Installation, Operation, and Maintenance Instruction Manual

Wide-Range Area Monitoring System

Model 945A

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PROCEDURES, WARNINGS, AND CAUTIONS

The equipment described in this manual is intended to be used for the detection and measurement of ionizing radiation. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures to be followed in the presence of radiation.

Although the equipment described in this manual is designed and manufactured in compliance with all applicable safety standards, certain hazards are inherent in the use of electronic and radiometric equipment.

WARNINGS and CAUTIONS are presented throughout this document to alert the user to potentially hazardous situations. **A WARNING** is a precautionary message preceding an operation which has the potential to cause personal injury or death. **A CAUTION** is a precautionary message preceding an operation which has the potential to cause permanent damage to the equipment and/or loss of data. Failure to comply with **WARNINGS** and **CAUTIONS** is at the user's own risk and is sufficient cause to terminate the warranty agreement between Fluke Biomedical RMS and the customer.

Adequate warnings are included in this manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Fluke Biomedical RMS. It shall be the owner's or user's responsibility to see to it that the procedures described here are meticulously followed, and especially that **WARNINGS** and **CAUTIONS** are heeded. Failure on the part of the owner or user in any way to follow the prescribed procedures shall absolve Fluke Biomedical RMS and its agents from any resulting liability.

Indicated battery and other operational tests must be performed prior to each use to assure that the instrument is functioning properly. If applicable, failure to conduct periodic performance tests in accordance with ANSI N323-1978 (R1983) **Radiation Protection Instrumentation Test and Calibration**, paragraphs 4.6 and 5.4, and to keep records thereof in accordance with paragraph 4.5 of the same standard, could result in erroneous readings or potential danger. ANSI N323-1978 becomes, by this reference, a part of this operating procedure.

READ YOUR INSTRUCTION MANUAL

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Section 1 - Introduction

General Description

The Victoreen Model 945A is a wide-range area monitoring system with a detectable range of 10^{-1} to 10^{7} mR/h. The system is comprised of the Model 977-210 Ion Chamber Detector, with local preamplifier, and a Model 946A-200 Universal Digital Ratemeter (UDR). The detector and preamplifier are connected by two five foot cables, encased in a flexible conduit. Other cable lengths, of up to 100 feet between preamplifier and detector, are available. Both the detector and preamplifier are wall mounted in an area designated by the customer. The 946A-200 Universal Digital Ratemeter is mounted in a rack in the control room. A more detailed description of each piece of equipment can be found in the following paragraphs.

Ion Chamber Detector/Preamplifier, Model 977-210

Ion chamber detectors are similar to capacitors, with two electrodes separated by a volume of air. In order to operate, an electrical potential is applied between the electrodes. Thus, one electrode will have a positive charge and the other a negative charge (relative to each other). Incident ionizing radiation will cause the air in the volume between the electrodes to dissociate into positive and negative ions. Each ion will be attracted to the electrode of opposite polarity. Ions that reach the electrode result in charge transfer. The charge transfer causes a current to flow in the connecting wiring, representing the measured amount of radiation intensity experienced by the ion chamber.

The Model 977-210 Wide-Range Ion Chamber Detector is a gamma sensitive radiation detection device, which measures radiation in the range of 1×10^{-1} mR/h to 1×10^{7} mR/h with an energy dependence of less than ± 10% from 60 keV to 3 MeV. The pre-amp is housed in a gasket sealed enclosure. Interconnection between the detector and pre-amplifier is accomplished via two five foot cables, encased in a flexible conduit.

The wide range ion chamber detector design includes a single ion chamber with a volume of approximately 1000 cc. The chamber walls are made of tissue equivalent plastic. An outer wall, made of aluminum, is provided to protect the ion chamber and to mechanically interface with Victoreen's Model 848-8 Field Test Source. The ion chamber is biased at a nominal 500 volts and produces an output current proportional to radiation absorbed in the chamber. The current is approximately 8×10^{-11} A/R/h.

The ion chamber assembly makes use of a double seal design, where the actual ion chamber is back filled with nitrogen at atmospheric pressure. The connector area is sealed against moisture and particulate through the use of a sealed, liquid tight flexible conduit between the detector and preamplifier electronics.

The preamplifier contains a microprocessor controlled, auto-zeroing, integrating electrometer, a programmable gain amplifier, an analog - to - digital converter, an asynchronous serial communications interface, an electronic check source, and the detector high voltage power supply. Communications with the UDR is accomplished via the optically isolated Victoreen Serial Communication Loop driver/receiver circuitry.

Specifications, Ion Chamber Detector

Detector Type	Ionization chamber
Detector Volume	Approximately 1000 cc
Detector Constant	Approximately 8 x 10^{-11} A/R/h
Detector Capacitance	30 Picofarads nominal
Inner Chamber Gas	Dry nitrogen @ atmospheric pressure
Radiation Detected	Gamma and X-Ray
Detectable Range	1 x 10^{-1} to 1 x 10^{7} mR/h
Energy Dependence	± 10% from 60 keV to 3 MeV (Refer to Figure 1-1)
Accuracy	± 15% of true dose for Cs-137
Power Requirement	Approximately 500 VDC; high voltage level verified through auto-check routine
Check Source	Electronic check source actuated from UDR front panel
Dimensions (H x W x D)	10.31 in. x 10.5 in. x 10.5 in. (26.19 cm x 26.67 cm x 26.67 cm)
Housing	Outer chamber protective cover is aluminum. Inner chambers are conductive, tissue equivalent, plastic
Weight	11 lb. (5 kg)
Operating Temperature	0^{o} to 130^{o} F (-16^{o} to 54^{o} C)
Storage Temperature	0^{o} to 132^{o} F (-16^{o} to 56^{o} C)
Relative Humidity	0 to 95% non-condensing
Max. External Pressure	15 psig

Specifications, Preamplifier, Model 977-210-95

Housing	Steel, NEMA 4 type
Interface to detector	Approximately 5 feet of signal cable and high voltage cable contained within a flexible conduit. (Other lengths available).
Interface to Readout	Victoreen Comm Loop interface to 942A UDR through Model 942-200-80 Communications Board. Capable of driving up to 3000 feet of cable at 4800 Baud.
Interface Cable Requirement	Seven (7) conductors, 16 AWG for maximum preamplifier/readout distance, excluding local alarm requirements
Power Requirement	+15 Vdc @ 250 mA -15 Vdc @ 50 mA
Auxiliary Alarm Output	- 12 Vdc @ 150 mA (maximum)
Auxiliary Analog Output	0 - 10 Vdc, 2 k? min.
Dimensions (H x W x L)	11.5 in. x 8.94 in. x 4.20 in. (29.21 cm x 22.71 cm x 10.67 cm)
Weight	12 lb. (5.4 kg)
Operating Temperature	0^{o} to 130^{o} F (-16^{o} to 54^{o} C)
Storage Temperature	0^{o} to 132^{o} F (-16^{o} to 56^{o} C)
Relative Humidity	0 to 95% non-condensing
Electronics Life Expectancy	Approximately 10^{4} rads

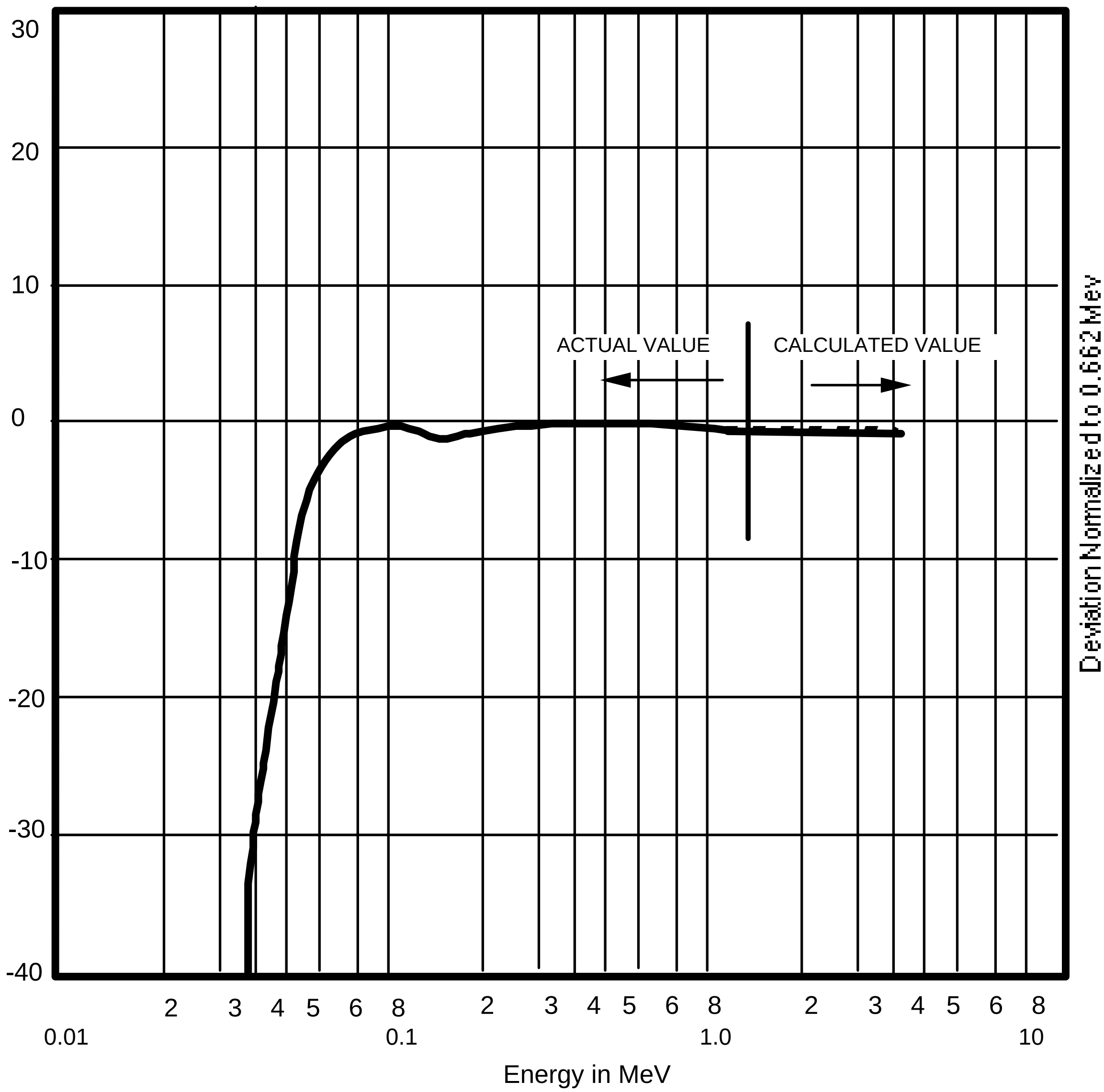

Figure 1-1. Detector Energy Response

Universal Digital Ratemeter, Model 946A-200

The Victoreen Model 946A-200 Universal Digital Ratemeter (UDR), when connected to a Model 977-210 Ion Chamber Detector, comprises a monitoring system which operates in the range of 10^{-1} to 10^{7} mR/h. The UDR provides display, control, and annunciation functions for the monitoring system. Refer to Figure 1-2 for view of the 946A-200 front panel.

Standard features for the instrument consist of a three digit display of the radiation value and a multi-colored bargraph indicator which covers the entire range of the detector. The bargraph will change color in the event of an alarm condition. Front panel alarm indicators and rear panel output relays for alarm annunciation are also included. Front panel pushbuttons are provided to apply power, display alarm limit set points, for alarm acknowledgment, and the activation of a check source function.

Analog outputs of 0 to 10 VDC and 4 to 20 mA (2) are provided for recording and computer monitoring. The 0 to 10 VDC output may also be used to drive a remote meter or a local (i.e. near the detector) indicator.

All electronics required to interface to the VICTOREEN 977-210 series detector/preamplifier are included within the 946A-200 UDR. These electronics consist of a low voltage power supply, and the hardware/software required for UDR operation. The system also includes a positive overrange indication on the display when radiation intensity exceeds the full scale value of 10^{7} mR/h.

The following paragraphs describe the available options. A separate manual, for each option board, is available with more detailed information. Listed below are the option boards currently available.

1. 942-200-75: ANALOG OPTION INPUT BOARD - (Generally not used for normal operation with the 946A-200 UDR, however, it is used if the UDR is part of a simulator) Contains four separate channels for analog input. A 0 to 10 VDC input or 4 to 20 mA input can be selected independently for each channel using the jumpers and switches provided on the board. Possible inputs to the board include: temperature, pressure, flow, or simulated radiation.

2. 942-200-80: COMMUNICATIONS LOOP OPTION BOARD - Designed to enable a EIA RS232C serial communications link between VICTOREEN's ratemeter and a user computer system or CRT terminal, with baud rates ranging from 50 baud to 19200 baud. An asynchronous communication interface adapter is utilized to format the data and control the interface.

   The Communication Loop Option Board also provides an isolated multi-drop, serial communications port for interface with a supervisory computer system. The serial data is in a modified RS232 format, and utilizes Victoreen’s proprietary VICO loop protocol. For maximum electrical noise protection, a six conductor communication cable is used.

   The 946A-200 UDR has one standard 942-200-80 Communications Board to support communications between the preamplifier and the 977-210 Detector/Preamplifier.

3. 942-200-95: ANALOG OUTPUT BOARD - Designed to provide a user selectable single output voltage of: 0 - 10 Vdc, 0 - 5 Vdc, 0 - 1 Vdc, 0 - 500 mVdc, 0 - 100 mVdc, 0 - 50 mVdc, or 0 - 10 mVdc.

4. 942-200-95M1: DUAL ANALOG OUTPUT BOARD - Designed to provide two user selectable output voltages. Output #1 is either 0 - 5 Vdc, or 0 - 10 Vdc, while output #2 is either 0 - 10 mV dc, 0 - 50 mVdc, 0 - 100 mVdc, 0 - 500 mVdc, or 0 - 1 Vdc.

Application

The Model 946A-200 UDR may be used with all VICTOREEN 977 series Ion Chamber Detectors. The detector/preamplifier, when connected to the UDR, will comprise a single channel digital area monitoring system. For additional information on various applications, please contact VICTOREEN, Inc., Applications Engineering Group.

Specifications

General specifications for the 946A-200 UDR are listed below. The 946A-200 is rated for nuclear applications, and any repairs to it by personnel not qualified to ANSI 45.2.6, 1978, Skill Level II will void the nuclear rating.

Main Display	Three digits with backlighted radiation units display and floating decimal point. Three digits plus exponent for data entry/display
Bargraph Display (Dynamic Range)	Three segments per decade, 10^{-1} to 10^{7} mR/h (24 segments), tri-color, indicating channel status.
Alarm Indicators	HIGH Alarm (Red LED) - Flashing until acknowledged WARN Alarm (Amber LED) - Flashing until acknowledged FAIL Alarm (Red LED) - Does not flash, is not manually acknowledged RANGE Alarm (Red LED), overrange/underrange - Does not flash, automatically acknowledges
Alarm Delay	3 minute alarm mute on channel power-up
Display Selection **(Momentary Pushbuttons)**	HIGH, High Alarm limit WARN, Warn Alarm limit
Check Source	Activates electronic Check Source and associated green LED indicator. "Latching pushbutton operation"
Alarm Ack.	Alarm acknowledgment: causes alarm indicators to go to a steady on state after acknowledgment, relays will reset when radiation level drops below setpoint. Internal jumper causes alarms to be reset automatically when radiation level drops below set point (no operator input required).
Power ON/OFF	Alternate action push-button for AC power to the unit
Relay Outputs **(Failsafe operation)**	HIGH Alarm - 1 set. DPDT rated 5 A @ 120 Vac (one set 120 Vac powered for use with optional local alarm) WARN Alarm - 2 sets. DPDT rated 5 A @ 120 Vac FAIL Alarm - 2 sets. DPDT rated 5 A @ 120 Vac DC contact rating for all relays is 5 A @ 29 VDC
Analog Outputs	4 to 20 mA (2) and 0 to 10 Vdc, logarithmic and may be scaled for any one decade (minimum) to the full range of the unit (maximum)
Alarm Ack Input	Optically isolated DC input
UDR Electronic Accuracy	± 1% digit (± 1% of the displayed value), exclusive of the detector energy response
Dimensions (H x W x D)	3.5 in. x 5.6 in. x 13.5 in. (8.9 cm x 14.2 cm x 34.3 cm)
Weight	Approximately 3.7 lb. (1.67 kg)
Power	120 Vac ±10%, 50/60 Hz, 28 watts (240 Vac optional)
Operating Temperature	32° F to 122° F (0° C to + 50° C)
Relative Humidity	0 to 95% non-condensing
Compatible Detector	977 Series, Ion Chamber

Auxiliary Equipment

Support/Test Equipment	Model 848-8: Field Calibrator
	Model 942TS: UDR Test Set
	Model 948-1: Rack Chassis
	Model 948A-4: Remote Alarm
	Model 948-3: Table Top Enclosure
	Model 948-10: Panel Adapter
	Model 50-150: Cable
Remote Indicator	Model 948A-4: Remote Alarm
	Model 948A-5: Remote Alarm/Meter

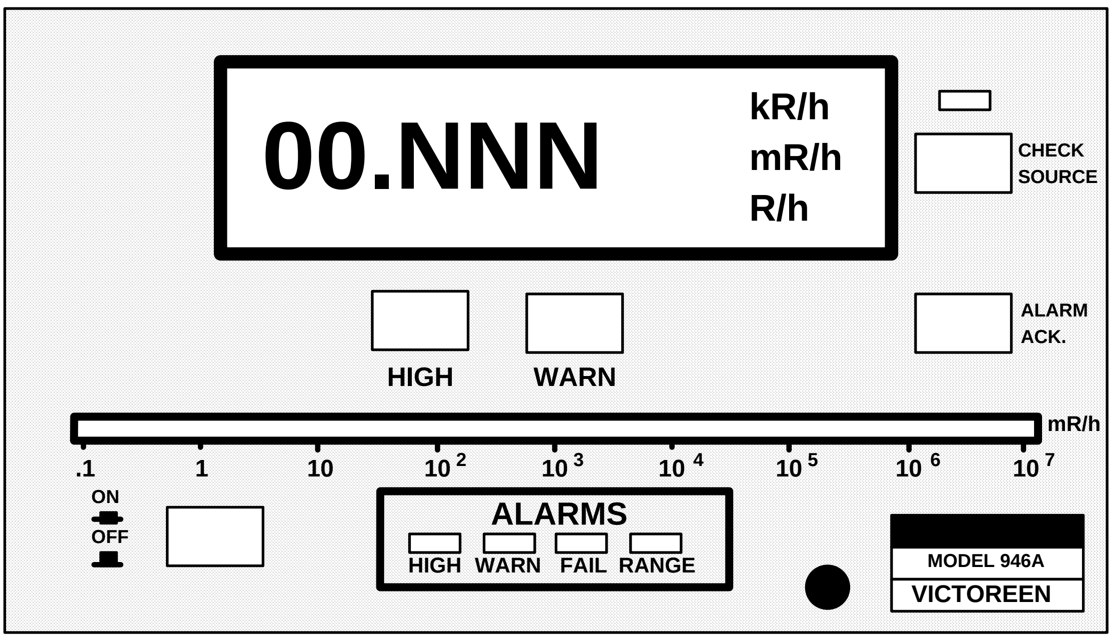

Figure 1-2. Front Panel, Model 946A-200 Universal Digital Ratemeter

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Section 2 - Receiving Inspection and Storage

Receiving Inspection

Upon receipt of the unit:

1. Inspect the carton(s) and contents for damage. If damage is evident, file a claim with the carrier and notify the Victoreen Customer Service Department.

