memory. They are the addresses used in the protocol messages to access data which is available from the interface. The starting addresses for Modbus protocol are

Data Type	Rack Starting Address
DIRECT VALUES	0
MONITOR STATUS	0

Note

For addressing purposes, a 2 channel double-wide monitor looks like a 2 channel single-wide monitor in the left slot followed by a empty right slot. A single channel monitor will be treated as a dual channel monitor with an invalid data value for channel 2.

DIRECT VALUES

Direct values occupy contiguous protocol addresses. The starting address for the direct values is address 0. This is the address of the first direct value of the first monitor location in the rack. The first monitor (slot 1) is the left most monitor just to the right of the System Monitor. The entire rack's direct values are found sequentially in adjacent addresses. Each monitor will have two direct values associated with it unless it is a 6-channel monitor. In that case, it will have 6 direct values. The presence of 6-channel monitors will be indicated by the SW3 switch on the Serial Interface circuit board. Channel direct values are ordered first channel to last channel. Once the configuration of the rack is known, then the exact locations of all the rack's direct values can be specified. A simple formula which can be used to calculate the starting address of any monitor's direct values is:

Starting address = 2(monitor slot number - 1) + 2(number of 6-channel monitors to left of the selected monitor)

Use the Read Input Registers command (Function Code 4) to access the direct values for the rack.

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Example 1:

Retrieve the direct values from a 3300 rack which contains a vibration monitor in slot 4 and a 6-channel temperature monitor in slot 5.

The vibration monitor has two values associated with it, channel one vibration and channel two vibration. The temperature monitor has 6 temperature values associated with it. The request message should have a starting register of 6 and request 8 values (registers).

Example 2:

Read the direct values from a 3300 rack which has dual vibration monitors installed into monitor positions 1 and 2 and a 6-channel temperature monitor in monitor position 5.

The data that we want consists of 10 values contained in nonsequential locations starting at word address 0. To retrieve the data most efficiently we should request the entire 14 value block which will include the values for the empty monitor positions 3 and 4. The host should then throw out the invalid data from monitor slots 3 and 4. The Read Input Registers query message will specify the start register as 0 and the number of registers as 14.

Example 3:

Read the temperature values from a 6-channel temperature monitor in slot 5 of a 3300 rack. This rack also has a 6-channel temperature monitor in slot 1 and 2 dual vibration monitors in slots 3 and 4.

The starting register address for the temperature monitor in slot 5 is 10. This is the temperature for channel 1. Channels 2 through 6 follow at addresses 11 through 15. The Read Input Registers query message will specify the start register as 10 and the number of registers as 6.

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16 PROTOCOL SPECIFICATIONS

MONITOR STATUS

The monitor status indicators have a value of 1 or 0. Each monitor will have these three status values associated with it: Alert, Danger and not OK. Individual channel status is not available. If any channel of a monitor is in alert, then the monitor status is Alert.

The monitor status values will be ordered Alert, Danger, not OK and occupy contiguous protocol addresses starting at address 0. To read the monitor statuses use the Read Input Status command (function code 2). A simple formula for computing the starting address for a monitor's status values is

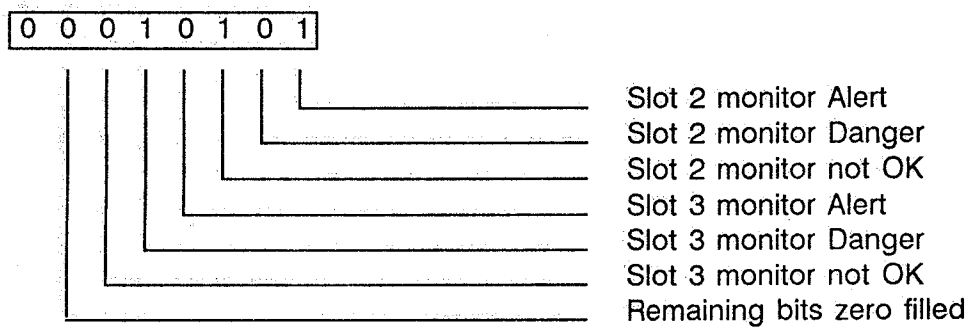
Starting address = 3(number of monitors to left of the selected monitor, including empty slots)

When a monitor position is not filled with a monitor, then the status values for that position are allocated but the values are invalid.

Example 1:

Retrieve the status values from a 3300 rack which contains a vibration monitor in slot 2 and a 6-channel temperature monitor in slot 3.

The Read Input Status query message will specify 6 status points starting at point address 3. The modbus response message will pack the response data into individual bits in the response message. Each bit represents a status point. A one bit in the response message indicates a true status. In the above example, if the monitor in slot 2 is showing alert and not OK and the monitor in slot 3 is showing danger, then the response message will consist of one data byte with a value of 15 hex (21 decimal). The response byte will be as shown below.



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Example 2:

Read monitor status from a 6-channel temperature monitor in slot 7. The rack also has a 6-channel temperature monitor in slot 1, with slots 3, 4, 5 and 6 empty.

Starting address (point number) = 3(5) = 15. Note that slot 2 is not considered an empty slot because it is occupied by the double wide 6-channel monitor. The Read Input Status command should request 3 status points starting at point number 15. Point number 15 contains the slot 7 monitor's Alert status, point number 16 the Danger status and point number 17 the not OK status. These status bits will be packed into the three least significant bits of a single response byte.

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16 PROTOCOL SPECIFICATIONS

MODBUS PROTOCOL DATA FORMAT

Internally the Serial Interface converts the backplane multiplexed static data signal into a digital value using an 8-bit analog-to-digital convertor. When an analog data request message is received on Modbus protocol, this 8-bit value is shifted left 4 bits to represent a 12-bit value.

Since the maximum value the 8-bit convertor can have is 255, then the maximum 12-bit value is 255(16) = 4080. The least significant four bits of the 12-bit binary word are always zero.

MODBUS PROTOCOL MESSAGE RESPONSE TIMES

The following specifications define the typical measured response times for messages. The response time is the time from the end of the last received message to the beginning of the subsequent response message. It does not include message transmission times.

Type of Read	Response Time (msec)
36 Registers	14
36 Points	8

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16 PROTOCOL SPECIFICATIONS

MODBUS PROTOCOL EXCEPTION RESPONSES

Error codes will be returned in the response message when the interface receives a message with an illegal function, address, or data range.

Exception Code	Exception Condition
1	Illegal function in request message
2	Illegal data address in request message
3	Illegal data range in request message

Example:

An unprotected read is attempted from address 36 which is an illegal address for a register read request. The reply message returns the exception code 2.

The maximum number of valid register addresses is 36. First valid address is 0, last valid address is 35.

Point (status) data addresses start at 0 also. The maximum number of valid point addresses is 36 (3 status points for each of 12 monitors). The last valid status address is 35.

Data requests outside of these ranges will either result in an exception code 2 or exception code 3 message response. Exception code 3 will occur if the starting address is valid but the number of registers or points requested results in a data address outside the valid range. Exception code 2 occurs if the starting register or point address is outside the valid address range.