Fluke Biomedical RMS
6045 Cochran Rd.
Cleveland. Ohio 44139
Phone: (440) 248-9300
Fax: (440) 349-2307

2. Remove the contents from the packing material.

3. Verify that all items listed on the packing list have been received and are in good condition.

NOTE
If any of the listed items are missing or damaged, notify the Fluke Biomedical RMS Customer Service Department.

Storage

Storage of Fluke Biomedical RMS instruments must comply with Level B storage requirements as outlined in ANSI N45.2.2 (1972) Section 6.1.2(.2). The storage area shall comply with ANSI N45.2.2 (1972) Section 6.2 Storage Area, Paragraphs 6.2.1 through 6.2.5. Housekeeping shall conform to ANSI N45.2.3 (1972).

Level B components shall be stored within a fire resistant, tear resistant, weather tight enclosure, in a well ventilated building or equivalent.

Storage of Fluke Biomedical RMS instruments must comply with the following:

1. Inspection and examination of items in storage must be in accordance with ANSI N45.2.2 (1972) Section 6.4.1.

2. Requirements for proper storage must be documented and written procedures or instructions must be established.

3. In the event of fire, post-fire evaluation must be in accordance with ANSI N45.2.2 (1972),Section 6.4.3.

4. Removal of items from storage must be in accordance with ANSI N45.2.2 (1972), Sections 6.5 and 6.6.

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Section 3 - Installation

Installation

Installation consists of mounting the equipment, making the required electrical connections, and entering the desired set points. Installation drawings are provided in Appendix B of this manual.

CAUTION

Remove all power prior to installing the UDR.

Detector Mounting

Refer to Engineering Drawing GEL 977-210, provided in Appendix B, for detector and preamplifier mounting dimensions, weights and recommended fasteners.

UDR Mounting

The UDR is a self contained unit which can be mounted in four different ways.

CAUTION

When installing the UDR in enclosed panels or cabinets, ensure that the maximum operating temperature (122° F) is not exceeded. The total heat load should be calculated to determine whether cooling by natural convection or forced ventilation (i.e. fans) is required. The heat load for a single UDR is approximately 96 BTU/hr.

When more than four units are to be mounted in a cabinet, it is recommended that the center position in each chassis be left blank to facilitate the flow of cooling air through the cabinet.

NOTE

For seismic applications, the rear of the chassis must be supported, or the sides of the chassis must be fastened together. For further information, contact Fluke Biomedical RMS.

1. The first mounting utilizes a 19 inch rack chassis adapter, Victoreen Model 948-1. This configuration requires 3.5 inches of rack height and can be used to mount up to three UDRs side by side. A blank filler panel, Victoreen Model 948-2, is available to cover unused mounting positions. In multiple UDR installations, the center mounting bay should be fitted with a Model 948-2 blank panel to facilitate cooling air flow.
2. The second mounting consists of a single channel table top enclosure, Victoreen Model 948-3. Dimensions for the enclosure are 4.5 inches high by 6.8 inches wide by 14.9 inches deep. This enclosure is used primarily in a laboratory environment. Refer to drawing 948-3-5 for mounting dimensions.
3. The third mounting consists of a panel mount enclosure, Victoreen Model 948-9. Cutout dimensions for this enclosure are 3.75 inches high by 6.45 inches wide, the outside dimensions for the enclosure are 4.0 inches high by 6.7 inches wide by 13.7 inches deep. This mounting must also be rear supported in seismic applications. Refer to drawing 948-9-5 for mounting dimensions.

4. The fourth mounting utilizes the Victoreen Model 948-10 Rack Chassis Adapter to mount a 946A-200 UDR into an existing Victoreen analog meter rack chassis, such as those used for the Victoreen 842 series of analog ratemeter.

The UDR is simply inserted into the selected mounting enclosure and secured using the front panel pawl fastener.

WARNING

Ensure all power is off prior to connecting the field wiring.

Electrical Interface

Electrical connections at the preamplifier are made via the mating “MS” style connector supplied with the detector. It is not necessary to open the preamplifier enclosure to complete the interconnection to the ratemeter. The desiccant bags inside the preamplifier enclosure should be checked for moisture absorbtion prior to placing into service. Each bag contains a color indicator that indicates when it should be replaced.

NOTE

The electrometer circuitry in the preamplifier is highly sensitive to moisture and physical damage. Use extreme care when the preamplifier case is opened as the high impedance electrometer circuitry is easily damaged. Do not leave the preamplifier enclosure in the open position for any extended period of time.

Electrical interconnections at the Model 946A-200 Readout are performed using the mating connector kit, VICTOREEN part number 946A-100-4 (supplied with the Readout), by using the connector Input/Output assignments provided in Tables 3-1 through 3-6, and the drawings provided in Appendix B. Refer to drawing 945A-3, showing complete channel loop wiring, including remote alarms (if used)

Connector pins should be soldered to customer furnished cable, using 60/40 tin/lead resin core solder with a soldering iron of 50 watts or less to avoid connector damage.

Table 3-1. Rear Panel Connections

Connector	Contact Function
P1	Relay, Remote Alarm Acknowledge
P2	Detector Connector, VICO Loop Communications, Remote Alarm Output
P3	AC Power Input
P6	Analog Outputs (4 - 20 mA, 0 - 10V)
P7	RS232C Communications

Table 3-2. Connector P1 - Input/Output

Pin	Signal	Internal Connection
1	Spare	Not Used
2	Spare	Not Used
3	Spare	Not Used
4	Spare	Not Used
5	Spare	Not Used
6	Spare	Not Used
7	Fail Relay, common	Relay Board K3-A
8	Fail Relay, n.o.	Relay Board K3-B
9	Fail Relay, n.c.	Relay Board K3-C
10	Fail Relay, common	Relay Board K3-D
11	Fail Relay, n.o.	Relay Board K3-F
12	Fail Relay, n.c.	Relay Board K3-E
13	Warn Relay, common	Relay Board K4-A
14	Warn Relay, n.o.	Relay Board K4-B
15	Warn Relay, n.c.	Relay Board K4-C
16	Warn Relay, common	Relay Board K4-D
17	Warn Relay, n.o.	Relay Board K4-F
18	Warn Relay, n.c.	Relay Board K4-E
19	Alarm Relay, common	Relay Board K5-A
20	Alarm Relay, n.o.	Relay Board K5-B
21	Alarm Relay, n.c.	Relay Board K5-C
22	Spare	Not Used
23	Spare	Not Used
24	Spare	Not Used
25	+ Remote Acknowledge	Main Circuit Board J9-1
26	- Remote Acknowledge	Main Circuit Board J9-2
27	Spare	Not Used
28	Spare	Not Used
29	Spare	Not Used
30	Spare	Not Used
31	Spare	Not Used
32	Spare	Not Used
33	Spare	Not Used
34	Spare	Not Used
35	Spare	Not Used
36	Spare	Not Used
37	Spare	Not Used

n.o. = normally open
n.c. = normally closed

Relay contacts listed are in the shelf or de-energized state. Relays are operated in the fail-safe mode, de-energizing to indicate a tripped condition.

Table 3-3. Connector P2 - Detector Connector

Pin	Signal	Internal Connection
1	+15 VDC	Not used in most applications
2	-15 VDC	Not used in most applications
3	Supply Ground	Power Supply Ground
4	Transmit +	Communication Board
5	Transmit -	Communication Board
6	Receive +	Communication Board
7	Receive -	Communication Board
8	Loop Voltage + Fused + 15 VDC	Communication Board
9	Loop Voltage - Fused -15 VDC	Communication Board
10	0 - 10 Vdc*	Main Circuit Board J5-10
11	Ground	Main Circuit Board J5-9
12	Check Source Line	Not used in most applications
13	Neutral	Not used in most applications
14	Alarm Switched Line	Not used in most applications

* 0 - 10 Vdc selected for customer use on P2 (10,11) or P6 (5, 6), not both.

Table 3-4. Connector P3 - Power Input

Pin	Signal	Internal Connection
1	120 Vac, Line	Line fuse (F2)
2	120 Vac, Neutral	Power Supply, 120 Vac (n)
3	Safety Ground	Chassis

Table 3-5. Connector P6 - Auxiliary I/O

Pin	Signal
1	4 - 20 mA Output # 1
2	Ground
3	4 - 20 mA Output # 2
4	Ground
5	0 - 10 V *
6	Ground
7	Analog Output Option
8	Ground
17	Not Used
18	Not Used
19	Not Used
20	Not Used
21	Not Used
22	Not Used
23	Not Used
24	Not Used

* 0 - 10 Vdc selected for customer use on P2 (10,11) or P6 (5, 6), not both.

Table 3-6. Connector P7 - RS232C

Pin	Signal
1	Protective Ground
2	Transmit Data
3	Receive Data
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground
8	Receive Line Signal Detect
20	Data Terminal Ready

Set-up

To place the UDR in operation, the following steps should be performed:

NOTE
Ensure you have read and fully understand section 4, prior to continuing.

1. Verify jumpers and DIP switches on the preamplifier and ratemeter are set for the operational features desired. Refer to Section 4 Tables 4-3 through 4-6 for additional information.

2. Apply power to the unit.

3. Enter detector dependent set points such as analog output, High/Low scale Value, and calibration constant, using the procedure outlined in Section 4, and Tables 4-2 & 4-7.

4. Enter channel dependent setpoints such as Alarm Limits are to be entered using the procedure described in Section 4, and Tables 4-2 & 4-7.

5. Electronic adjustments affecting calibration are factory set and should not be readjusted for initial operation unless the UDR has been in storage for more than one year. If the Unit has been in storage for more than one year, the electronic calibration described in Chapter 6 should be performed.

Section 4 - Operation/Functional Description

Operation

This section describes the operation and set up of an area monitoring system consisting of a Model 946A-200 UDR and a Model 977-210 Detector/Preamplifier interconnected via a serial communications interface. The detector preamplifier provides the electronics interface between the detector and the UDR. It consists of a high voltage/communications interface printed circuit board and an electrometer printed circuit board. The preamplifier measures the current output of the ion chamber, generates the high voltage supply for the detector, performs periodic diagnostic checks, and performs an electronic check source function on demand from the UDR. The current measurement is converted to a dose rate and this, along with the operational status of the preamplifier and detector, are transmitted to the UDR.

The 946A-200 UDR uses this information to generate the dose rate display, error codes, alarms, and analog outputs.

Operation of the 946A-200 UDR consists of operator functions and configuration functions. All operator functions are performed using the front panel shown in Figure 4-1. Configuration functions are performed using internal switches and/or jumpers, which are accessible with a partial removal of the UDR from the mounting enclosure (refer to Table 4-6). Calibration involving trimpots are described in Section 6.

Detector Operation

The Model 977-210 wide range ion chamber detector is an eight decade, linear reading radiation monitor. The chamber, cables, and preamplifier are sensitive to moisture; therefore, the detector and preamplifier are sealed. The preamplifier box contains a desiccant package to remove moisture from the interior of the preamplifier. The desiccant has a color indicator to show when it should be replaced.

The detector electrometer converts the current from the ion chamber to a voltage which is measured by the analog to digital converter of the preamplifier. Under program control, this measurement is made every 50 milliseconds on the first five decades and every 100 milliseconds on the upper three decades.

The electrometer is auto-ranging and auto-zeroing. An internal coarse zero control (factory adjusted) is provided. The microprocessor in the preamplifier performs data collection, averaging, multiplication by a stored calibration factor, range changing, high voltage check, detector cable integrity check, and communication with the 946A-200 UDR.

The high voltage check and integrity check are run, under program control, every 256 seconds. The high voltage check is a measurement of the high voltage to ensure that the value is sufficient for 100% collection at full scale.

The detector cable integrity check is a pulse that is injected on the detector high voltage. The chamber capacitance couples the pulse into the electrometer where it is seen as a high current. If either the high voltage lead or signal lead are not connected to the chamber, the pulse does not appear on the electrometer. The measurement cycle is interrupted for approximately one (1) second whenever the integrity check is performed. The integrity check and high voltage check are not performed when the instrument is reading on the three highest decades. A reading in these ranges serves as an indication of the functioning of the instrument. The Maintenance mode operation also inhibits these checks from being made.

There is a hysteresis built into the range changing function of the electrometer. The range change-up occurs at the decade points whereas the range change-down occurs at 80% of the decade points. This hysteresis results in the display of only two significant digits when in the upper 20% of a decade. Whether or not this occurs depends on which direction the radiation level is trending. An increasing trend will result in three significant digits while a decreasing trend will result in two significant digits.

The response times for a change in reading within the same decade are listed in Table 4-1. If a change of 100 to 1000 times the current reading occurs, the instrument will range change within a single 50 millisecond clock cycle.

Table 4-1. Response Time

DECADE	RANGE	RESPONSE TIME
1	0.1 to 1.0 mR/h	80 sec.
2	1.0 to 10 mR/h	32 sec.
3	10 to 100 mR/h	16 sec.
4	100 to 1000 mR/h	4 sec.
5	1.0 to 10 R/h	2 sec.
6	10 to 100 R/h	0.9 sec.
7	100 to 1000 R/h	0.2 sec.
8	1.0 k to 10 kR/h	0.2 sec.

A manual electronic check source may also be initiated from the UDR by the operator to check detector operation. Upon removing the check source request, the UDR again displays the detector output

CAUTION

Do not actuate the check source when the reading is above 1 R/h. The radiation measurement is additive to the check source signal resulting in improper values from the check source. This may result in the UDR indicating a failure when the instrument is operating correctly.

The detector preamplifier contains a High Voltage/Communications Interface Board containing an RS232 driver, a Victoreen Communications Interface Driver, the detector high voltage power supply, a local 0 - 10 Vdc analog output, and a -12 Vdc open collector alarm output.

Operation / Functions

Operation of the 946A-200 UDR consists of operator functions and configuration functions. All operator functions are performed using the front panel. Configuration functions are performed using internal switches and/or jumpers which are accessible with a partial removal of the UDR from the mounting enclosure.

Normal Operation

If the measured radiation field is within the range of the detector during power-up, the mR/h, R/h, or kR/h value will be displayed as a three digit number with a floating decimal point (i.e. **.XXX mR/h**). The bargraph will display the value of radiation, with a resolution of three segments per decade, over the range of the detector or eight decades. The bargraph should be green, providing the operator with a visual indication of normal operation. All other indicator LEDs should be off. In very low background environments (< 0.1 mR/h), the range indicator LED may be illuminated.

WARN/HIGH Alarms

If the measured radiation field increases above the WARN alarm limit, the WARN alarm indicator will turn on flashing (amber color), the bargraph will change color to amber, and the warn alarm relay will de-activate. If the measured radiation field increases above the HIGH alarm limit, the HIGH alarm indicator will turn on flashing (red color), the bargraph will change color to red, and the high alarm relay will de-activate.

NOTE

Non-failsafe relay operation for the HIGH and WARN alarms is available as an option at time of purchase.

The UDR can be configured to automatically reset the alarm relays and alarm indicators by removing JP3-3, or it can hold the alarm relays energized and flash the alarm indicators until the alarm acknowledge (ALARM ACK) push-button is pressed. If the ALARM ACK push-button is pressed while the alarm condition still exists, the indicators will go to a steady state, and the relays will remain energized until the alarm condition returns to normal. Upon resumption of normal operation, the relays and alarm indicators will de-energize. The bargraph color will always indicate the current status; green for normal, amber for warn, and red for a high alarm.

Front panel pushbuttons labeled HIGH and WARN can be used to display the respective alarm set points.

Range Alarm

If the measured radiation field is below the Underrange setpoint, the front panel display will indicate 0.00 mR/h, and the RANGE alarm indicator will illuminate in red, the bargraph will indicate the actual radiation value, and the analog output will be set to zero. The minimum range is an adjustable setpoint and is defaulted to 1.00-1 mR/h. When the measured radiation field increases into the range of the detector, the RANGE alarm indicator will extinguish and normal operation will continue.

If the measured radiation field goes above the overrange set point, the RANGE alarm indicator will illuminate and the front panel display will indicate EEEEE, the bargraph will illuminated in RED, and the analog output will be set to full scale. The maximum range of the detector is used is determine by the overrange set point. When the measured radiation field returns within the maximum operating range of the detector and the condition is acknowledged, the RANGE alarm indicator will extinguish and normal operation will resume.

Fail Alarm

Detector failure, communication loss, or UDR microprocessor failure are some of the conditions which can produce a FAIL alarm and in some cases an error display. The fail condition is true whenever an equipment failure is detected and false when no equipment failures are detected. When a fail condition occurs, other than power failure, the red FAIL alarm indicator illuminates and the fail relay coil de-energizes.

A FAIL alarm will clear automatically when the failure conditions are no longer present.

Check Source

The check source push-button and electronics are provided to verify detector operation. To operate the check source, press the CHECK SOURCE push-button and hold it down for one second. The electronic check source circuit will energize, the check source indicator will illuminate (green), and the check source radiation value will be displayed on the front panel. Pressing the CHECK SOURCE push-button again will cause the UDR to return to normal operation. Removing JP3-5 allows alarms to be activated if alarm limits are exceeded by the check source radiation value. Installing JP3-5 allows alarms to be muted if alarm limits are exceeded by the check source radiation value.

The analog outputs are set to zero during check source operation.

A built-in timer will turn the Check Source OFF after 10 minutes.

Firmware Version

Both detectors and UDR require a programmed PROM for operation. For the part number and the latest revision of these PROMs, see the detector Calibration Data Sheet and/or Factory Test Data Sheet.

Operational Modes

Rate Mode (Normal Operation)

The system is in RATE MODE when SW3-3 on the high voltage /comm board (Model 977-210-10) in the preamplifier is set to the OFF position, the UDR function switch is in any position, but 8 or 9, and the Check Source button is OFF. In the Rate Mode, the display shows the dose rate data received from the preamplifier in mR/h, R/h, or kR/h units as appropriate. The bargraph also shows the dose rate. The color of the illuminated segments is green when the dose rate is below the WARN setpoint, amber when the dose rate is above the WARN setpoint and below the HIGH setpoint, and red when the dose rate is above the HIGH setpoint. The analog outputs are active while the UDR is in RATE MODE and all alarms are enabled.

Data Entry Mode

Data Entry Mode is selected by pressing the ENTER push-button while the rotary FUNCTION switch is in a valid setpoint position **(see How to Enter Setpoints)**. The selected setpoint is displayed in exponential format (e.g. 1.00E2) with the left most digit flashing. If the FUNCTION switch is not in a setpoint position, pressing the ENTER button has no effect. Refer to Table 4-2 for FUNCTION switch positions.

In the Data Entry Mode, the alarms, bargraph and analog outputs are active. The check source and alarm acknowledge functions are inoperative.

Alarm Inhibit Mode

Alarms are inhibited in situations where an alarm trip would be meaningless, because the UDR preamplifier is not in a normal measurement mode (i.e., when the UDR is in the Check Source Mode). New alarm trips cannot occur and old alarms cannot be reset. When the inhibit period is over, alarm trips and resets are enabled again. Alarm inhibit conditions are discussed in the following paragraphs. Alarms are inhibited for three minutes after channel power-up to allow time for induced charges within the detector output to subside.

Check Source Mode

In the Check Source Mode, the dose reading displayed is the result of pulsing the high voltage to the detector to simulate a radiation field. The value displayed is in the nominal range of 2.5 to 5 R/h and is dependent on component value and gain in the check source driver. When in the check source mode, alarms may be inhibited or active depending on jumper selection (JP3-5). Analog outputs are always set to zero during check source operation.

To operate the check source, press the CHECK SOURCE push-button and hold it down for approximately 1 second. The electronic check source circuit will energize, the green check source indicator will illuminate (approximately 1 second after the button is depressed), and the check source radiation value will be displayed on the front panel. An internal configuration jumper allows alarms to be activated or muted if alarm limits are exceeded by the check source radiation value. The alarm inhibit function may be disabled by removing jumper JP3-5 from the UDR main board. If this is done, alarms will be enabled in Check Source Mode.

Pressing the CHECK SOURCE push-button again will cause the UDR to return to normal operation.

A built-in timer will turn the Check Source OFF after 10 minutes.

CAUTION

Do not actuate the check source when the reading is above 1 R/h. The radiation measurement is additive to the check source signal resulting in improper values from the check source. This may result in the UDR indicating a failure when the instrument is operating correctly.

NOTE

The Check Source relay, though energized in the Check Source Mode, Does not have an active function in the 945A Area Monitoring System.

The bargraph operates normally during Check Source operation.

The analog outputs are set to zero (i.e. 0 Vdc or 4 mA) during Check Source operation.

Maintenance Mode

The Maintenance Mode is designed to allow adjustments to be made on the electrometer board in the preamplifier without tripping the FAIL alarm. Maintenance Mode is selected by setting SW3-3 on the 977 interface board, in the preamplifier, to the ON position.

The bargraph works the same as in Rate Mode. The units on the numeric digital display flash as long as data is being received from the preamplifier. If communication with the preamplifier fails, the flashing stops.

The FAIL alarm and all failure error codes except E0007 (communications failure) are inhibited. The UDR analog outputs are active. The local preamplifier analog output may be checked at this time. SW3-4 in the OFF position forces the output to zero; SW3-4 in the ON position forces the output to full (refer to Table 4-3).

The HIGH, WARN, and RANGE alarms may be inhibited during Maintenance Mode by setting SW3-2 on the 977 interface board to the OFF position. These alarms are enabled when SW3-2 is in the ON position.

Auto Zero Mode

The contents of the auto zero counter, in the preamplifier, may be displayed at any time by placing the UDR function switch to position 8. The display shows the current value of the counter and is updated about once per second.

All units flash once per second as long as data is being received from the preamplifier. If a communications break occurs, the units will stop flashing.

All alarms and error codes are inhibited except E0007 (loop fail).

The bargraph is blanked and the analog outputs are at low scale while the auto zero counter is displayed.

Refer to "Auto Zero Failure" and "Auto Zero Set-Up" for more information on the Auto Zero Mode.

Loop Test Mode

The functioning of the preamplifier communications loop can be tested by looping +TX and -TX back to +RX and -RX on the UDR P2 connector and setting the UDR FUNCTION switch to position 9. While executing the loop test, the bargraph will light (green) from left to right as characters are sent. The numeric display will be blanked. If the test fails, the display will show E0009 and the bargraph will be red.

This test verifies proper operation of the UDR transmit/receive function, and may be used to determine if the source of a communications error is in the UDR or the preamplifier.

The test runs continuously until the UDR FUNCTION switch is moved out of position 9.

All alarms are inhibited and the analog outputs are at low scale while the loop test is running.

There is an available device as part of the 942 Test Set for use with loop tests (P/N 942TS-100-45) that is plugged into P2 to perform the interconnection function.

Alarms

The alarm functions provided by the UDR include HIGH, WARN, FAIL, and RANGE. The HIGH, WARN , and FAIL alarms drive relay contact outputs. Some operating modes of the UDR disable alarms. The user is cautioned to read and fully understand section 4.

Alarm Logic

Alarm logic defines whether alarm relay coils are energized or de-energized in normal operation.

Standard alarm reset logic for the UDR is manual reset for the HIGH, and WARN alarms, and auto reset for the FAIL and RANGE alarm.

Auto reset for HIGH and WARN alarms may be selected by jumper JP3-3.

Manual Reset

When an alarm trips, the relay coil goes to its abnormal position. The indicator flashes until the alarm is acknowledged by pressing the ALARM ACK button on the UDR. The indicator then remains steady on until the alarm condition becomes false. At that time, the alarm resets by turning the indicator off and returning the contact to its normal position.

Auto Reset

When an alarm trips, the contact goes to its abnormal position. The indicator goes steady on. When the alarm condition becomes false, the alarm automatically resets, returns the relay coil to normal position, and turns the indicator off.

Auto reset may be selected for the HIGH and WARN alarms by removing jumper JP3-3 from the UDR main board.

Standard relay operation for the UDR is fail-safe. When the unit is powered, the relay coil energizes. If power is lost to the relay coil, or an alarm condition occurs, the relay de-energizes, giving a trip indication. This logic provides fail-safe operation for the alarm function.

Non-fail safe relay operation for the HIGH and WARN alarms is available as an option.

HIGH Alarm

The HIGH alarm condition is "true" when the display dose rate is greater than or equal to the HIGH alarm set point and "false" for all other conditions.

The standard logic for the HIGH alarm is fail-safe, manual reset.

When the HIGH alarm is tripped, the red HIGH alarm indicator begins flashing, the bargraph goes to red, the HIGH alarm relay coil de-energizes, and the UDR commands the preamplifier to set its auxiliary output high. When the alarm is acknowledged, the HIGH alarm indicator goes steady on and the UDR commands the preamplifier to set its auxiliary output low. The auxiliary output on the preamplifier can be used to drive a remote alarm/alarm indicator. The HIGH alarm relay will change state when the radiation value drops below the setpoint if the alarm has been acknowledge.

The HIGH alarm is inhibited in Auto-Zero and Loop Test modes, and may be inhibited in Check Source and Maintenance modes via jumper selection.

WARN Alarm

The WARN alarm condition is "true" when the display dose rate is greater than or equal to the WARN alarm set point and "false" for all other conditions.

The standard logic for the WARN alarm is fail-safe, manual reset.

When the WARN alarm is tripped, the amber WARN alarm indicator begins flashing, the bargraph goes to amber, the WARN alarm relay coil de-energizes. When the alarm is acknowledged, the WARN alarm indicator goes steady on. With the alarm acknowledged, the relay will change state when the radiation value drops below the setpoint.

The WARN alarm is inhibited in Auto-Zero and Loop Test modes, and may be inhibited in Check Source and Maintenance modes via jumper selection.

RANGE Alarm

The underrange condition is "true" when the dose rate is below the underrange setpoint and "false" for all other conditions. The RANGE indicator illuminates, the analog output is set to zero, and the display reads 0.00 mR/h when the underrange condition is true. The bargraph will operate normally.

The underrange condition clears automatically when the detector output returns within the normal range. There is no relay contact associated with the underrange alarm.

The overrange is true when the dose rate is greater than or equal to the overrange set point or the preamplifier is sending an overrange status to the UDR. The condition is false when neither of the above conditions is true.

When the OVER RANGE alarm is active; WARN and HIGH alarms are true, the red RANGE indicator illuminates, the bargraph illuminates red, the analog output reads full scale, and the display reads EEEEE. The default overrange setpoint is 1.00E7 mR/h.

Once the radiation value is less than the setpoints, the overrange condition may be manually reset to return to normal operation. There is no relay contact associated with the overrange alarm.

FAIL Alarms

Several equipment failure conditions are monitored which produce a FAIL alarm and in some cases an error message. The fail condition is "true" whenever any equipment failure is detected and "false" when no equipment failures are detected. When a fail condition occurs, other than power failure, the red FAIL alarm indicator illuminates and the fail relay coil de-energizes.

The FAIL alarm logic is always fail-safe, auto reset.

The following are the fail alarms included in the 946A-200 UDR:

1. LOW SIGNAL Failure
2. AUTO ZERO Failure
3. HIGH VOLTAGE Failure
4. LOOP Failure (communications)
5. POWER Failure
6. MPU Failure (hardware) in either detector or UDR

Low Signal Failure

If the dose rate reported to the UDR by the preamplifier is zero for five minutes, a low signal failure is detected. A low signal alarm usually indicates a failure in the electrometer since normal leakage currents will result in a non-zero dose rate. The UDR display may read zero for five minutes or more without a low signal fail alarm. In this case, the preamplifier is reporting a dose rate that is below the underrange setpoint value. The low signal failure alarm can be disabled by removing jumper JP3-4 from the UDR main board. Error code E0011 will be displayed under the fail conditions given.

Auto Zero Failure

If the preamplifier zero offset correction is near its limit, the preamplifier notifies the UDR. Error code E0012 is displayed. The zero offset correction is related to the value of the auto zero counter which can be displayed by setting the FUNCTION switch to position 8. A value of 0 to 255 is possible. A value that is significantly different from 128 indicates that an auto zero adjustment on the electrometer board, in the preamplifier, is needed.

High Voltage Failure

The preamplifier checks the ion chamber integrity approximately every four (4) minutes by pulsing the high voltage and checking the response. This operation has no effect on the dose rate reported to the UDR. If the integrity test fails, the failure is reported to the UDR, and the UDR will display E0011.

This failure generally indicates a loss of continuity in the ion chamber or bad connections between the ion chamber and the preamplifier (cable failure). This failure will also occur if the high voltage drops to a level such that 100% collection at full scale cannot be achieved by the ion chamber. If the detector is disconnected for the purpose of inputting a test signal into the electrometer, the high voltage failure will be detected. To prevent an unwanted FAIL alarm, during testing, the Maintenance Mode previously described should be used.

Loop Failure

If the UDR does not receive a valid message from the preamplifier in ten seconds, a loop failure is detected and an E0007 code is displayed.

The loop failure can originate from bad seating of the serial communications board in the UDR, bad connections in the preamplifier, bad connections at the P2 connector of the UDR, a baud rate mismatch between the setting on the serial board and that in the preamplifier, an invalid address setting on the serial board, or blown loop fuses.

The baud rate of the preamplifier can be set to 300 or 4800 baud. SW3-1 on the 977 interface board selects 300 when in the OFF position and 4800 in the ON position. 4800 baud is the normal factory setting. The address of the serial board must be set 4040. If the wiring of the serial option board to the P2 connector is suspected, a loop test can be performed as described in "Loop Test Mode". The instruction manual for the communications loop option board (P/N 942-200-80-1) contains details on how to set up the serial board in the UDR.

Power Failure

If power is lost to the UDR, the bargraph, alarm indicators, and the display are blanked (turned off). The HIGH, WARN, and FAIL relay coils de-energize.

MPU Failure

If the fail timer circuit, which monitors the MPU function, is allowed to time out (because of a hardware failure), a failure condition will be true.

Power Up Procedure

To place the system in operation, the following steps should be performed:

1. Verify that the UDR FUNCTION switch, located on the front right section of the UDR main board, is in a position other than 8 or 9.

2. Verify that SW3-3 on the 977 interface board, located in the preamplifier enclosure, is set to the OFF position.

3. Verify that the detector, preamplifier, and UDR are properly connected.

4. Apply power to the system. If all connections are good, the UDR will come up in the Rate Mode.

NOTE

The appearance of error codes E0002 or E0008 may indicate that the setpoint memory has not been initialized. To initialize the set point memory to the default values, power-up the UDR with the ENTER button held down. (The UDR must be pulled out from its mounting to access the ENTER button).

The appearance of error code E0007 indicates a communication failure. Verify communication wiring, jumper and switch settings (refer to tables 4-3 and 4-5). Also check the communications board set-up using the instruction manual provided in Appendix A.

When the system is first powered up, the preamplifier will detect a high dose rate and pass this data to the UDR. This is the result of currents generated by turning on the high voltage to the detector, and takes several minutes to stabilize. The Overrange, High, and Warn alarms are inhibited for three minutes after power-up. The analog outputs are at low scale during this period.

5. Channel dependent set points, such as alarm limits, are to be entered using the procedure described later in this section. The UDR contains default values for all setpoints to permit power-up prior to user defined values being entered.

6. Electronic adjustments affecting calibration are factory set and should not be readjusted for initial operation unless the UDR has been in storage for more than one (1) year. If the unit been in storage for more than one (1) year, the electronic calibration described in section 5 should be performed.

How to Enter Setpoints

Available setpoints are listed in Table 4-2. The setpoints are accessed using the FUNCTION switch, the DIGIT button, the VALUE button, and the ENTER button. These are located on the main printed circuit of the UDR. The UDR must be pulled about halfway out of its rack chassis in order to access them. The buttons are on the right side of the main board about two inches behind the front panel. The FUNCTION switch is on the right side directly in front of the power supply.

To display a setpoint, rotate the FUNCTION switch to one of the positions shown in Table 4-2 and press the ENTER button. The setpoint will be displayed in exponential format with the leftmost digit flashing. Pressing the ENTER button enters whatever is displayed into the non-volatile set point memory.

To change a setpoint, the DIGIT button is pressed and released until the digit to be changed is flashing. Then the VALUE button is pressed and released until the desired value appears. This process is repeated for all digits to be changed. The sign of the exponent can assume the values "E" or "-". The former represents a positive power of 10 and the latter represents a negative power of 10.

When all digits and the exponent have been changed to their desired values, the ENTER button is pushed to enter the new value into memory. Setpoint entries not accepted by the UDR are indicated by the error code E0002 being displayed.

Table 4-2. Setpoints

Function Switch Position	Description	Default Values	Units
0	HIGH Alarm Limit	1.00E5	mR/h
1	WARN Alarm Limit	1.00E3	mR/h
2	Overrange Limit	1.00E7	mR/h
3	Underrange Limit	1.00E-1	mR/h
4	Analog Full Scale	1.00E7	mR/h
5	Calibration Factor	1.00E2	percent
7	Analog Low Scale	1.00E-1	mR/h

Setpoint Descriptions

HIGH Alarm Limit

If the display dose rate is above the HIGH alarm limit, then the HIGH alarm is tripped. The HIGH alarm limit must be greater than or equal to the WARN alarm and the underrange limit. It must be less than or equal to the overrange limit.