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16 PROTOCOL SPECIFICATIONS

MODBUS PROTOCOL DIAGNOSTIC COUNTERS

There are four diagnostic counters and one diagnostic register which are maintained by the Serial Interface when implementing the Modbus protocol. Each of these counters and the diagnostic register may be accessed via the Loopback/Maintenance function code 8.

Counter Name	What gets counted	Access counter by using Function code	Diagnostic code
Message	All messages received by the Serial Interface	8	11
Communications Error	Framing, parity or CRC errors	8	12
Character Overrun Error	Overrun errors that occur on received messages	8	18
Exception	Messages that result in an exception response	8	13

Note

All counters get reset on power-up or by receiving a function code 8, diagnostic code 10 command.

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16 PROTOCOL SPECIFICATIONS

DIAGNOSTIC REGISTER

The diagnostic register is a status word that is maintained by the Serial Interface and is returned in response to a function code 8, diagnostic code 2 command. Failure of self tests will cause bits to be set in the diagnostic register. The diagnostic register is reset on power-up or after receiving a function code 8 diagnostic code 10 command.

The structure of the diagnostic register is as follows:

BIT0	CHECKSUM ERROR	BIT8	NOT USED
BIT1	RAM ERROR	BIT9	NOT USED
BIT2	MUX UNSTABLE	BIT10	NOT USED
BIT3	STORAGE OVERFLOW	BIT11	NOT USED
BIT4	SCANNER OVERFLOW	BIT12	NOT USED
BIT5	I/O PORT ERROR	BIT13	NOT USED
BIT6	SPI ERROR	BIT14	NOT USED
BIT7	NOT USED	BIT15	NOT USED

Refer to section 17, Self Test, for an explanation of the error bits 0, 1, 5, and 6.

MUX UNSTABLE — This error bit is set if while scanning the 3300 backplane, the multiplexer control lines change state during the static data settling time. Setting of this bit generally indicates noise has interfered with the data scanning process.

STORAGE OVERFLOW — If there is an attempt to store data internally at an illegal data address, this bit is set. Setting of this bit indicates an internal firmware failure.

SCANNER OVERFLOW — If the 3300 backplane multiplexer value changes state before a previous scan is completed, this error bit is set. Setting of this bit indicates noise has interfered with the data scanning process.

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16 PROTOCOL SPECIFICATIONS

BACKPLANE DATA SCAN RATES

ACTIVE MODE

When there is no Communications Processor connected to the monitor rack, the Serial Interface must control scanning of the 3300 rack backplane to acquire direct and status values. When operating in this mode the interface data base is completely updated for an entire rack in 120 msec.

PASSIVE MODE

When a Communications Processor (DDM or TDM) is connected to the 3300 rack and the Cp is configured, then the interface must release control of the backplane mux control signals and the interface will acquire its data by observing the mux signals as the Communications Processor controls them. This means that while operating in this mode, only those monitors that are configured in the Data Manager are scanned. Also the scan rate is controlled by the Communications Processor.

When a Transient Data Manager (TDM) is connected and configured for a full rack of 12 dual channel monitors, the scan rate for the status values (Alert, Danger, and not OK) is 83 msec. Since the TDM Communications Processor scans direct values only once every four seconds, the interface data base update rate for direct values is every four seconds. This means that the direct data returned over the serial communications link may be up to four seconds old. On the other hand, status data is guaranteed to be no more than 83 msec old. Data scan rates do not affect the response rate for communications messages.

When a Dynamic Data Manager (DDM) is connected and configured for a full rack of 12 dual channel monitors, the scan rate for both status and direct values is a minimum of 120 msec.

In both the TDM and DDM, static data collection has a lower priority to other more important tasks which may have to be performed. Servicing of alarms and receiving communications messages are examples of higher priority tasks. Scan rates may be lengthened if higher priority tasks are very active.

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16 PROTOCOL SPECIFICATIONS

MODEM CONTROLS

The following definitions apply to the RS-232C signals as implemented by the Serial Interface. The modem control signals DTR, DSR, DCD, RTS and CTS are active only if the MDEM switch (SW2) on the Serial Interface circuit board is set ON.

Note

A RS-232C ON condition is a binary state of 0 and has a positive voltage level on the interface. A RS-232C OFF condition is a binary state of 1 and has a negative voltage level on the interface.

RTS - REQUEST TO SEND
Continually asserted ON.

DTR - DATA TERMINAL READY
Asserted ON unless DCD is OFF for greater than 10 seconds. Then DTR is placed OFF until DSR is set OFF. Once DSR is OFF, DTR is set ON.

TXD - TRANSMITTED DATA
When not transmitting, TXD is in OFF state

CTS - CLEAR TO SEND
Received from modem. If Modem controls are on (MDEM ON), this signal must be ON to enable message transfers. Loss of CTS does not turn DTR OFF.

DCD - DATA CARRIER DETECT
Received from modem. If DCD is OFF, message transfers will be disabled to/from interface. Loss of DCD for 10 seconds causes DTR to be turned OFF.

DSR - DATA SET READY
Received from modem. DSR should be set OFF at modem when DTR is set OFF at Serial Interface. When DSR is set OFF, DTR will be set ON. Then the modem should set DSR ON completing the handshake.

RXD - RECEIVED DATA
Data received from modem.

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17 SELF TEST

The Serial Interface performs the following internal self tests on power-up:

Rom Check A checksum calculation is performed on the rom memory. The value obtained is compared with a previously calculated value stored in memory. If the values do not compare, an error flag is set and bit 0 of the Diagnostic Register is set.

Ram Check An alternating ones and zeros ram test is done on all but the upper 30 bytes of ram (482 bytes). Also a test is conducted to verify that the COP ON bit is set in the 68HC11 processor. If a ram failure occurs, bit 1 of the Diagnostic Register is set.

I/O Port Test This test checks a portion of the mux control comparator hardware on the interface circuit board. If a failure occurs, bit 5 of the Diagnostic Register is set.

SPI Test A loop through check of the switch registers on the interface circuit board is performed using the serial peripheral interface of the 68HC11 processor. If an error occurs, bit 6 of the Diagnostic Register is set.

If any error occurs during the Power-up self test, the red OK led on the Serial Interface circuit board will be turned off. The interface program will be allowed to continue. Reliable operation of the interface will be questionable if the OK led is off.

If the Power-up self tests pass, the red OK led will be permanently turned on.

The Serial Interface OK led is controlled only at power-up. No on-line tests are performed.

If the SERV switch is set ON at power-up, the same self tests are performed but the interface will not be allowed to continue operation after completion of the tests. If a self test fails the OK led will be turned off. If the self tests all pass, the OK led will be flashed at a constant rate.

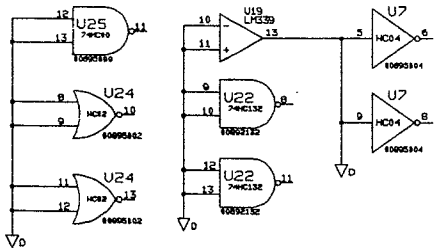
The Diagnostic Register can be returned with a Modbus message using function code 8 and diagnostic code 2 (loopback maintenance message).

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18 SCHEMATICS AND DRAWINGS

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SPARES



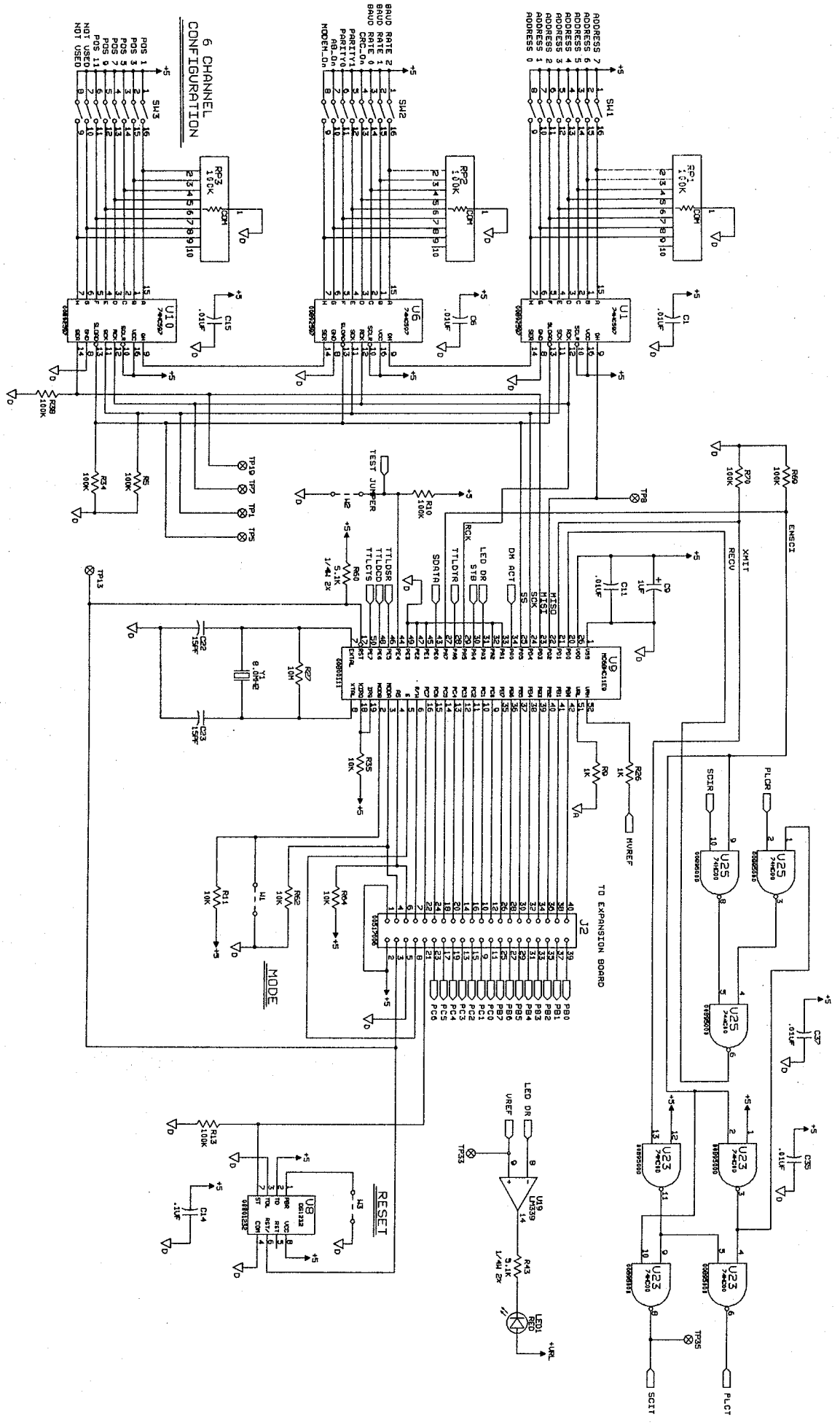
VOLTAGE CHART		
U5, U6	7	DCOM
	14	+5V
U8	12	DCOM
	3	+5V
U22	7	DCOM
	14	+5V
U12	7	DCOM
	14	+5V
U11	7	DCOM
	14	+5V
U23	8	+7.5V
	4	-7.5V

REFERENCE DESIGNATOR	
LAST USED	NOT USED
J2 LED1 W13 R71 TP43 CR7 L26 C39 Y1	

10. ALL RESISTORS ARE 1/8TH W, 1%.
9. REF: 83995 MAG TAPE.
8. REF: 83990 SCHEMATIC DISK.
7. VOLTAGE CHART NOT COMPLETE.
6. ∇_I DENOTES ISOLATED GND.
5. ∇_A DENOTES ANALOG GND.
4. ∇_D DENOTES DIGITAL GND.
3. ⊏⊃ DENOTES SIGNAL CONTINUATION.
2. REF: 155309 PERFORMANCE AND TEST SPEC.
1. THIS SCHEMATIC REPRESENTS PWA 83989-01