WARN Alarm Limit

If the display dose rate is above the WARN alarm limit, then the WARN alarm is tripped. The WARN alarm limit must be greater than or equal to the low scale value and less than or equal to the HIGH alarm limit.

Overrange Limit

If the displayed dose rate goes above the overrange limit, the RANGE alarm is tripped. The overrange limit must be greater than or equal to the HIGH, WARN, and Underrange setpoints.

Underrange Limit

If the displayed dose rate goes below the underrange limit, an underrange condition is indicated. The underrange limit must be less than or equal to the HIGH and WARN limits. Note the radiation display will be 0.00 for dose rates under the underrange limit.

Analog Full Scale

This value is the dose rate at which the analog output is 10 volts or 20 milliampers. This value must be an even power of 10 that is at least 1 decade higher than the low scale value. An even power of 10 is a number of the form 1.00EX, where E indicates a positive exponent or "-" for a negative exponent any X is an integer from -9 to +9.

Calibration Factor

The calibration factor is determined from the calibration data as the ratio of the theoretical to the actual response of the detector. The permissible values are between 70% (7.00E1) and 129% (1.29E2). A factor of 100% (1.00E2) gives no correction. The calibration factor is recorded on the calibration data sheet supplied with the detector.

Analog Low Scale

This value is the dose rate at which the analog output is at 0 volts or 4 milliamperes. This value must be an even power of 10 that is at least 1 decade less than the high scale analog output.

Set Point Error Codes

If, after entering a setpoint or upon power-up, an error code is displayed, it may be due to incorrect setpoints. If error code E0002 or E0008 is displayed, all alarms are inhibited.

Code E0001 indicates that the display value is negative. This may indicate a defective EPROM or that initialization of the unit is required. To initialize the setpoint memory to the default values, power up the UDR with the ENTER button held down. After power has been applied, release and depress the ENTER button and release again. If initializing the setpoint memory does not help, then the setpoint PROM is defective or there is a hardware malfunction.

Code E0002 indicates that the combination of setpoints violates one or more of the rules stated under setpoint descriptions. All setpoints should be checked for agreement with the setpoint descriptions.

The appearance of either code may indicate that the setpoint memory has not been initialized.

Code E0007 indicates a detector to preamplifier communications loop failure.
Code E0008 indicates that the analog output setpoints are invalid.
Code E0011 indicates a detector a high voltage power supply or cabling failure.
Code E0012 indicates an electrometer auto-zero adjustment is required.

Refer to Table 4-8 for a listing of all error codes.

Analog Output

The analog outputs are a logarithmic function of the current UDR reading. The outputs are scaled by the Full Scale Value and Low Scale Value, positions 4 and 7 respectively of the FUNCTION switch. An 8 bit DAC is used to convert the displayed dose rate to a 4-20 mA or 0-10 Vdc output on connector P6 (on the rear panel). Other outputs may be provided through the use of the Analog Output Option Board (942-200-95). Refer to the option board manual for adjustment and value selection. The option board output is also a logarithmic value. Output current or voltage is calculated using the following equations (shown below):

P = log (R/LSV)/ [log (FSV) - log (LSV)]

and

V = P (VMax - VMin) + VMin   or   I = P (IMax - IMin) + IMin

where:

P	=	Percent of scale, expressed in a decimal number
R	=	Current reading
LSV	=	Low Scale Value
FSV	=	Full Scale Value
V	=	Voltage output
I	=	Current output
VMax	=	Maximum voltage available (usually 10 Vdc)
IMax	=	Maximum current available (usually 20 mA)
VMin	=	Minimum voltage available (usually 0 Vdc)
IMin	=	Minimum current available (usually 4 mA)

If the current reading (R) is greater than the full scale value (FSV) the output is limited to the MAX value (typically 10 Vdc or 20 mA).

As an example:

Assume:	LSV	=	1E-1, FSV = 1E7, R = 1E3, IMax = 20 mA, and IMin = 4 mA.
Then:	P	=	[log (1E3/1E-1)] / [log (1E7) - log (1E-1)]
		=	log (1E4) / log (1E8)
		=	4/8 = 0.5
and:	I	=	0.5 (20 mA - 4 mA) + 4 mA
		=	0.5 (16 mA) + 4 mA
		=	12 mA

To aid in calibrating the analog output, the high scale or low scale setpoint may be set to zero to force the output high or low. If the low scale setpoint is set to zero, the analog output goes to low scale. If the high scale value is set to zero, the analog output goes to full scale. If both are set to zero, the output goes to full scale. Error code E0008 will be displayed if either setpoint is set to zero. The procedure for calibrating the analog outputs is contained in Section 5.

Victoreen Communications Loop

Communication between the detector preamplifier and the UDR is performed via a Victoreen loop, a serial asynchronous communications interface. The communication utilizes Victoreen protocol and is intended for use in electrically hostile environments where high noise immunity is required. Noise immunity is achieved using differential line driving, and electrically isolating the end of each transmit/receive pair with opto-isolators. Using a ±15 Vdc communications power supply, each 0 to 1 transition is equivalent to a 30 volt swing in loop voltage. Refer to the Model 942-200-80-1 Communications Board instruction manual located in Appendix A for further information.

Preamplifier Switch & Jumper Settings

Switch and jumper settings for the preamplifier are summarized in Table 4-3, 4-4, and 4-5.

Table 4-3. Preamplifier Interface Board 977-210-10 Switch Settings

Switch	Normal Op.	Switch Function
SW3-1	ON	0/OFF Selects 300 baud • 1/ON Selects 4800 baud (normal setting)
SW3-2	OFF	0/OFF Selects alarm inhibit, SW3-3 must be on for this state to be true. 1/ON Selects alarm enable
SW3-3	OFF	0/OFF Selects Rate Mode (normal) • 1/ON Selects Maintenance Mode
SW3-4	OFF	0/OFF forces 977 analog output to 0 V (low scale) (SW3-3 must be on for state to be true) 1/ON forces 977 analog output to 10 V (SW3-3 must be on for state to be true)

NOTE

The above switches are located in a 4 position dip switch on the 977 interface board (977-210-10).

Table 4-4. Jumper Positions for Preamplifier Interface Board 977-210-10

Jumper	Normal Setting	Function	Alternate Setting	Function
JMP1	A to B	Enables Victoreen Loop (normal)	B to C	Enables RS232C
JMP2	N/A	Deleted, Not Used	N/A	Deleted, Not Used
JMP3	A to B	Enables Alarm Output - Non-Failsafe	B to C	Enables Alarm Output Failsafe
JMP4	A to B	Enables 0 - 10 Vdc Analog Output (normal)	B to C	Disables Analog Output (stays at 10 Vdc)
JMP5	B to C	Enables HV Output (normal)	A to B	Disables HV Output

Table 4-5. Jumper Positions for Preamplifier Electrometer Board 977-200-15

Jumper	Normal Setting	Function	Cal. Position	Function
JMP1	A to B	Normal Operation	B to C	PGA Offset Adjust *

* Programmable Gain Amplifier

Digital Ratemeter Configuration Options

The UDR contains a series of five hardware jumpers and up to seven user specified set points which affect operation of the unit.

The jumpers are designated as JP3-1 through JP3-5. Refer to the main circuit board assembly drawing located in Appendix B of this manual for JP3 locations. The functions affected by JP3 are described in the following paragraphs.

UDR Switch & Table Settings

Jumper and switch settings for setpoint selection for the UDR are summarized in Tables 4-6 and 4-7, while error codes are listed in Table 4-8.

Jumper Selectable Options

NOTE
The unit must be turned off when changing jumpers.

Refer to Table 4-6 for a list of option jumpers and their functions.

With jumper JP3-3 (Alarm Automatic Acknowledge) installed, the operator is required to acknowledge the HIGH and WARN dose rate alarms. With the jumper removed, the HIGH and WARN alarm will be automatically acknowledged and will be cleared when the dose rate falls below the setpoint.

With jumper LP3-4 (Enable Fail Alarm) installed, the 5-minute low signal Fail Alarm is enabled. With the jumper removed, the 5-minute low signal Fail Alarm is disabled. Note that other conditions which cause a Fail Alarm are not affected by this jumper setting.

Table 4-6. Model 946A-200 Option Jumpers

Jumper	Function	Norm Position	Operation
JP3-1,	Not Defined	in	Not Applicable
JP3-2	Not Defined	in	Not Applicable
JP3-3	Alarm Reset Select	in	Manual reset with jumper installed Auto reset with jumper removed
JP3-4	Fail Alarm Enable	in	Fail alarm enabled with jumper in Fail alarm disabled with jumper out
JP3-5	Check Source Alarm Mute	in	Alarms disabled during C/S with jumper in Alarms enabled during C/S with jumper out

UDR Function Switch / Function

Table 4-7 shows the UDR Function Switch positions and their function.

Table 4-7. UDR Function Switch Positions/Function

Switch Position	Function
0	Selects HIGH Alarm Setpoint
1	Selects WARN Alarm Setpoint
2	Selects Overrange Limit
3	Selects Underrange Limit
4	Selects Analog Full Scale
5	Selects Calibration Factor
7	Selects Analog Low Scale
8	Selects Auto Zero Display Mode
9	Selects Loop Test Mode

Error Codes

The error code for the 946A-200 UDR are listed in Table 4-8.

Table 4-8. Model 946A-200 Error Codes

Error Codes	Function	Reference Section
E0001	Negative display data	Setpoint Error Codes
E0002	Invalid setpoint value (s)	Setpoint Error Codes
E0007	Loop time out	Communication Loop Failure
E0008	Invalid analog scale values	Setpoint Error Codes
E0009	Loop test failure	Loop Test Mode
E0011*	High voltage failure	Fail Alarms
E0012*	Auto zero correction failure	Fail Alarms

* These error codes always indicate a detector failure.

Preamplifier/UDR Diagnostic LED Indicators

977-210 Detector/Preamplifier

The LEDs listed below are located on the 977-210-10 Communication/Interface board. This is the larger of the two circuit boards in the detector assembly.

Designator	Function / Status Indicated
LED 1	+15 VDC is being supplied to the detector from the UDR when ON
LED 2	ON (bright): both + 15 and -15 volt loops present ON (dim): Only one loop supply present OFF: no loop voltage from either supply
LED 4	HV is being generated when LED is ON. No HV supply when LED is OFF
LED 5	+12 VDC is being supplied to the HV driver when LED is ON. +12 VDC is not present to the HV driver when LED is OFF

NOTE: There is no LED 3 installed on the circuit board

946A-200 UDR

The sole diagnostic LED in the UDR is CR10, located on the 942-200-80 Communications Interface Board. When CR10 is ON (bright), both the +15 and -15 loop voltages are present at receive. A dim CR10 indicates only one supply is present. CR10 is OFF indicates that no loop supplies are present at the receive terminal.

Functional Description

Detector and Preamplifier

The wide range ion chamber detector block diagram is shown in figure 4-1. Detector electronics are contained within two circuit board assemblies located in the preamplifier enclosure: the 977-210-10 High Voltage/Communications Interface circuit board assembly and the 977-200-15 Electrometer circuit board assembly. Schematic diagrams are located in Appendix B.

The 977-200-15 Electrometer circuit board contains the microprocessor, the EPROM, the integrating electrometer, the programmable gain amplifier, the analog to digital (A/D) converter, and the auto zero DAC circuit.

The 977-210-10 High Voltage/Communications Interface circuit board contains the dc voltage regulator, the high voltage power supply, the BDC/DC converter, the asynchronous communication interface adapter (ACIA), the Victoreen communication loop driver/receiver, the RS232 communications driver/receiver, the local 0 - 10 Vdc analog output, the local 0 / - 12 Vdc alarm output, and the communication loop fuses.

Refer to the electrometer schematic 977-200-18 located in Appendix B. Z7 is a Texas Instruments TMS 70C00 microprocessor, which is utilized to control detector operation. Z8 latches port C of the microprocessor to form the lower order bits of memory address. Z10 is a 27C64 EPROM containing the operational firmware for the detector. Z18 is an optional RAM socket which is not utilized for this model detector. Z9 is a decoder for the upper order address bits. Z11 is a latch used to store control bits to select the gain of the programmable gain amplifier formed by the combination of Z5, Z4, and RN2. Available gains are 1 through 128 in binary increments 1, 2, 4, . . . 128. Z3 is an eight bit analog to digital converter used to digitized the output of the programmable gain amplifier. Analog switch Z17 pin 11 selects either the integrating electrometer or the high voltage sense line as the input to the programmable gain amplifier. Refer to Table 4-9 for preamplifier register addresses and Table 4-10 for electrometer control bit assignments.

Table 4-9. Preamplifier Register Addresses

Function	**Hex Address**
Electrometer Control	2000
ADC Convert CMD	4000
ADC Read Data	6000
ACIA T/R Data	A000
ACIA Status Register	A001
ACIA Command Register	A002
ACIA Control Register	A003
Input SW3	A008
RAM (not used)	C000-DFFF
EPROM	E000-FFFF

Table 4-10. Electrometer Control Bit Assignments

Bit Position								
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Description**
X	X	X	X	X	0	0	0	Gain = 1
X	X	X	X	X	0	0	1	Gain = 2
X	X	X	X	X	0	1	0	Gain = 4
X	X	X	X	X	0	1	1	Gain = 8
X	X	X	X	X	1	0	0	Gain = 16
X	X	X	X	X	1	0	1	Gain = 32
X	X	X	X	X	1	1	0	Gain = 64
X	X	X	X	X	1	1	1	Gain = 128
X	X	X	X	0	X	X	X	Unshort capacitor
X	X	X	X	1	X	X	X	Short capacitor
X	X	X	0	X	X	X	X	Digitize electrometer
X	X	X	1	X	X	X	X	Digitize high voltage

X = Bit position does not matter (1 or 0)

The integrating electrometer is formed by the combination of current source Z6, dual MOSFET Q4, operational amplifier Z12, transistor Q3, and analog switch Z17, pin 15.

Counter Z15 and ladder network RN3 form the auto-zero portion of the integrating electrometer. Refer to section 5 for auto-zero adjustment instructions.

Dual MOSFET Q4 acts as a low leakage input buffer to the electrometer. C17 is an integrating capacitor, while Z17, pin 15 and Q3 are the shorting elements of the integrator.

Refer to High Voltage/Communications Interface, P/N 977-200-15, schematic diagram 977-210-13 in Appendix B. U12 is an asynchronous communications interface adapter (ACIA) which communicates with the UDR. U1 is an analog switch used to select either the Victoreen loop or the RS232 driver/receiver for external communications. Optical isolation U10 isolates data transmitted on the Victoreen loop while the circuitry comprised of Q6, Q7, Q14, and Q18 are the actual loop drivers. Optical isolator U8 isolates the receive data from the Victoreen loop.

U2 and U3 are, respectively, the receiver and driver circuits for the RS232 port. U14 decodes address block A000 to provide chip enables to the ACIA switch input register U6.

Power for the detector, analog, and digital outputs is derived from three terminal regulators VR3 and VR4. The ±5 Vdc logic power is derived from the three terminal regulators VR1 and VR2. Regulator VR5 provides +12 Vdc for the high voltage power supply. Operational amplifier U5, transformer TX1, and transistors Q21 & Q23 form the high voltage power supply. Nominal operating point voltage for the power supply is 500 Volts. Transistor Q3 is a switch under control of port bit B2 of the microprocessor. This switch is toggled to induce a pulse on the high voltage output, activating current flow due to the capacitance of the ion chamber. This operation occurs during the check source mode and during integral cable check.

Power for the detector is normally provided by the electronic high voltage power supply (jumper 5 in position B to C). However, high voltage can be supplied to the detector by connecting battery terminals 1 (+) and 2 (-) of J7, and placing jumper 5 in the A to B position.

The high voltage board has a 100 to 1 voltage divider circuit which permits monitoring high voltage through operational amplifier U15 on TP5 with an ordinary voltmeter (10 Meg impedance), without loading down the high voltage circuit or requiring the use of a high impedance probe. The high voltage adjustment is provided by R118. Refer to section 5 for adjustment instructions and precautions.

The following LEDs are provided to indicate operation of certain functions of the 977-210-10 board:

LED #	**Indicates**
LED1	The presence of +15 Vdc supplied to the circuit board from the UDR
LED2	Communications - Receive
LED4	Regulated +12 Vdc is supplied to the electronic high voltage circuit
LED5	High voltage is present at J6

Test points are provided on the high voltage board as follows:

Test Point	**Function**
TP3	High Voltage 1:1
TP4	DC Ground
TP5	High voltage divided by 100

NOTE
TP1 and TP2 are not installed on the 977-210-10 circuit board.

A 0 - 10 Vdc analog output signal is obtained from an 8 bit D/A converter U7 and operational amplifier U11. JMP4 controls the operation of the analog output. This output is normally used to drive a local meter or display. The analog output is logarithmic.

Transistors Q13, Q101, Q103, and Q102 are used to provide a -15 Vdc output voltage to drive a local alarm. The normal state of the output (energized or de-energized) is selectable via jumper JMP3.