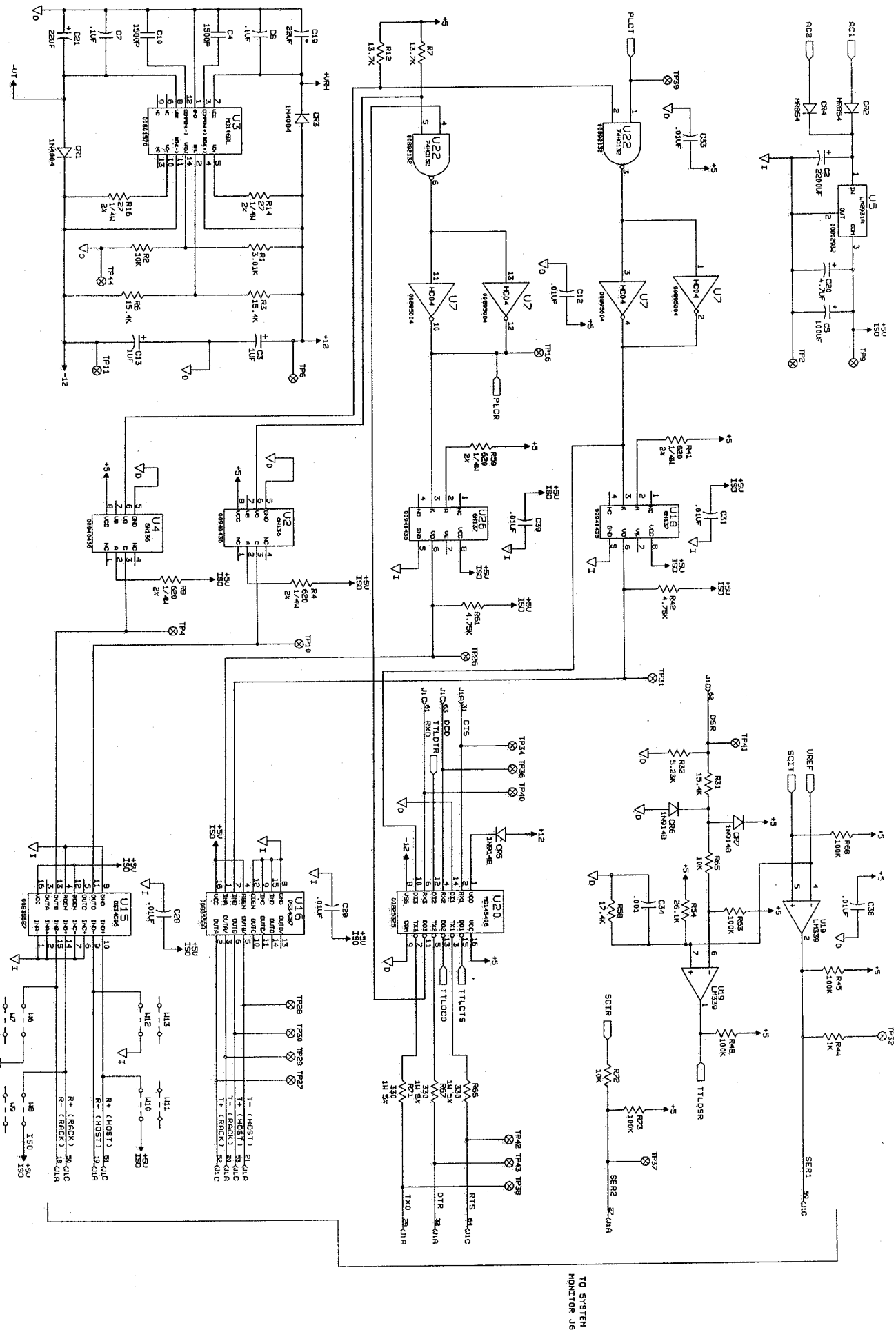
SERIAL INTERFACE SCHEMATIC SHEET 1 OF 4

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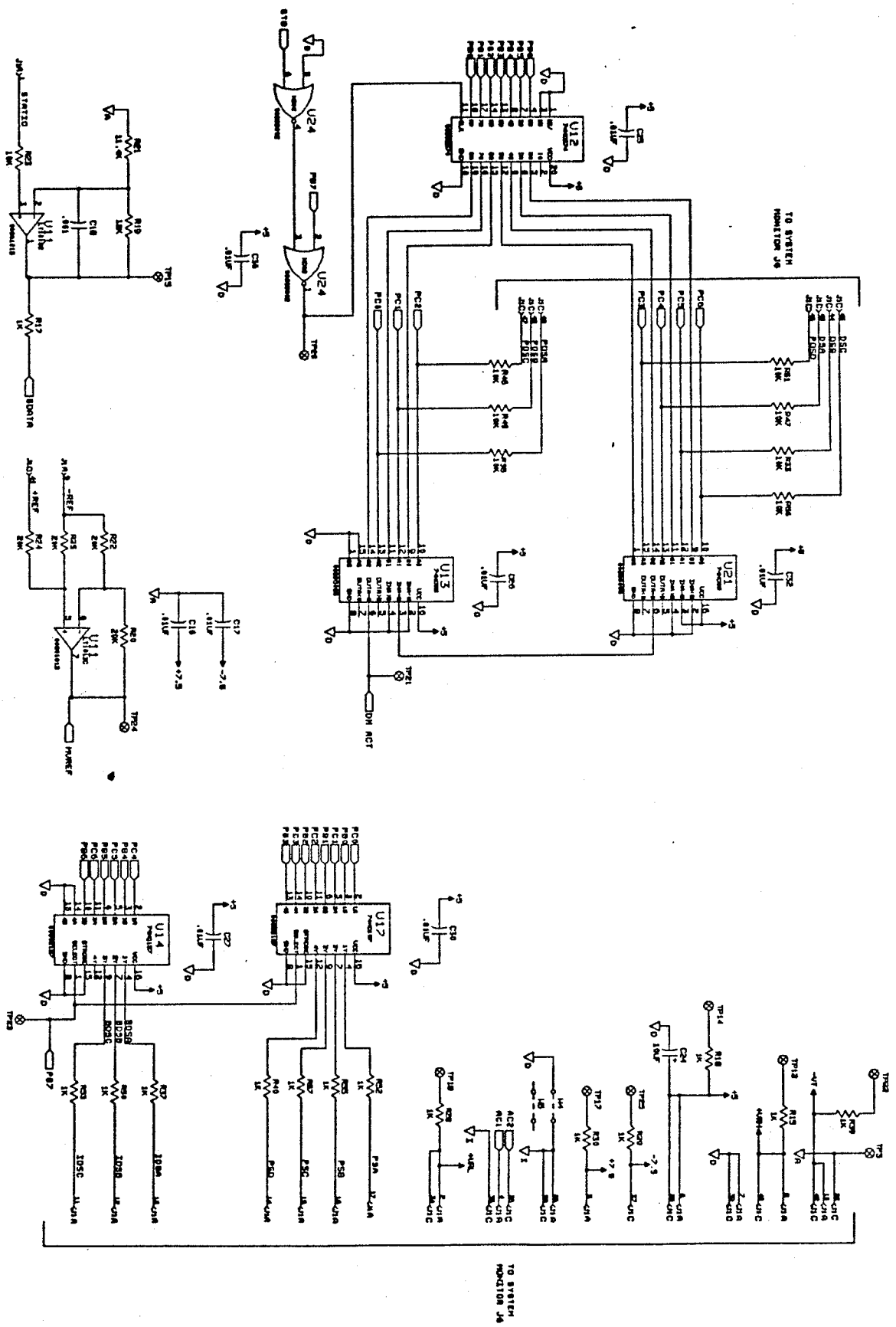
SERIAL INTERFACE SCHEMATIC SHEET 2 OF 4

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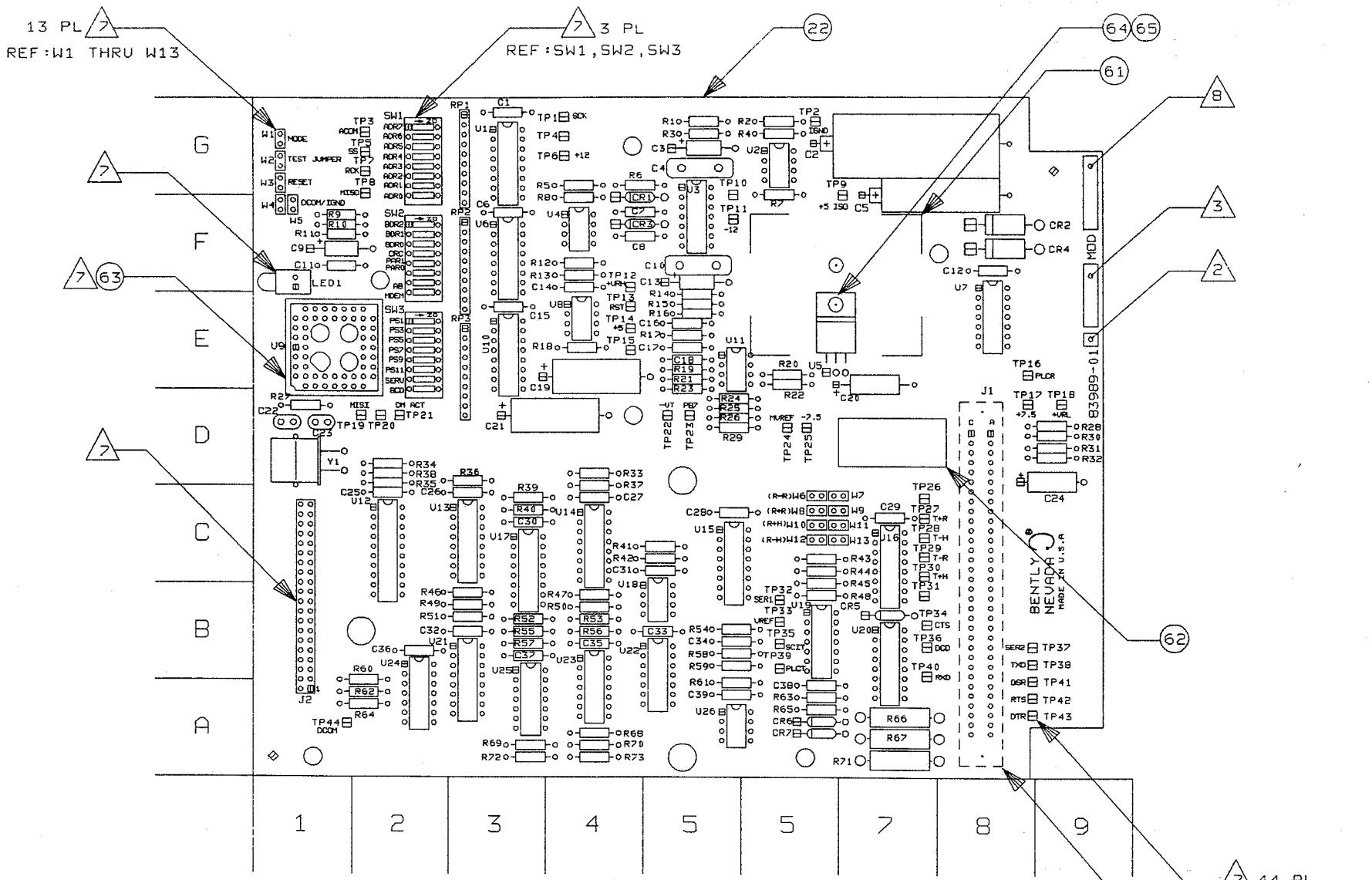
SERIAL INTERFACE SCHEMATIC SHEET 3 OF 4

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SERIAL INTERFACE SCHEMATIC SHEET 4 OF 4

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13 PL
REF:W1 THRU W13
3 PL
REF:SW1,SW2,SW3
44 PL
REF:TP1 THRU TP44
REF:J1
INSTALL FARSIDE
COMPONENT SIDE
INSTALL SHIPPED AS OPTION
JUMPERS BELOW
W4,W7,W9,W11,W13
SERIAL INTERFACE PRINTED WIRING ASSEMBLY
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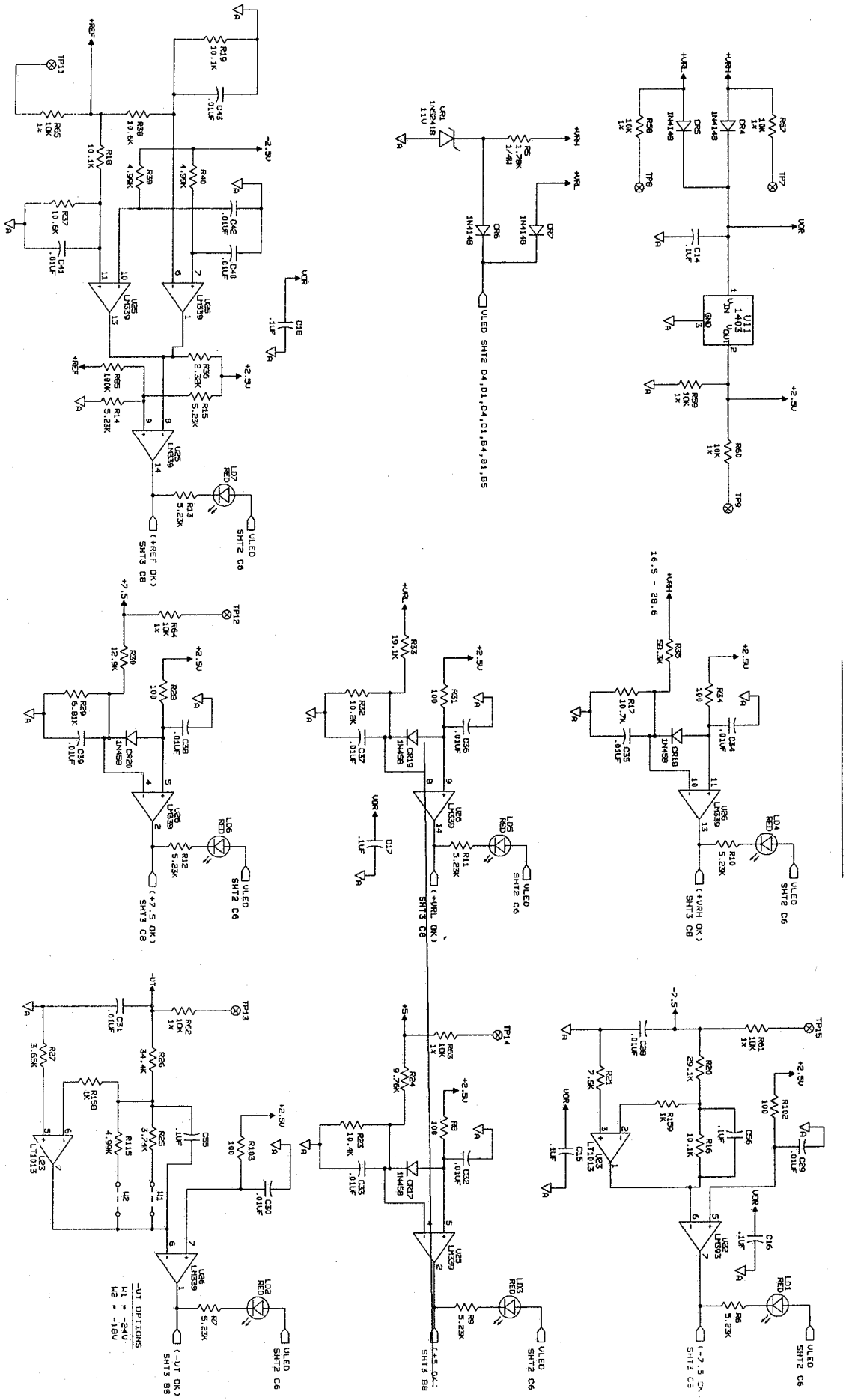
VOLTAGE CHART		
U14	12	DCOM
	24	+5V
U25,26	3	VOR
	12	ACOM
U7,17,4,6,5	7	DCOM
	14	+5V
U1-U3	1	+5V
	8	DCOM
U22,23	4	ACOM
	8	VOR
U20,21	4	-VT
	8	+7.5V
U18	4	DCOM
	8	+VRH
U15	4	-12DM
	8	+7.5V
U19	4	DCOM
	8	+VRL
U16	8	DCOM
	16	+5V

REFERENCE DESIGNATORS	
LAST USED	NOT USED
C58	C53,54
CR21	
Q7	
VR5	
LD7	
W2	
TP17	TP4,10,16
J6	J4,5
U26	U8-10,12
	U13,24
R159	R155,156

10. (SIGNAL) DENOTES ACTIVE LOW.
9. REF: 84036 MAG TAPE.
8. REF: 84037 SCHEMATIC DISK FOR BLOCK DIAGRAM SHEET 8.
7. ALL RESISTORS VALUES ARE IN OHMS, 1/8W, .1%.
6. SEE VOLTAGE CHART FOR IC PWR/GND PINS.
5. ∇_A DENOTES ANALOG COMMON.
4. ∇_D DENOTES DIGITAL COMMON.
3. —⊐ DENOTES SIGNAL CONTINUATION.
2. REF: 155310 PERFORMANCE AND TEST SPEC.
1. THIS SCHEMATIC REPRESENTS PWA 84030-01.