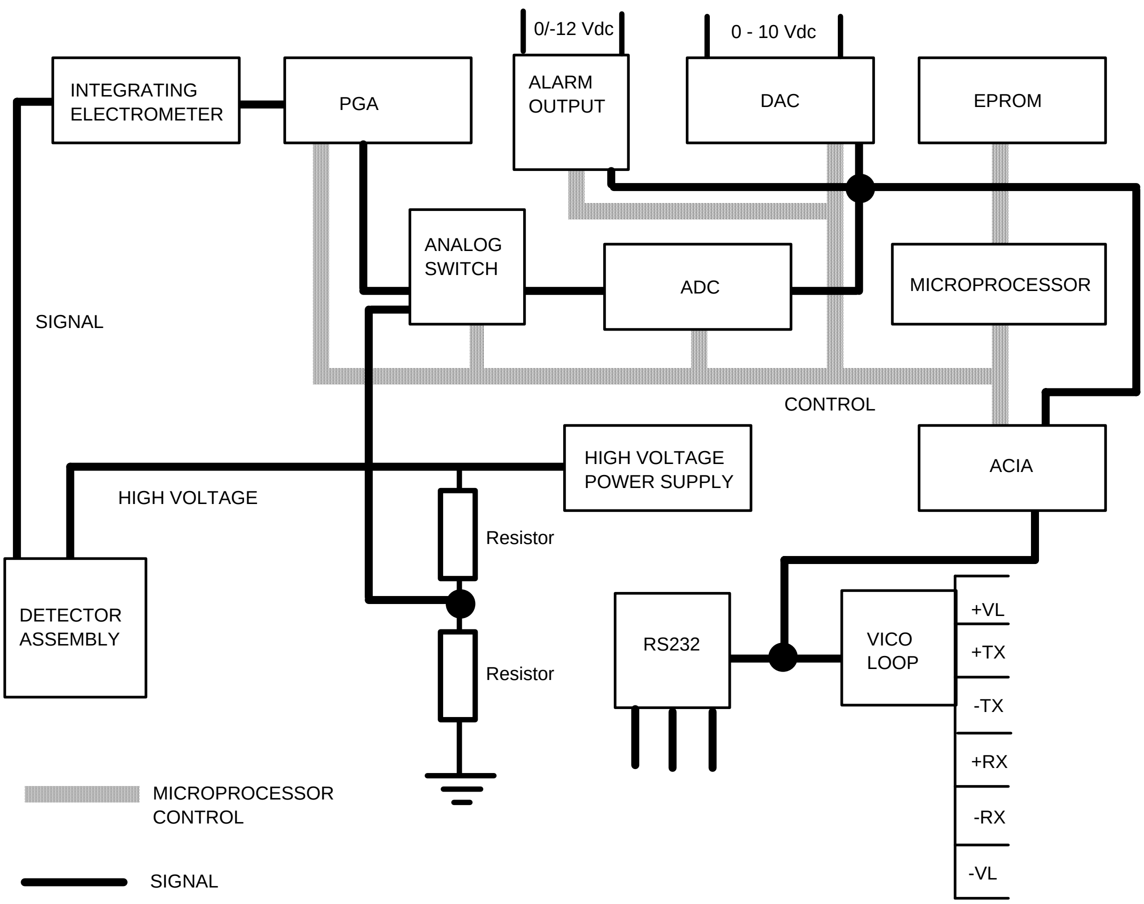


Figure 4-1. Detector Electronics Block Diagram

Universal Digital Ratemeter (UDR), Model 946A-200
The Model 946A-200 UDR is composed of five (5) circuit board assemblies mounted within the unit. These circuit boards provide input/output, display, power, and control for the UDR. Each circuit board is described in detail in the following sections and accompanied by a block diagram where applicable. Schematic diagrams are located in Appendix B.

Main Circuit Board

The main circuit board contains the microprocessor, memory, standard analog outputs, and control circuitry. The following paragraphs explain the operation of the circuits in detail. Figure 4-2 is a block diagram of the main circuit board.

Microprocessor

The 6802 /6808 (U15) is a monolithic 8 bit microprocessor with 16 bit memory addressing. The 6802 / 6808 contains a crystal controlled internal clock oscillator and driver circuitry.

A 4 MHz crystal is utilized with the internal clock circuitry to obtain 1 MHz operation. The (E) enable pin on the MPU supplies the clock for both the MPU and the rest of the system. Figure 4-3 is a typical timing diagram for write and read cycles.

The read/write output signals the memory / peripherals that the MPU is in a read (high) state or a write (low) state. The normal standby state is read (high).

The valid memory address (VMA) output indicates to peripheral and memory devices that there is a valid address on the address bus.

The address bus outputs (A0 - A15) provide for addressing of external devices.

The data bus (D0 - D7) is bi-directional and is used for transferring data between the MPU and memory/peripheral devices. The data bus will be in the output mode for a write cycle and in the input mode for a read cycle.

The Interrupt Request Input (IRQ), when low, requests that an interrupt sequence be generated within the MPU. The processor will wait until it completes the current instruction that is being executed before it recognizes the request. Various internal registers are stored on the stack before a branch to the interrupt vector is carried out. When the interrupt routine has completed, the registers are restored and the MPU continues to execute the program. The IRQ input is not utilized on the main circuit board, however, it is provided to the external bus connector to be used by IRQ generating devices located on the option boards.

The reset input (active low) is used to restart the MPU from a power down condition, (restart from a power failure or an initial start-up). A manual detector MPU reset is also provided via SW2, on the 977-210-10 board. A low to high transition on this input signals the MPU to begin the restart sequence.

The non-maskable interrupt (NMI) input, upon detection of a low-going edge, requests that a nonmaskable interrupt sequence is generated within the MPU. As with the interrupt request signal, the processor will complete the current instruction being executed before it recognizes the NMI signal. Various internal registers are stored on the stack before a branch to the NMI vector occurs. Upon completion of the NMI routine, the internal registers are restored and program execution continues.

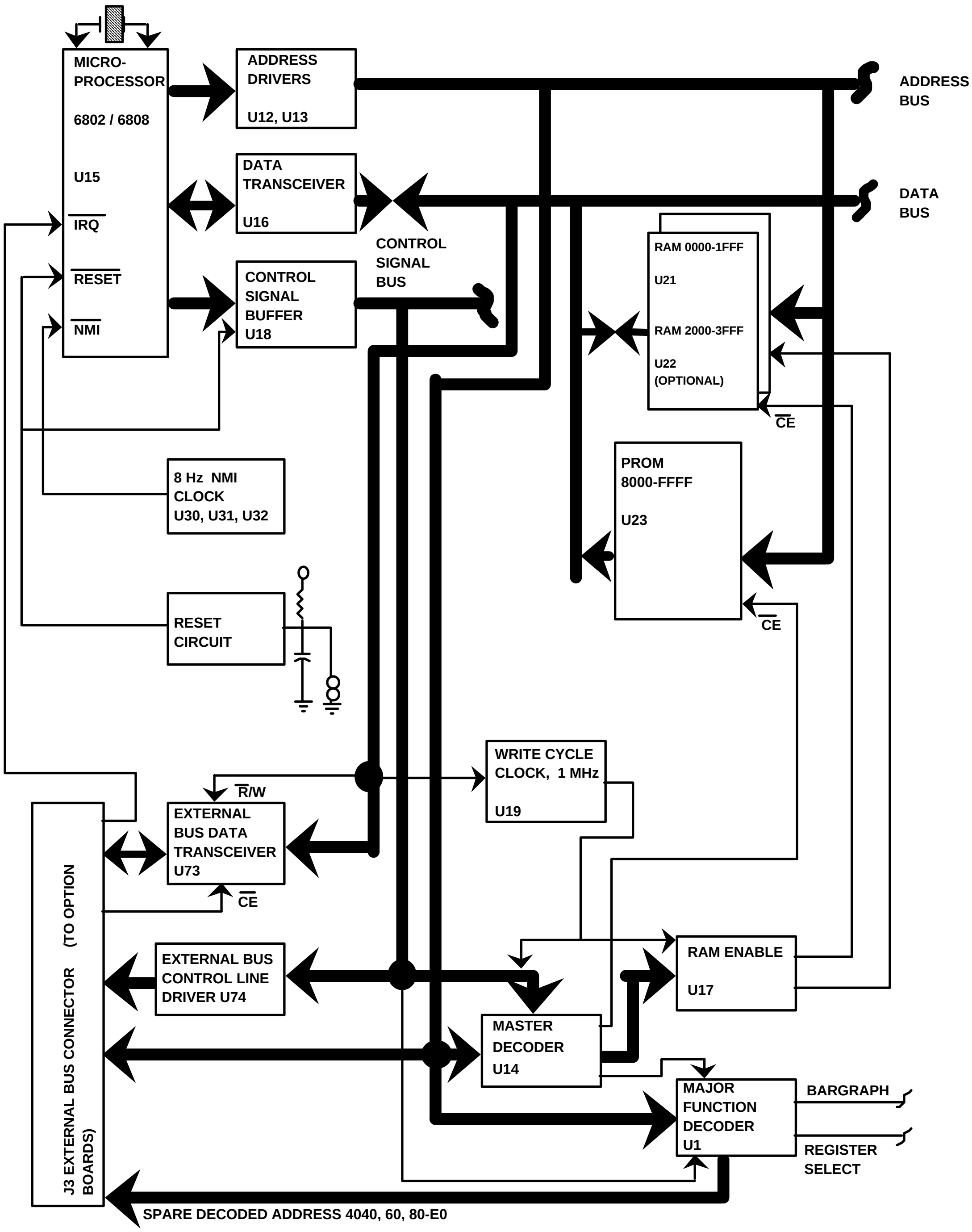


Figure 4-2. Page 1 of 3. Block Diagram - Main Circuit Board

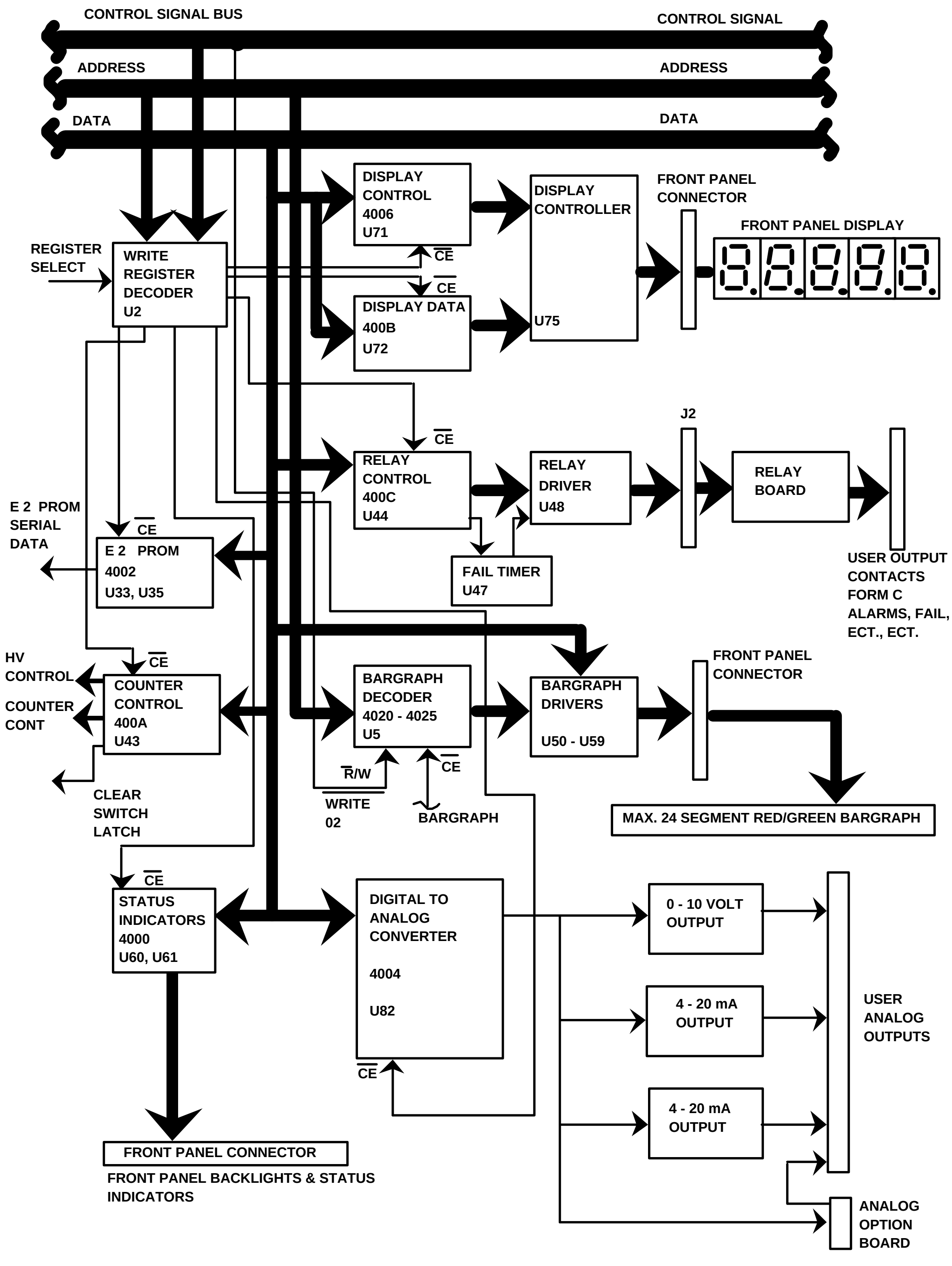


Figure 4-2. Page 2 of 3. Block Diagram - Main Circuit Board

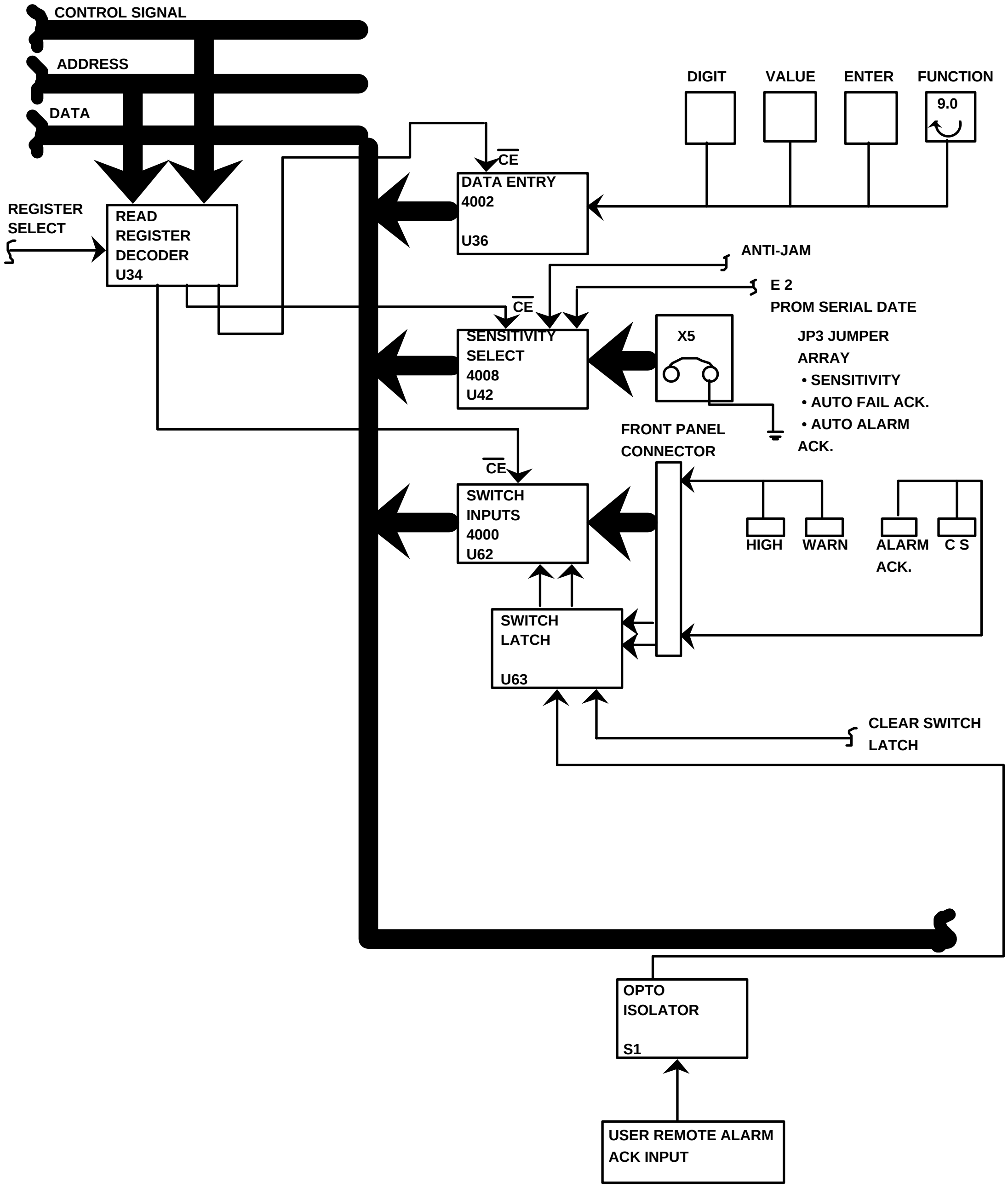
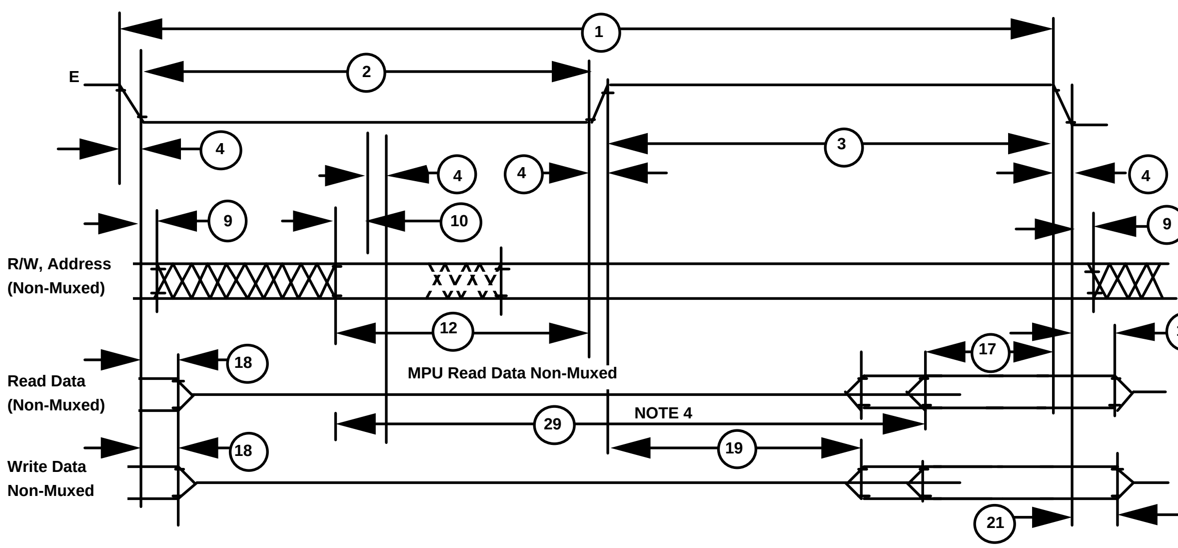