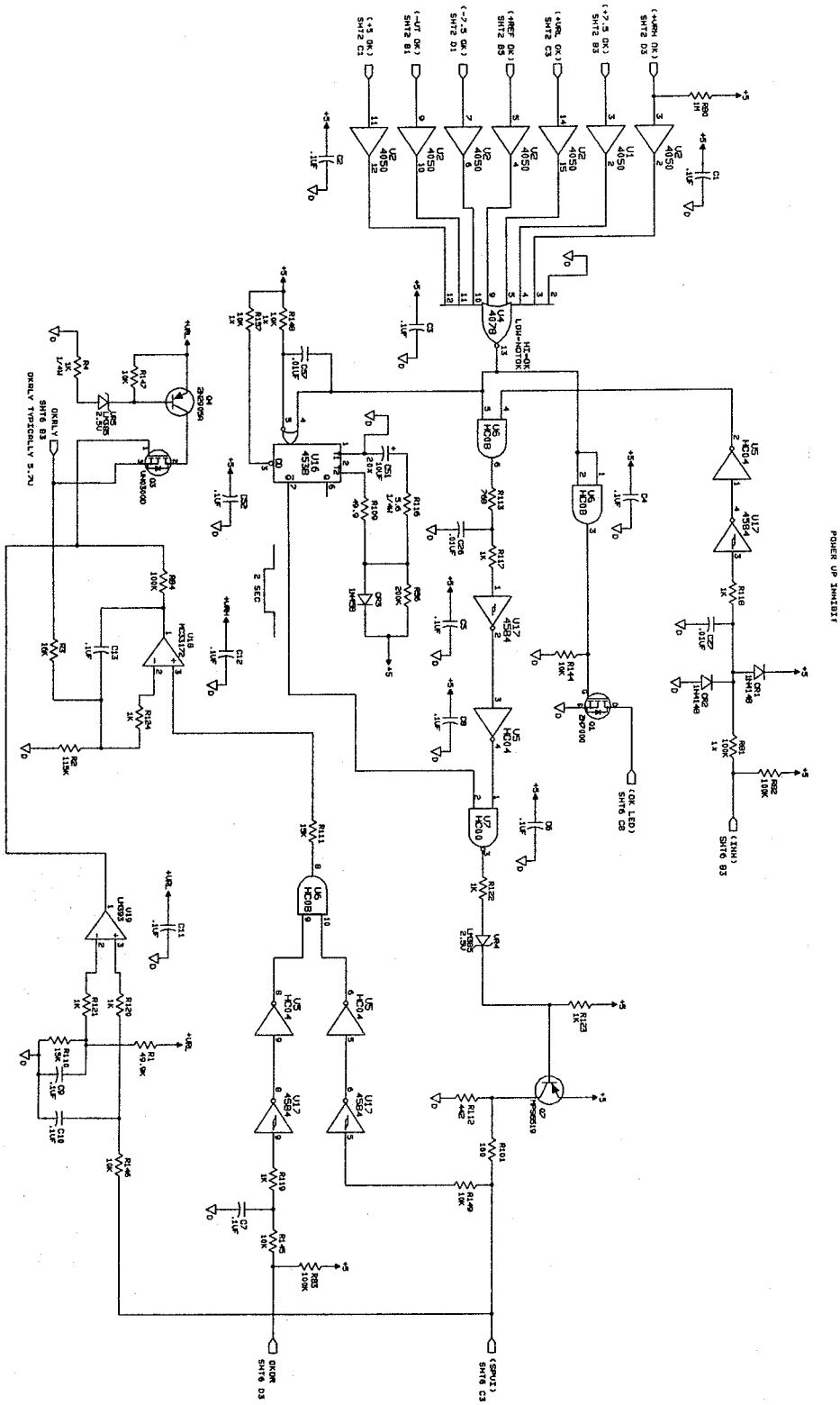
SYSTEM MONITOR SCHEMATIC SHEET 1 OF 6

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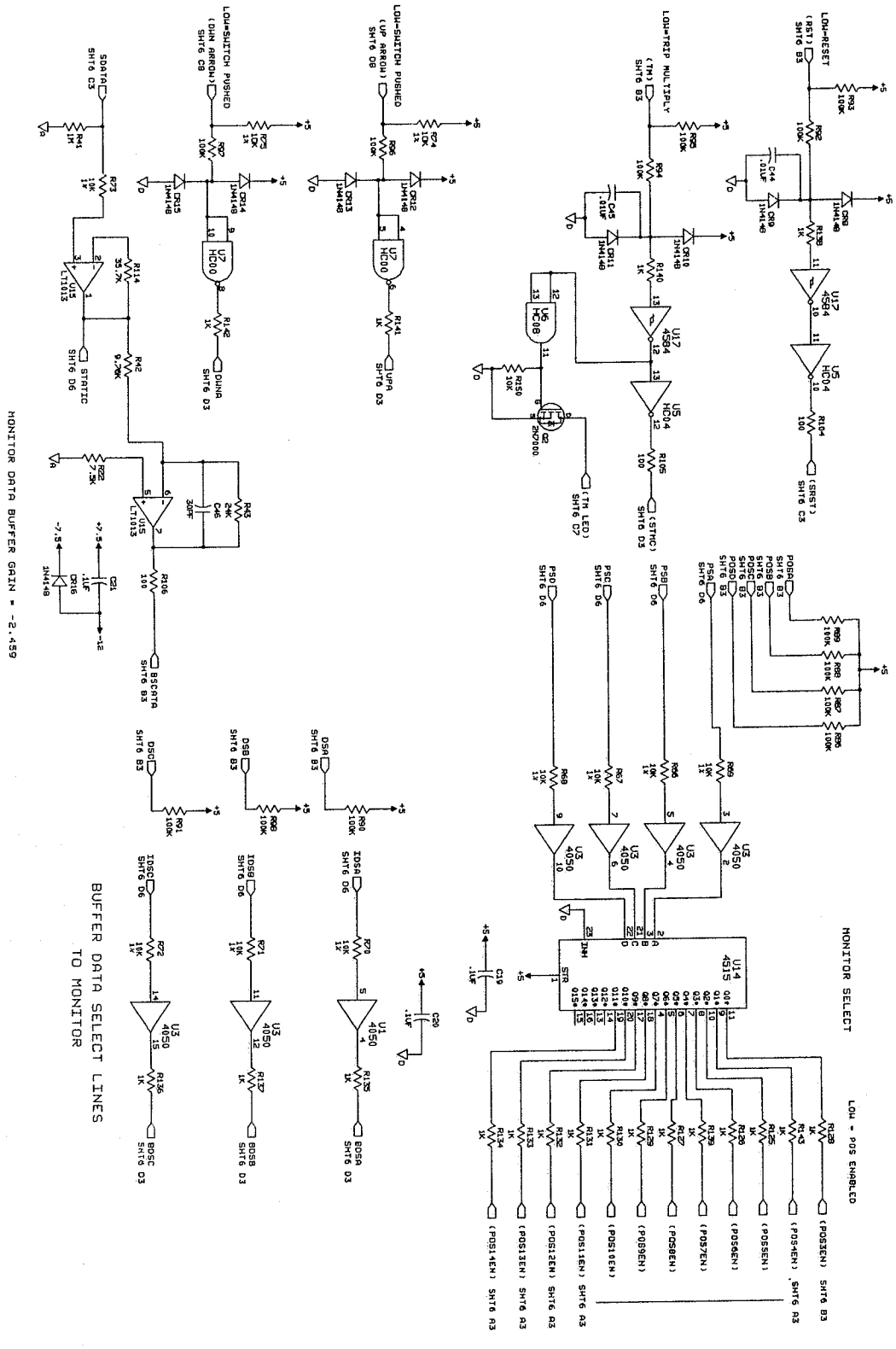
SYSTEM MONITOR SCHEMATIC SHEET 2 OF 6