Figure 4-2. Page 3 of 3. Block Diagram - Main Circuit Board

Bus Timing Characteristics

Ident. Number	Characteristics	Symbol	MC6802NS MC6802 MC6808		MC68A02 MC68A08		MC68B02 MC68B08		UNIT
			Min	Max	Min	Max	Min	Max	
1	Cycle Time	t_{cyc}	1.0	10	0.667	10	0.5	10	µs
2	Pulse Width, E Low	PW_{EL}	450	5000	280	5000	210	5000	ns
3	Pulse Width, E High	PW_{EH}	450	9500	280	9700	220	9700	ns
4	Clock Rise and Fall Time	t_r, t_f	- - -	25	- - -	25	- - -	20	ns
9	Address Hold Time	t_{AH}	20	- - -	20	- - -	20	- - -	ns
12	Non-Muxed Address Valid Time to E (See Note 5)	t_{AV1} t_{AV2}	160 - - -	- - - 270	100 - - -	- - - - - -	50 - - -	- - - - - -	ns ns
17	Read Data Setup Time	t_{DSR}	100	- - -	70	- - -	60	- - -	ns
18	Read Data Hold Time	t_{DHR}	10	- - -	10	- - -	10	- - -	ns
19	Write Data Delay Time	t_{DDW}	- - -	225	- - -	170	- - -	160	ns
21	Write Data Hold Time	t_{DHW}	30	- - -	20	- - -	20	- - -	ns
29	Usable Access Time (See Note 4)	t_{ACC}	605	- - -	310	- - -	235	- - -	ns



NOTES:
1. Voltage levels shown are $V_L \leq 0.4$ V, $V_H \geq 2.4$ V, unless otherwise specified.
2. Measurement points shown are 0.8 V and 2.0 V, unless otherwise noted.
3. All electricals shown for the MC6802 apply to the MC6802NS and MC6808, unless otherwise noted.
4. Usable access time is computed by: 12 + 3 + 4 - 17.
5. If programs are not executed from on-board RAM, TAV1 applies. If programs are to be stored and executed from on-board RAM, TAV2 applies. For normal data storage in the on-board RAM, this extended delay does not apply. Programs cannot be executed from on-board RAM when using A and B parts (MC68A02, MC68A08, MC68B02, MC68B08). On-board RAM can be used for data storage with all parts.

Figure 4-3. Read / Write Timing Diagram

Reset Circuitry

The reset circuit generates a 650 ms wide low pulse to the MPU reset input and various external registers. The R1 / C1 network generates a delayed trigger pulse to the U10 multivibrator. Upon power up, C1 charges through R1. When approximately 1.4 volts is reached, U11-8 goes low, triggering U10. U10-4 goes low, U10-13 goes high; this condition is held for 650 ms. When U10's delay is complete, U10-4 returns high and U10-13 returns low. The low to high transition on U10-4 signals the MPU to begin a reset sequence. JP1 - Reset Pins, on the circuit board, may be shorted to initiate an MPU reset for troubleshooting purposes.

Clocks

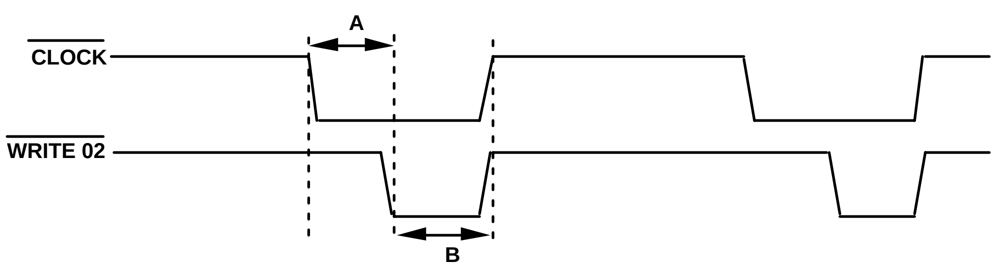
The system clock is generated by the MPU using a 4 MHz crystal, CR1. The system clock, from which others are derived, is an output on the MPU pin 37 and operates at 1 MHz.

NMI Clock

The NMI clock is generated by U30, U31, and U32, which are dual decade counters. The 1 MHz system clock is applied to the U30-1 input. U30 is a divide by 100 counter, while U31 is a divide by 50 counter, with respect to the input frequency. Therefore, U30-9's output is 10 kHz and U31-9's output is 200 Hz. U32 is connected for operation as a divide by 25 counter, which produces an 8 Hz output on U32-9.

Write Cycle Clock

The Write Cycle Clock is generated by U19. The 1 MHz system clock is applied to the U19-2 input, which is adjusted via VR13 for a 225 nanosecond delay from the falling clock edge. The second stage of U19 produces a 225 nanosecond output pulse width. Figure 4-4 is the timing diagram for the write cycle clock. Signals short 02 and short 02 are buffered by U18 to produce write 02 and write 02 which are used by the system.



A. 225 ns minimum B. 235 ns typical

Figure 4-4. Write Cycle Clock Timing Diagram

Address Drivers

Line drivers U12 (low order addresses) and U13 (high order addresses) provide signal buffering and capability to drive 15 TTL's unit loads for the address bus. The output drives are all internal devices utilizing address signals on the main circuit board as well as the J3 option interface bus connector for additional circuit boards.

Data Transceivers

Data transceiver U16 is an octal tri-state bi-directional transceiver which provides drive capability to the data bus. The MPU data I/O signals are connected to U16 "A" ports. U16 "B" ports drive the data bus under control of the read/write signal. When U16-11 is low, data is transferred from the "B" ports (internal bus) to the "A" ports (MPU data). When U16-11 is high, data is transferred from the "A" ports (MPU data) to the "B" ports (internal bus) during a write cycle.

Data transceiver U73 provides buffer and drive capability to the external data bus interface, available for optional circuit boards on J3. Data direction is controlled by the read/write line on U73-11 providing U73-9 (bus enable) is low, which enables port to port data transfer to occur. The bus enable signal is generated by the option board/boards when they are addressed by the MPU. When U73-11 is low, for a read cycle, data is transferred from the external bus to the internal bus. When U73-11 is high, for a write cycle, data is transferred from the internal bus to the external bus.

Control Signal Buffer

Line driver U18 provides a signal drive for all system control signals and clocks utilized by circuitry within the main circuit board.

Line driver U74 provides the drive for control lines and clock signals for external circuitry utilizing the J3 option interface connector.

Address Decoding

The master decoder (U14) is an open-collector 32 x 8 bit bipolar PROM. Address lines A15, A14, A13, and A12 as well as read/write are used to decode memory and I/O addresses in 4K hex blocks. Table 4-11 lists the output signals from U14.

Table 4-11. Output Signals (U14)

U14 Pin	Signal Name	Address	Read/Write
9	$\overline{\text{PROM 8000}}$	8000-FFFF	Read Only
7	Spare	Spare	
6	$\overline{\text{RAM 2000}}$ *(future)*	2000-3FFF	Read/Write
5	$\overline{\text{RAM 0000}}$	0000-1FFF	Read/Write
4	$\overline{\text{I / O}}$	4000-4FFF	Read/Write
3	$\overline{\text{RAM Write}}$	0000-3FFF	Write Only
2	$\overline{\text{RAM Read}}$	0000-3FFF	Read Only
1	$\overline{\text{5000 Block}}$	5000-5FFF	Read/Write

PROM 8000 directly drives the enable pins of the PROM. RAM 0000, RAM 2000 and RAM Read are logic OR'd with Clock from U17. RAM Read drives the RAM output. Enable pins RAM 0000 and RAM 2000 act as chip enables for the appropriate RAM. RAM Write is logic OR'd with Write 02 by U17, which is connected to the write enable pins on the rams. The 5000 Block output signal is applied to driver U74 and connect to J3, the optional interface connector.

The I/O output signal is applied to major function decoder U1 which is a 1 of 8 decoder. U1 utilizes address lines A5, A6, A7, and A8 as well as Clock to generate outputs which are decoded in 32 hex blocks starting at address 4000. Table 4-12 lists U1 outputs, their functions and addresses.

Table 4-12. U1 Outputs

Address State A8 A7 A6 A5	Address	Function
0 0 0 0	4000	Register Select
0 0 0 1	4020	Bargraph
0 0 1 0	4040	ACIA (Communication Interface)
0 0 1 1	4060	SCA (Analyzer)
0 1 0 0	4080	GPIB (General Purpose Interface Bus)
0 1 0 1	40A0	(Spare)
0 1 1 0	40C0	(Spare)
0 1 1 1	40E0	(Spare)

Address 4000 is further decoded by the write register decoder (U2) and the read register decoder (U34). The bargraph output, address 4020, is further decoded by U5. The remaining output address (4040 through 40E0) are provided to the optional interface connector for use by external option circuit boards.

PROM

The Programmable Read Only Memory is typically a 27256 which is a UV erasable 32K x 8 bit PROM. U23, which responds to address 8000-FFF, is always present. U23 contains the operating program for the UDR (firmware). Jumper JP2 is normally set from 2 - 3. By setting JP2 from 2 - 3, A14 is applied to pin 27 of U23 which allows the use of a 27256 PROM (32K x 8).

RAM

Dynamic Random Access Memory (U21) is utilized for temporary data storage. U21 responds to address 0000-1FFF (8K x 8 bit). Data stored in the RAM is lost on power down since this data is not backed up by battery power.

E^2

Sixteen (16) monitor specific, operator entered setpoints are stored in 64 bytes of electrically erasable memory (E^2). U33 provides storage for the setpoints (256 bytes max.). The 16 setpoints are loaded serially into RAM memory (U21) upon power up. U35 is an 8-Bit control register for the setpoints. Setpoint values stored in the (E^2) are retained during power-down.

Read - Write Cycles

A read cycle is performed by sequencing RAM 0000 and RAM Read, while RAM Write is held high (inactive). The address (A0 - A12) are latched by the failing edge of RAM 0000. Data becomes valid approximately 250 ns later.

A write cycle is performed by sequencing RAM 000 and RAM Write, while holding RAM Read high (inactive). Identical to the read cycle, the address (A0 - A12) are latched by the falling edge of RAM 000. Data is strobed into RAM on the failing edge of RAM Write.

Write Register Decoding

Decoding for write registers within the main circuit board is performed by U2, which is a 1 of 8 decoder. Control signals for U2 are Reg. Select, R/W (active high), Write 02 as well as addresses A1, A2, and A3. U2 decodes two addresses per output, starting at 4000, and ending with 400E. These outputs are active low. Table 4-13 lists write registers, their assigned function and address.

Table 4-13. Write Register Functions

Address State			Hex Address	Function
A3	A2	A1		
0	0	0	4000	Status Indicators
0	0	1	4002	E^2 PROM
0	1	0	4004	D/A Converter
0	1	1	4006	Display Control
1	0	0	4008	Display Data
1	0	1	400A	Counter Control
1	1	0	400C	Relay Control
1	1	1	400E	(Spare)

Counter Control (Write Only)

The counter control register (U43) is an 8 bit register with clear, and responds to address 400A. Upon initial power-up, the system resets all outputs low. Table 4-14 lists the counter control register write functions.

NOTE

Data written into U43 remains at the outputs until a reset occurs or new data is written.

Table 4-14. Counter Control Register Write Functions

Data Bit	Function
D0	Counter Clear
D1	Counter Enable
D2	Not Used
D3	Not Used
D4	Clear Switch Latch
D5	Not Used
D6	Not Used
D7	Not Used

Relay Control Register (Write Only)

The Relay Control Register (U44) is an 8 bit register with clear, and responds to address 400C. Upon initial power-up, the system reset signal sets all outputs low. Data written into U44 remains at the outputs until a reset occurs or new data is written. Table 4-15 lists relay control write functions.

Table 4-15. Relay Control Register Write Functions

Data Bit	Function
D0	Fail Relay and Indicator
D1	Check Source Relay
D2	Warn Relay
D3	Alarm Relay
D4	Rate-of-rise Relay (not used)
D5	Remote Indicator

With the exception of the fail bit (D0), all outputs are applied to U48, which is an inverting open collector driver. The outputs of U48, including fail, drive (via the J2 connector) mechanical relays located on the relay board. The fail bit is used as an input to U47-3 which, when set high-low-high once per second, causes output U47-6 to remain low. Should this high-low-high sequence fail to occur (under MPU control), U47 will time out and set U47-6 high, causing the fail indicator on the panel and the fail relay to de-activate.

Bargraph (Write Only)

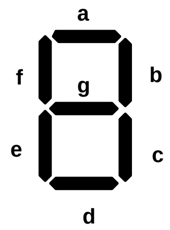
The bargraph addresses are decoded by U5, which is a 1 of 8 decoder. Control line inputs to U5 are R/W, Write 02, and Bargraph. When the bargraph address is selected (4020-4025), U5 further decodes the addresses listed in Table 4-16.

Table 4-16. Bargraph Write Address

Address State A3 A2 A1	Hex Address	Function	Driver
0 0 0	4020	Green 1-10	U55, U56
0 0 1	4021	Green 11-20	U57, U58
0 1 0	4022	Green 21-24	U59
0 1 1	4023	Red 1-10	U50, U51
1 0 0	4024	Red 11-20	U52, U53
1 0 1	4025	Red 21-24	U54

The outputs of U5 drive the latch enable pins on U50-U59 in pairs as shown in Table 4-16. U50-U59 are BCD-to-7 segment latch/decoder/drivers. Each drives five segments (either red or green) with the exception of U54 and U59 which drive four segments each. BCD to bargraph decoding is accomplished by latching data into the appropriate device to turn on the required bargraph segments. Segment decoding is shown below:

Typical 7 - Segment



BCD Character

LED 1 OF 5 =	**1**
LED 2 OF 5 =	**7**
LED 3 OF 5 =	**3**
LED 4 OF 5 =	**9**
LED 5 OF 5 =	**8**
NONE =	**A = F**

Assume that all bargraph segments are off. Example: Write hex data 38 to bargraph address 4020. Data 38 is stored, low byte (8) in U55 and high byte (3) in U56. Data (8) in U55 causes the code for an 8 to be output, which drives all output segments. The result is that the first five green LEDs turn on. Data (3) in U56 causes the code for a 3 to drive segments 1,2, and 3 connected to that device. The result is that the first 3 of 5 segments associated with U56 will turn on green.

Status Indicators (Write Only)

The status register (U60) is an 8 bit register with clear, and responds to address 4000. Data written into U60 remains at the outputs until a reset occurs or new data is written. Upon initial power-up, the system reset signal sets all outputs low. The status indicator write functions are listed in Table 4-17.

Table 4-17. Status Indicator Write Functions

Data Bit	Function
D0	Check Source Indicator
D1	Rate-of-Rise (when applicable)
D2	Overrange Indicator
D3	Warn Indicator
D4	High Alarm Indicator
D5	R/hr Backlight
D6	KR/h Backlight
D7	mR/h Backlight

U60 output's, when high, control U61 inverter/driver to activate the appropriate front panel status indicators. U60 output's, when low, control U61 to deactivate the appropriate front panel status indicators.

Display Control (Write Only)

Registers U71 and U72 are used to control and display data on the front panel 7-segment displays. Five digits are used along with two spare digit drive signals. The display control register (U71) is an 8 bit register, utilizing four data bits (D0-D3). The display data register (U72) is also an 8 bit register utilizing five data bits (D0-D4). Both U71 and U72 outputs are reset (low) upon initial power-up.

U71 is used to select the digit to be written as well as to set the WRITE bit input to U75, the display controller. U72 is used to enter the data to be written and a decimal point for the selected digit.

U75 is a universal eight digit 7-segment LED driver controller used with common anode devices. Address inputs (A0-A2), supplied by U71, are used to select the digit as shown below:

A2	A1	A0	Selects
0	0	0	Digit 1
0	0	1	Digit 2
0	1	0	Digit 3
0	1	1	Digit 4
1	0	0	Digit 5

7 - Segment Front Panel Display

Digit 5 **Digit 4** **Digit 3** **Digit 2** **Digit 1**

Data inputs D0-D3 and the decimal point, supplied by U72, are used to enter data in the selected digit as shown in Table 4-18.