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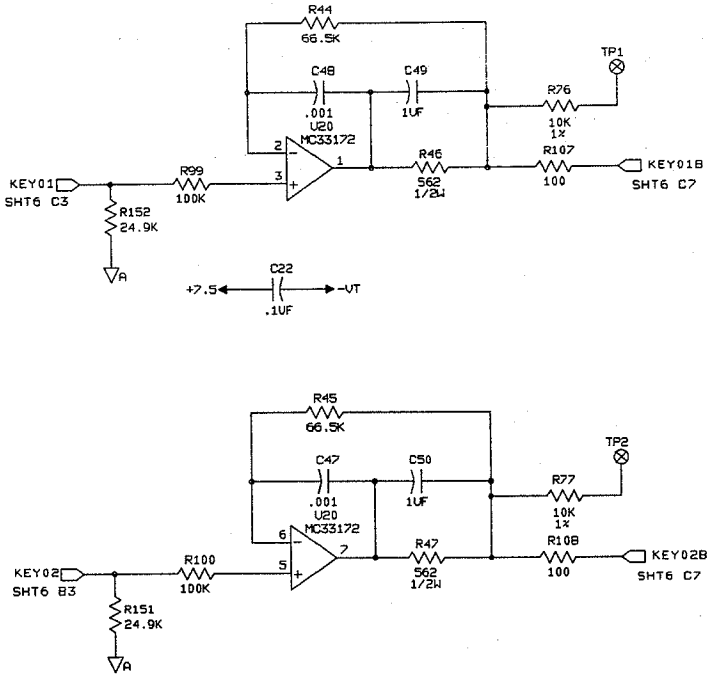
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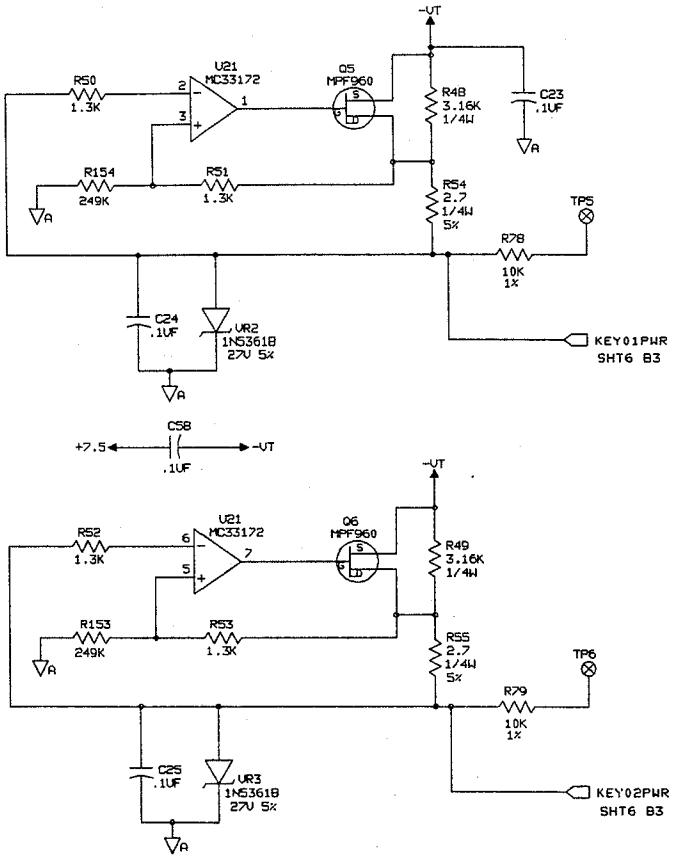


SYSTEM MONITOR SCHEMATIC SHEET 4 OF 6

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KEYPHASOR BUFFERS



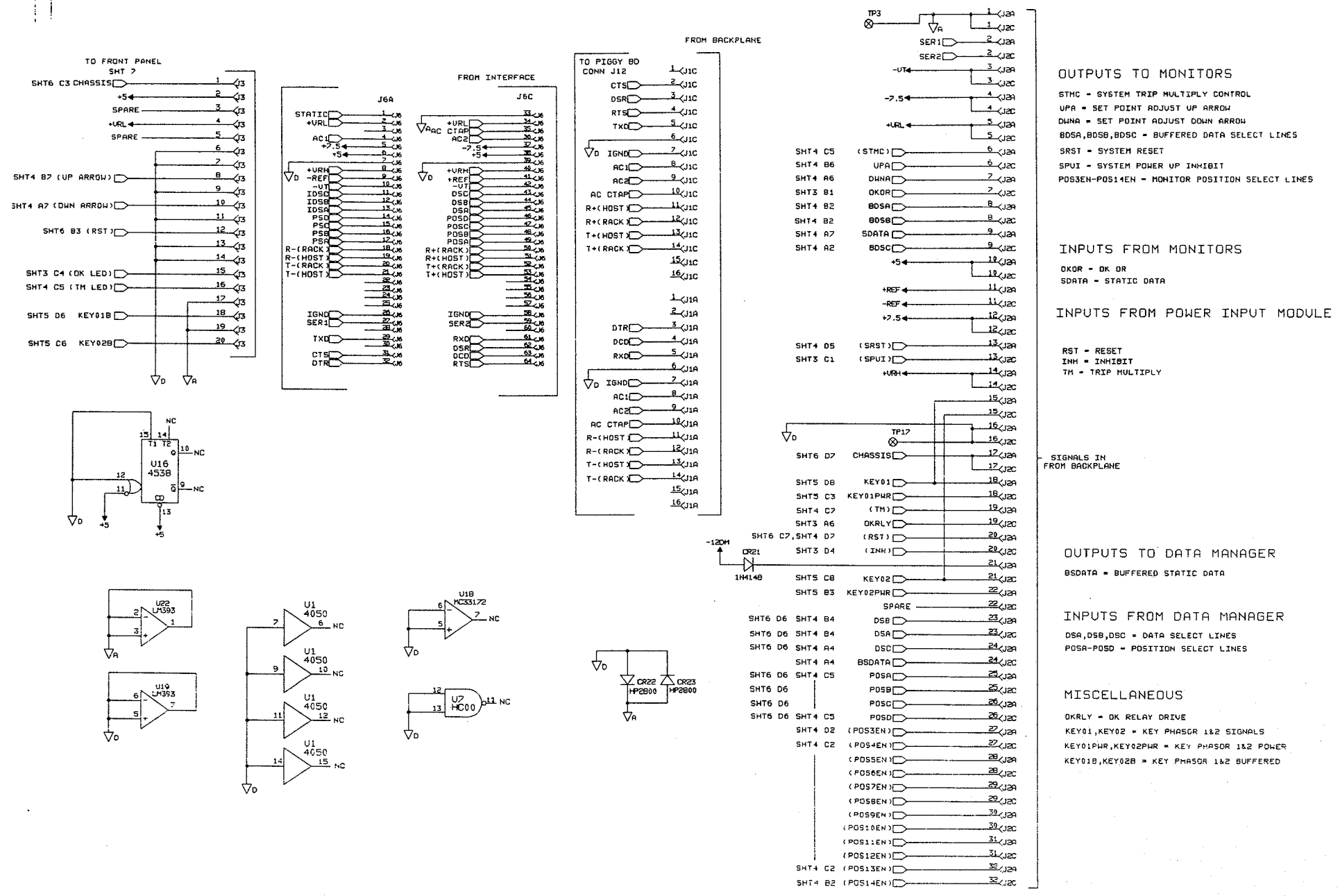
KEYPHASOR CURRENT LIMIT

@ -24V, I FOLDBACK POINT = ≈45mA + 5mA.

@ -18V, I FOLDBACK POINT = ≈35mA + 5mA.

SYSTEM MONITOR SCHEMATIC SHEET 5 OF 6

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OUTPUTS TO MONITORS

STMC = SYSTEM TRIP MULTIPLY CONTROL
UPA = SET POINT ADJUST UP ARROW
DWNA = SET POINT ADJUST DOWN ARROW
BDSA,BDSB,BDSC = BUFFERED DATA SELECT LINES
SRST = SYSTEM RESET
SPUI = SYSTEM POWER UP INHIBIT
POS3EN-POS14EN = MONITOR POSITION SELECT LINES

INPUTS FROM MONITORS

OKOR = OK OR
SDATA = STATIC DATA

INPUTS FROM POWER INPUT MODULE

RST = RESET
INH = INHIBIT
TM = TRIP MULTIPLY

OUTPUTS TO DATA MANAGER

BSDATA = BUFFERED STATIC DATA

INPUTS FROM DATA MANAGER

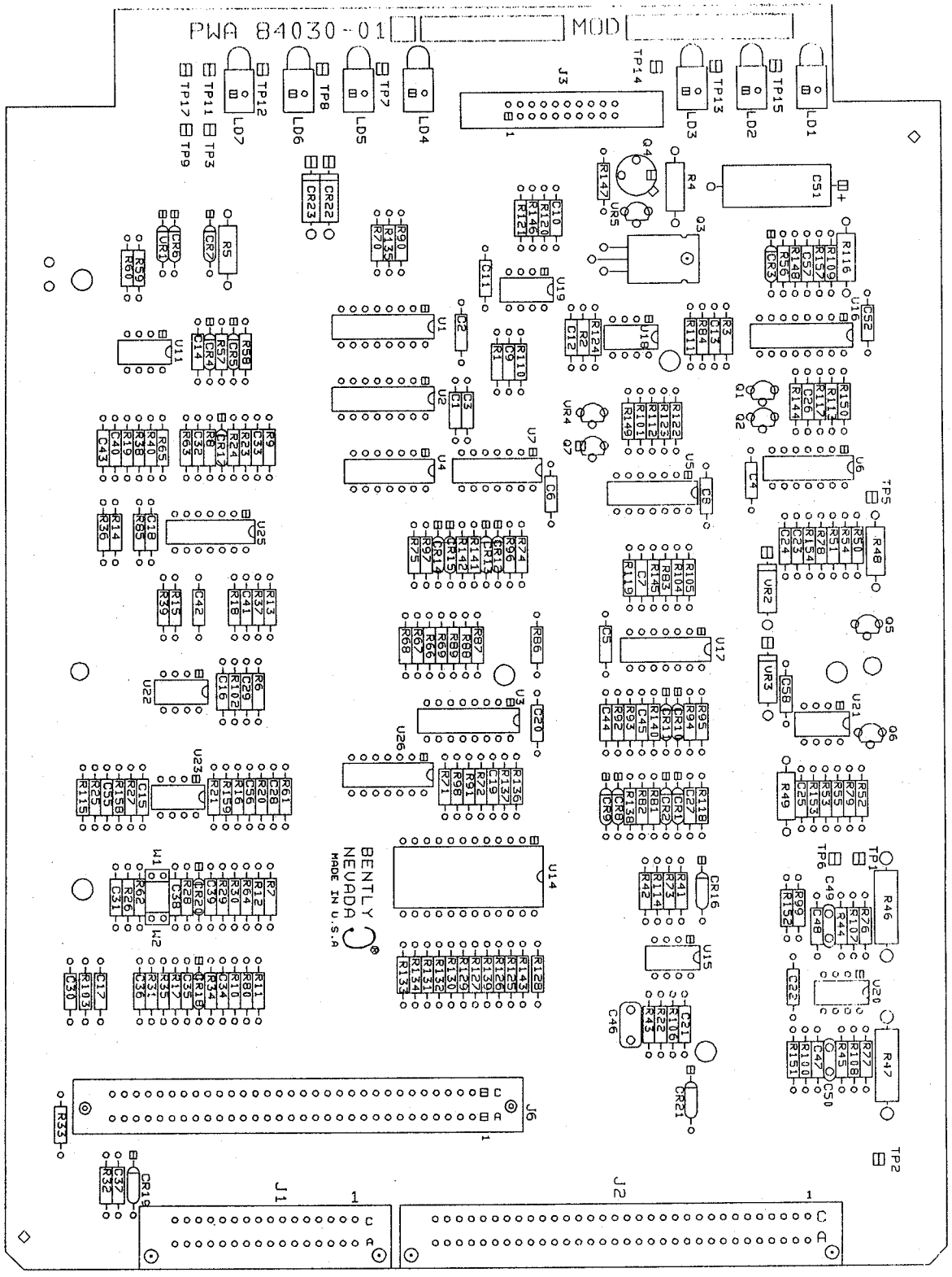
DSA,DSB,DSC = DATA SELECT LINES
POSA-POSD = POSITION SELECT LINES

MISCELLANEOUS

OKRLY = OK RELAY DRIVE
KEY01,KEY02 = KEY PHASOR 1&2 SIGNALS
KEY01PWR,KEY02PWR = KEY PHASOR 1&2 POWER
KEY01B,KEY02B = KEY PHASOR 1&2 BUFFERED

SYSTEM MONITOR SCHEMATIC SHEET 6 OF 6

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SYSTEM MONITOR PRINTED WIRING ASSEMBLY

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