Table 4-18. Hex Data (Written to Address 4008)

Hex Data	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Display Character	0	1	2	3	4	5	6	7	8	9	-	E	H	L	P	(blank)

The display controller contains all necessary circuitry including address decoding, static RAM, and multiplex oscillator for interdigit blanking.

Digital to Analog Converter and Output Circuitry (Write Only)

The D/A converter (U32) is an 8 bit buffered multiplying device which responds to address 4004. Data is written and latched by U82 when CS and WR are active (low). The converter is configured for unipolar operation with a voltage reference of + 10 VDC. Below is the digital to analog conversion table with the voltage measured at U82-1 referenced to ground.

MSB LSB	Analog Output
1111 1111	- 10 VDC
1000 0000	- 5 VDC
0000 0001	- 0.039 V
0000 0000	0 V

U81 operational amplifier 1 buffers the converter output to drive the three analog output circuits. This voltage is also provided to J4, analog option connector. J4 is provided with the necessary supply voltages to configure a custom analog output range for special applications (i.e. 10 mV to 50 mV). U81 operational amplifier 3 provides the user with a 0 - 10 volt analog output. VR1 is the zero adjustment and VR2 is the gain adjustment for the 0 - 10 volts output.

The circuitry comprised of U80 operational amplifiers 1 and 2, as well as U81 operational amplifier 2, provides a 4 - 20 mA user output. VR7 is adjusted to obtain a 4 mA reading on the output, and VR4 is adjusted to obtain a 20 mA reading on the output. U81 operational amplifier 2 and Q1 are configured as a constant current source controlled by the output of U80 operational amplifier 1. The positive feedback circuitry, comprised of R41 and R43, ensures that the output current will remain constant regardless of the output load impedance. The maximum load impedance is 500 ohms.

The circuitry comprised of U80 operational amplifiers 3 and 4 as well as U81 operational amplifier 4 provides a second 4 - 20 mA user output. Operation is identical to the circuitry previously described in this section. VR6 is adjusted to obtain a 4 mA reading at the output and VR5 is adjusted to obtain a 20 mA reading at the output.

Read Register Decoding

Decoding for READ registers within the main circuit board is performed by U34, which is a 1 of 8 decoder. Control signals for U34 are REG SELECT, and R/W (active high) as well as address A1, A2, and A3. U34 decodes address per output, starting with 4000 and ending with 400E. These outputs are active low. Table 4-19 lists the READ register, the assigned function and the address.

Table 4-19. Control Signal Address Decoding (U34)

Address State A3	A2	A1	Hex Address	Function
0	0	0	4000	Switch Interface
0	0	1	4002	Data Entry
0	1	0	4004	Gross Counter Low
0	1	1	4006	Gross Counter High
1	0	0	4008	Sensitivity Select
1	0	1	400A	(Spare)
1	1	0	400C	(Spare)
1	1	1	400E	(Spare)

Data Entry (Read Only)

Octal buffer U36 functions as an interface to supply the status of the switches for data entry to the internal data bus address (4002). The data entry read functions are shown in Table 4-20. The function switch logic is shown in Table 4-21

Table 4-20. Data Entry Read Functions

Data Bit	Function
D0	Enter Switch (Active Low)
D1	Value Select Switch (Active Low)
D2	Digit Select Switch (Active Low)
D3	(Not Used)
D4	(16 position function switch, see Table 4-21)
D5	(16 position function switch, see Table 4-21)
D6	(Not Used)
D7	(Not Used)

Table 4-21. Function Switch Logic

Hex Data	D7	D6	D5	D4	Position	Function
F	1	1	1	1	0	High
E	1	1	1	0	8	Auto Zero Test
D	1	1	0	1	1	Warn
C	1	1	0	0	9	Loop Test Mode
B	1	0	1	1	4	Analog Full Scale Value
A	1	0	1	0	C	Undefined
9	1	0	0	1	5	Calibration Factor
8	1	0	0	0	D	Undefined
7	0	1	1	1	2	Overrange
6	0	1	1	0	A	Undefined
5	0	1	0	1	3	Underrange
4	0	1	0	0	B	Undefined
3	0	0	1	1	6	Undefined
2	0	0	1	0	E	Undefined
1	0	0	0	1	7	Analog Low Scale Value
0	0	0	0	0	F	Undefined

Sensitivity Select (Read Only)

Octal buffer U42 functions as an interface to provide the status of the sensitivity selection jumpers, mode jumpers, anti-jam bit data, and serial data from E^2 PROM to the internal data bus and MPU. U42 responds to address 4008. The sensitivity read functions are listed in table 4-22.

Table 4-22. Sensitivity Select Read Functions

Data Bit		Function
D0		Serial data from E^2 PROM
D1		Anti-Jam
D2		(not used)
D3	JP3-5	(IN) Inhibit alarms during check source operation
		(OUT) Alarms active during check source operation
D4	JP3-4	(IN) Fails in five minutes with a 0.00 mR/h value displayed
		(OUT) Does not fail
D5	JP3-3	(OUT) Auto alarm acknowledge, after counts return to normal
		(IN) Manual Reset

JP3 jumper IN MPU reads a low (0)
JP3 jumper OUT MPU reads a high (1)

Switch Inputs

Octal inverting buffer U62 functions as an interface to provide the status of the front panel control switches to the internal data bus and MPU. U62 responds to address 4000. The switch input bit assignments are listed in table 4-23.

Table 4-23. Switch Input Bit Assignments (U62)

Data Bit	Function
D0	Alarm Acknowledge (Latched)
D1	Check Source (Latched)
D2	(Spare)
D3	(Spare)
D4	Rate-of Rise (when applicable)
D5	Warn Alarm
D6	High Alarm

When a switch is pressed, the appropriate input to U62 is pulled low. When U62 is read by the MPU, a high (1) is available on the data bus. When no switches have been pressed, all outputs (U62) will be low when read. U63 is a latch which latches switch data from the check source and alarm acknowledge switches. The MPU controls the clear switch latch signal to reset U63. The circuit comprised by S1, D1, and R11 is a remote alarm acknowledge. R11 is selected to allow a 20 mA signal to flow through the S1 infrared diode when a given voltage is present on the J9 remote acknowledge input. When this voltage is present, the S1 infrared diode is forward biased, causing the S1 phototransistor to conduct. This effectively forces a low (0) to U63-10, setting the alarm acknowledge bit.

Option Board Bus

The option board bus is available on connector J3. All address, data, and control signals are provided to allow various digital/analog circuit boards to directly interface to the main circuit board. Decoded signals for asynchronous communications interface adapter option, and the general purpose interface bus option are available on the option board interface connector.

Relay Circuit Board

The relay circuit board contains four independently controlled mechanical relays. Each relay provides two Form C sets of contacts with the exception of the check source and alarm relays which provide a single Form C set of contacts. Interconnection is from J2 on the relay board to J2 on the main circuit board. The control signals (active low) and + 15 volts common are provided. The relays typically perform the following functions:

K1 Spare - Normally not controlled by std. 946A
K2: Check Source
K3: Fail
K4: Warn
K5: Alarm

The relay contacts are provided to the user via rear panel connector P1. See specifications for contact ratings. Varistors (V1-V16) provide transient protection across the contacts.

Front Panel Circuit Board

The front panel circuit board consists of the 7 segment display, backlights, status indicators, switches, and bargraph assembly. The front panel interfaces to the main circuit board via interconnecting row 100, 200, and 300. The main power switch also mounts to the front panel circuit board. Refer to figure 4-5 for a view of the front panel.

Circuit Description (Front Panel Circuit Board)

The 7 segment displays are controlled by the display controller as described in "Display Control". The bargraph is controlled by the circuitry described in "Bargraph (Write Only)". The status indicators are described in "Status Indicators (Write Only)". Switches are described in "Switch Inputs".

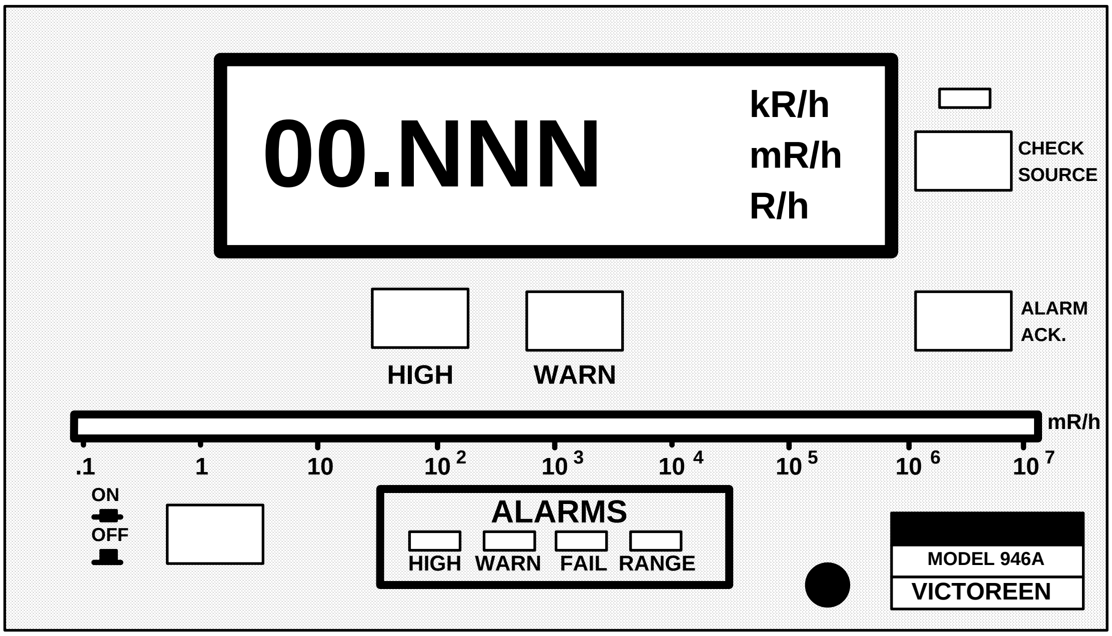


Figure 4-5. Front Panel, Model 946A-200.

Power Supply

The UDR power supply is rated at +5 volts @ 3 amps, +15 volts @ 2.0 amps, and -15 volts @ .5 amps. The AC input to the power supply may range from 90 to 204 VAC @ 50/60 Hz. However, the 946A must be specifically configured for use at voltages exceeding 125 VAC 50/60 Hz. The power supply is designed to meet safety requirements UL/CSA/VDE. EMI emissions comply with FCC/Class B requirements.

The power supply provides all internal UDR voltages as well as detector supply voltages. All outputs are protected with automatic recovery upon removal of overload or short circuit condition.

Optional Circuit Boards

Option circuit boards are installed into the 50 pin J3 connector available on the main circuit board. As many as three option boards may be stacked into the J3 bus. The following paragraphs describe the available options. A separate manual, for each option board, is available with more detailed information. Listed below are the option boards currently available. Refer to Table 1-2 for currently available modifications and to Appendix C for the Bill of Materials.

1. 942-200-75: ANALOG OPTION INPUT BOARD - (Generally not used for normal operation with the 946A-200 UDR, however, it is used if the UDR is part of a simulator) Contains four separate channels for analog input. A 0 to 10 VDC input or 4 to 20 mA input can be selected independently for each channel using the jumpers and switches provided on the board. Possible inputs to the board include: temperature, pressure, flow, or simulated radiation.

2. 942-200-80: COMMUNICATIONS LOOP OPTION BOARD - Designed to enable a EIA RS232C standard communications link between VICTOREEN's ratemeter and a user computer system or CRT terminal, with baud rates ranging from 50 baud to 19200 baud. An asynchronous communication interface adapter is utilized to format the data and control the interface.

   The Communication Loop Option Board also provides an isolated multi-drop, serial communications port for interface with a supervisory computer system. The serial data is in a modified RS232 format, and utilizes Victoreen's proprietary VICO loop protocol. For maximum electrical noise protection, a six conductor communication cable is used.

   The 946A-200 UDR has one standard 942-200-80 Communications Board to support communications between the preamplifier.

3. 942-200-95: ANALOG OUTPUT BOARD - Designed to provide a user selectable single output voltage of: 0 - 10 Vdc, 0 - 5 Vdc, 0 - 1 Vdc, 0 - 500 mVdc, 0 - 100 mVdc, 0 - 50 mVdc, or 0 - 10 mVdc.

4. 942-200-95M1: DUAL ANALOG OUTPUT BOARD - Designed to provide two user selectable output voltages. Output #1 is either 0 - 5 Vdc, or 0 - 10 Vdc, while output #2 is either 0 - 10 mV dc, 0 - 50 mVdc, 0 - 100 mVdc, 0 - 500 mVdc, or 0 - 1 Vdc.

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Section 5 - Maintenance

Maintenance 946A-200

The 946A-200 Universal Digital Ratemeter (UDR) is designed to operate for extended periods of time with no scheduled maintenance required. If a problem develops, trouble shoot the UDR per section 7 and the drawings in Appendix B.

Replacement Parts:

Part No.	Description
92-7027-1A	Main Power Fuse, 2A, 250 Vac
946A-100-4	Mating UDR Connector Kit

Maintenance 977-210

The 977-210 is designed to operate for extended periods without requiring maintenance. If the preamplifier enclosure has been left open or has been exposed to high levels of humidity with the cover removed, the desiccant package should be replaced or removed. The desiccant package contains an indicating color strip which will change from blue to pink when it has reached it's limit of absorption.

Replacement Parts:

Part No.	Description
92-7072	Communications Fuse, 1A, 125V (2 required)
92-7005-17A	Mating Preamplifier Connector
92-7005-9A	Mating Preamplifier Connector Cable Clamp

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Section 6 - Calibration

Calibration

The 977 Ion Chamber Detector is factory calibrated on a 137Cs/60Co range. A ± 15%, 10 point NIST traceable factory calibration is performed to obtain a calibration factor for the detector. The calibration factor is stated on the factory calibration data sheet, and is adsjusted via set-point 5 on the 946A UDR. A field test source, P/N 848-5, is available as an option to verify detector operation. The detector/preamplifier pair should be returned to Fluke Biomedical RMS for recalibration whenever performance degredation is observed.

Electronic Adjustments

Table 6-1 lists the electronic adjustments for the 946A UDR and 977-210 preamplifier. The procedures for making these adjustments are contained in the factory Calibration Procedure listed below. Note that test firmware is required to perform the electrical adjustments. Refer to Section 7 for a description of user permitted adjustments.

Table 6-1. Electronic Adjustments

Adjustment (UDR)	Purpose	Tolerance
VR1	Zero Adjust / 0 - 10 Volt Analog Output	0.000 Vdc ±5 mV
VR2	Gain Adjust / 0 - 10 Volt Analog Output	±.5% of full scale
VR4	20 mA Adjust / 4 - 20 mA Volt Analog Output #1	±.5% of full scale
VR5	20 mA Adjust / 4 - 20 mA Volt Analog Output #2	±.5% of full scale
VR6	4 mA Adjust / 4 - 20 mA Volt Analog Output #2	±.5% of full scale
VR7	4 mA Adjust / 4 - 20 mA Volt Analog Output #1	±.5% of full scale
VR13	Write Cycle Clock Adjust	±5 ns
Adjustment (977)	Purpose	
R11	Programmable Gain Amplifier Offset Adjustment	± 2 mV
R12	Auto Zero Set-Up Adjustment	± 10 mV
HV Supply R118	High Voltage Adjust	± 20 V
R53	Analog Output Adjustment	± 10 mV

Note

Refer to the drawings in Appendix B to locate adjustment and/or test points, if required.

WARNING

Sections of this circuit board contain voltages in excess of 500 volts. Use extreme care when making any adjustments.

Use extreme care when making high voltage measurements directly at J6 or TP3.

The follow factory calibration and test procedures are included for reference.

Document	Description
Cal-ION2	Factory Calibration Procedure for the 977 Detector
TP977-201/210	Test Procedure for 977 Series
LT946/977	Factory Loop Test for 945 System
TP946A-100-3	Factory Test Procedure for 946A-200
MB95-1004	Field Cable Termination for Replacement 977-210 Detector
TP-977 Cable	Factory Test Procedure for 977-210-66 cables

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Section 7 - Troubleshooting

Troubleshooting

Both the Model 946A Digital Ratemeter and the Model 977-210 Preamplifier are microprocessor controlled electronic decices. Complete troubleshooting of these devices requires specialized factory test equipment. The following paragraphs identify field troubleshooting aids that may be performed in the field.

WARNING

Extreme care must be used when troubleshooting a system that has power applied. All standard troubleshooting precautions apply.

WARNING

Once a problem has been located, remove all power before continuing with the repair.

CAUTION

Personnel performing the troubleshooting/repair must be qualified to ANSI 45.2.6, 1978, Skill Level II.

Personnel performing the following procedure must be familiar with the operation of the monitoring system and the location of each piece of equipment used in the system.

NOTE

Improper set point entry can discontinue UDR operation. This includes the alarm set point, underrange set point, overrange set point, analog output low scale value, and analog output high scale value. (i.e., If the HI alarm set point is entered above the overrange set point, the UDR will display error Message E0002.)

If a problem cannot be resolved by using the drawings in the Appendix while applying the troubleshooting instructions found in this manual, or by performing the electronic adjustments in Section 6, please contact the Fluke Biomedical RMS Customer Service Department at (440) 248-9300 for assistance.

Troubleshooting / Adjustments

Error Codes E0011 & E0012

If error code E0011 is displayed on the UDR, determine if the high voltage is present in the detector through the use of the test points described in the following paragraphs. E0011 will also be displayed if the level of HV is not sufficient for proper detector operation. High voltage adjustment is also described.

Two test points are provided for the measurement of the high voltage supply. TP3 is a direct or 1:1 test point, requiring a high impedance high voltage probe. This type of probe has a nominal 1000 meg impedance, and will not load down the supply under test. The ground reference used should be TP4. A second test point, TP5, provides a buffered output whose voltage is 105:1 of the actual high voltage. This point may be measured with a 10 meg input impedance voltmeter directly. To set a nominal 525 volt high voltage output, the value at TP5 should be 5.0 Volts. The high voltage value is adjusted by potentiometer R118.

If error code E0012 is displayed on the UDR, the auto-zero correction is out of adjustment range. Specialized test equipment and firmware are required to adjust the auto-zero. **If the test equipment and firmware is not available, the unit should be returned to Fluke Biomedical RMS for re-alignment.**

Required equipment:

a. Test Firmware labeled **TEST 977 V10**
b. Digital voltmeter with mini clip leads
c. Pot tweeker or small slotted screwdriver
d. Laptop computer running a terminal emulation program such as “GT” or a programmable terminal set up as follows:

Baud Rate:	4800
Data Bits:	8
Stop Bits:	1
Parity:	None (N)
Keyboard:	CAPS locked

e. The 946 series readout module and interconnection cable from the 946 to 977 detector; used to supply ±15 VDC power to the detector.

f. A test cable that will connect the 977 J4 RS-232 connector to the laptop or terminal RS-232 port. Cable pinout is J4-1 (XMIT) to terminal receive, J4-3 (ground) to terminal ground pin and J4-4 (RCV) to terminal transmit.

Auto-Zero Adjustment Procedure:

1. Turn OFF the power to the unit when you change any jumpers or you change operating firmware. Use caution when in close proximity to the red coaxial lead on the 977-200-15 board; the red coax lead is the electrometer input and is static sensitive.

2. When the power is OFF, replace the operating firmware (found in the Z10 location with numerical label on it) with the test firmware labeled 977 TEST V10. Make sure it's inserted correctly - pin 1 should be pointing toward the TP7 test point on the 977-200-15 board.

3. Move the JMP1 jumper block (found in the lower right corner of the 977-210-10 board when viewed from the connector end) to the B - C position or outward toward the edge of the board. This jumper block determines which communication driver is active and B - C position activates the RS-232 port on J4 (next to JMP1).

4. Connect your test cable between J4 and your laptop or terminal RS-232 port. Refer to the applicable drawings in Appendix B to make this cable if unavailable.

5. Set-up the four position DIP switch on the 977-210-10 board to match the switch the following sequence:
   Switch 1: (OFF / OPEN)
   Switch 2: (OFF / OPEN)
   Switch 3: (ON / CLOSED)
   Switch 4: (ON / CLOSED)

6. Move the JMP1 jumper block to the B -C position, shorting the op amp input so that the offset can be adjusted. JMP1 is located near the two adjustment potentiometers, on the upper portion of the 977-200-15 board).

7. Connect your digital voltmeter ground (negative lead) to TP7 and the positive lead to TP8; both found on the 977-200-15 or upper board. Set your DVM DC range to 200 mV for a 3 1/2 digit meter or 2 V for a 4 1/2 digit meter.

8. Turn on power at the 946 readout. It will display an E0007 error code because the communications port is now J4, not the VICO loop It communicates with the detector on. Your terminal should display a menu to select from that looks like the following:

   977 TEST
   A-977 TEST MENU
   B-MONITOR COMMANDS

   SUBTEST:

If it doesn't, recheck the terminal or laptop set-up, 977 switch and jumper block positions and your 977 to terminal/laptop communications cable. Remember - transmit from one device should go to receive of the other device and vice versa.

9. Select type “A” and the following test menu should appear on the screen:

   SUBTEST: A
   997 PREAMPLIFIER TESTS
   0 - VICO LOOP TEST
   1 - BAUD RATE TEST
   2 - ANALOG OUTPUT
   3 - PROG. GAIN AMP OFFSET ADJ. (Z5)
   4 - AUTO ZERO ADJUSTMENT
   5 - ECS TEST
   6 - HV TEST
   R - RESET
   SUBTEST?

10. Type “3” to select the “PROG, GAIN OP AMP OFFSET ADJ”.

11. Disregard the text that appears on the display, it’s for a previous version of 977 that was removed from service. Step 6 accomplishes the message displayed on the screen. Allow the detector to stabilize for two minutes before continuing.

12. Adjust the R11 potentiometer on the 977-200-15 board until the DVM reads 0 Volts ±1 mV. Clockwise adjustment increases the voltage, while counter-clockwise adjustment decreases the voltage.

13. Turn <u>OFF</u> the power to the 946 UDR and move jumper JP1, on the 977-200-15 Board, back to the A - B position.

14. Turn <u>ON</u> the power to the 946 UDR and repeat steps 8 and 9 to return to the TEST menu.

15. Set your DVM range to 2 volts and type “4” to select “AUTO ZERO ADJUSTMENT”. Wait two minutes to allow the detector to stabilize before continuing.

16. The DVM should display a voltage close to -250 mV. Adjust potentiometer R12 on the 977-200-15 board until the DVM reads -250 mV ± 3 mV. Clockwise adjustment increases the voltage, while counter-clockwise adjustment decreases the voltage. If the voltage cannot be adjusted into spec., one of two things may be the cause. If “4” was entered more than once, the detector’s analog to digital converter will increment. To check this, turn the 946 UDR OFF and then ON to reset the ADC. Repeat steps 8, 9, 15, & 16. If the auto zero value still cannot be adjusted to spec., the problem lies in the detector’s electrometer circuitry.

17. After the adjustments have been made, turn the 946 UDR power OFF and return the 977-210-10 JMP1 jumper block to the A - B position to enable the VICO communications loop.

18. Reset the 977-210-10 DIP switch settings to their original positions. Refer to the switch positions listed below if required.

   Switch 1: (ON / CLOSED)
   Switch 2: (OFF / OPEN)
   Switch 3: (OFF / OPEN)
   Switch 4: (OFF / OPEN)

19. Remove the TEST 977 V10 firmware and reinstall the 977 operating firmware in the Z10 location on the 977-200-15 board. Make sure that the operating firmware is inserted correctly or damage to the 977 or PROM could result.

20. Remove the 977 to terminal communications cable from J4 on the detector. Apply power to the 946 UDR. The 946 display should show a radiation value which will slowly decrease toward the actual background level present in the detector's location. If error code E0007 is displayed, recheck jumper block JMP1 on the 977-210-10 board, and verify that it is in the A - B position and the DIP switched are set correctly.

21. If the detector is being returned to service, check the desiccant and replace if required.

22. Place the lid clamps over the preamplifier box lid and tighten down the four screws. This completes the adjustment.

Analog Output Adjustments (946A UDR)

1. The following steps may be performed without the use of test firmware installed, but does require that the detector is in a 1 mR/h field or greater. If the normal channel background is below 1 mR/h, a bias source or the closed position of the Victoreen Model 848-8 Field Calibrator may be used to provide the necessary constant dose rate. Zero and span adjustments are accomplished by "forcing" the output low and high respectively through setpoint entry for analog low scale (position 4) and analog full scale (position 7) that adhere to the following criteria.

Zero Adjust	low scale setpoint set above dose rate displayed on 946A
Span Adjust	full scale setpoint set below dose rate displayed on 946A.

A one decade separation must be maintained between the analog low scale and analog full scale setpoint. Both entries must exact powers of ten to be accepted as valid entries. The following adjustment steps pertain only to the standard 0 - 10 Volt and 4 - 20 mA outputs. Refer to the appropriate analog option instruction manual for adjustment details of option boards that may be supplied.

0 to 10 Volt, zero, and span adjust

1. Note the dose rate value on the display and set the low scale setpoint value (position 7 of the 946A function switch) to the next even decade value above the display value.

2. Connect the DVM to the 946A connector P6-5 (+) and P6-6 (-).

3. Adjust VR1 for a DVM reading of 0 ± 0.005 Volts. Return the low scale setpoint to the original value.

4. Set the analog full scale value (position 4 of the 946A function switch) to the next even decade value below the display value.

5. Adjust VR2 for a DVM reading of 10 ± 0.01 Volts. Return the full scale setpoint to the original value. Return the full scale setpoint to the original value.

6. Repeat steps 1 - 5 until adjustment interaction has been eliminated.

4 - 20 mA Analog Output Adjustment

The Model 946A contains two identical 4 - 20 mA current outputs; each independently adjustable for zero and span. In the following steps, the adjustment potentiometers for output # 2 are given in parenthesis following the output for #1 potentiometer. The adjustment must be performed with the device to be driven with the output connected or with a standard 250 ohm, 1% termination resistor. The 4 - 20 mA output will be measured as a 1 - 5 Volt signal developed across the input terminal of the driven device or across the 250 ohm resistor. It should be noted that the maximum loop resistance is 500 ohms for a signal output.

1. Note the dose rate value on the display and set the analog low scale setpoint value (position 7 of the 946A function switch) to the next even decade value above the display value.

2. Connect the DVM to the desired 4 - 20 mA output. Output #1 is sourced from P6-1 (+) and P6-1 (-). Output #2 is sourced from P6-3 (+) and P6-4 (-).

3. Adjust VR7 (VR6) until the DVM reads 1 ± 0.005 Volts. Return the low scale setpoint to the original value.

4. Set the analog full scale value (position 4 of the 946A function switch) to the next even decade value below the display value.

5. Adjust VR4 (VR5) until the DVM reads 5 ± 0.005 Volts. Return the full scale setpoint to the original value.

6. Repeat steps 1 - 5 until adjustment interaction has been eliminated.

977-210 Detector Analog output Adjustments

The 977-210 Detector provides an independent 0 - 10 Volt analog output that may be used to drive a local meter or display. This output is logarithmic and covers the entire 8 decade range of the device. Adjustments for zero and span are located on the 977-210-10 interface circuit board. To perform the zero and span adjustments, the DIP switch SW3-3 must be ON to place the detector in the maintenance mode of operation.

1. Place SW3-4 in the OFF position and connect the DVM to 977-210-10 connector J3-10 (+) and J3-8 (-). Refer to drawing 977-210-10 for connector locations.

2. Adjust potentiometer R53 for a DVM indication of 0 ± 0.01 Volts.

3. Place SW3-4 in the ON position and adjust R19 for a DVM indication of 10 ±0.01 Volts.

4. Repeat steps 1 through 3 until interaction of zero and span adjustments is minimized.

5. Return SW3-3 to the OFF position to return the detector to normal operation.

Appendix A. - Connector Designations

Rear Panel Connections

Connector	Contact Function
P1	Relay, Remote Alarm Acknowledge
P2	Detector Connector, VICO Loop Communications, Remote Alarm Output
P3	AC Power Input
P6	Analog Outputs (4 - 20 mA, 0 - 10V)
P7	RS232C Communications

Connector P1 - Input/Output

Pin	Signal	Internal Connection
1	Spare	Not Used
2	Spare	Not Used
3	Spare	Not Used
4	Spare	Not Used
5	Spare	Not Used
6	Spare	Not Used
7	Fail Relay, common	Relay Board K3-A
8	Fail Relay, n.o.	Relay Board K3-B
9	Fail Relay, n.c.	Relay Board K3-C
10	Fail Relay, common	Relay Board K3-D
11	Fail Relay, n.o.	Relay Board K3-F
12	Fail Relay, n.c.	Relay Board K3-E
13	Warn Relay, common	Relay Board K4-A
14	Warn Relay, n.o.	Relay Board K4-B
15	Warn Relay, n.c.	Relay Board K4-C
16	Warn Relay, common	Relay Board K4-D
17	Warn Relay, n.o.	Relay Board K4-F
18	Warn Relay, n.c.	Relay Board K4-E
19	Alarm Relay, common	Relay Board K5-A
20	Alarm Relay, n.o.	Relay Board K5-B
21	Alarm Relay, n.c.	Relay Board K5-C
22	Spare	Not Used
23	Spare	Not Used
24	Spare	Not Used
25	+ Remote Acknowledge	Main Circuit Board J9-1
26	- Remote Acknowledge	Main Circuit Board J9-2
27	Spare	Not Used
28	Spare	Not Used
29	Spare	Not Used
30	Spare	Not Used
31	Spare	Not Used
32	Spare	Not Used
33	Spare	Not Used
34	Spare	Not Used
35	Spare	Not Used
36	Spare	Not Used
37	Spare	Not Used

n.o. = normally open, shelf state, relay de-energized
n.c. = normally closed, shelf state, relay de-energized

Connector P2 - Detector Connector

Pin	Signal	Internal Connection
1	+15 VDC	Not used in most applications
2	-15 VDC	Not used in most applications
3	Supply Ground	Power Supply Ground
4	Transmit +	Communication Board
5	Transmit -	Communication Board
6	Receive +	Communication Board
7	Receive -	Communication Board
8	Loop Voltage + Fused + 15 VDC	Communication Board
9	Loop Voltage - Fused -15 VDC	Communication Board
10	0 - 10 Vdc*	Main Circuit Board J5-10
11	Ground	Main Circuit Board J5-9
12	Check Source Line	Not used in most applications
13	Neutral	Not used in most applications
14	Alarm Switch Line	Not used in most applications

* 0 - 10 Vdc selected for customer use on P2 (10,11) or P6 (5, 6), not both.

Connector P3 - Power Input

Pin	Signal	Internal Connection
1	120 Vac, Line	Line fuse (F2)
2	120 Vac, Neutral	Power Supply, 120 Vac (n)
3	Safety Ground	Chassis

Connector P6 - Auxiliary I/O

Pin	Signal
1	4 - 20 mA Output # 1
2	Ground
3	4 - 20 mA Output # 2
4	Ground
5	0 - 10 V *
6	Ground
7	Analog Output Option
8	Ground
17	Not Used
18	Not Used
19	Not Used
20	Not Used
21	Not Used
22	Not Used
23	Not Used
24	Not Used

* 0 - 10 Vdc selected for customer use on P2 (10,11) or P6 (5, 6), not both.

Connector P7 - RS232C

Pin	Signal
1	Protective Ground
2	Transmit Data
3	Receive Data
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground
8	Receive Line Signal Detect
20	Data Terminal Ready

Preamplifier Interface Board 977-210-10 Switch Settings

Switch	Normal Op.	Switch Function
SW3-1	ON	0/OFF Selects 300 baud • 1/ON Selects 4800 baud (normal setting)
SW3-2	OFF	0/OFF Selects alarm inhibit, SW3-3 must be on for this state to be true. 1/ON Selects alarm enable
SW3-3	OFF	0/OFF Selects Rate Mode (normal) • 1/ON Selects Maintenance Mode
SW3-4	OFF	0/OFF forces 977 analog output to 0 V (low scale) (SW3-3 must be on for state to be true) 1/ON forces 977 analog output to 10 V (SW3-3 must be on for state to be true)

NOTE

The above switches are located in a 4 position dip switch on the 977 interface board (977-210-10).

Jumper Positions for Preamplifier Interface Board 977-210-10

Jumper	Normal Setting	Function	Alternate Setting	Function
JMP1	A to B	Enables Victoreen Loop (normal)	B to C	Enables RS232C
JMP2	N/A	Deleted, Not Used	N/A	Deleted, Not Used
JMP3	A to B	Enables Alarm Output - Non-Failsafe	B to C	Enables Alarm Output Failsafe
JMP4	A to B	Enables 0 - 10 Vdc Analog Output (normal)	B to C	Disables Analog Output (stays at 10 Vdc)
JMP5	B to C	Enables HV Output (normal)	A to B	Disables HV Output

Jumper Positions for Preamplifier Electrometer Board 977-200-15

Jumper	Normal Setting	Function	Cal. Position	Function
JMP1	A to B	Normal Operation	B to C	PGA Offset Adjust *

* Programmable Gain Amplifier

Model 946A-200 Option Jumpers

Jumper	Function	Norm Position	Operation
JP3-1,	Not Defined	in	Not Applicable
JP3-2	Not Defined	in	Not Applicable
JP3-3	Alarm Reset Select	in	Manual reset with jumper installed Auto reset with jumper removed
JP3-4	Fail Alarm Enable	in	Fail alarm enabled with jumper in Fail alarm disabled with jumper out
JP3-5	Check Source Alarm Mute	in	Alarms disabled during C/S with jumper in Alarms enabled during C/S with jumper out

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Appendix B. - Applicable Drawings

Drawing No.	Description
GEL-977-210	Dimensional Outline
977-210-5	Detector Main Assembly
977-1-36	Support Bracket, Mounting
977-210-35	Assembly, Detector Cover
977-210-105	Assembly, Chamber
977-210-66(TAB)	Cable Assembly
977-210-95	Preamplifier Assembly
977-210-10	Preamplifier HV/Interface Printed Circuit Board Assembly
977-210-13	Preamplifier Printed Circuit Board Schematic
977-200-15	Preamplifier Electrometer Board Assembly
977-200-18	Preamplifier Schematic
450-1-0531	Dryer, Air (5 Grams)
977-210-100	Harness Assembly
GEL 942A	General Equipment Layout
946A-100-6	Wiring Diagram
945A-3	Loop Diagram
946A-200-5	Main Assembly
946-200-10	Ratemeter Main Circuit Board
942-200-13	Schematic Diagram
946A-100-20	Front Panel Assembly
956-100-15	Front Panel Circuit Board Assembly
946A-100-30	Rear Panel Assembly
942A-200-55	Assembly, Power Supply Bracket
942-200-50	Power Supply
942A-100-70A	Harness Assembly, Relay Board
942-100-70	Relay Board Assembly
GEL 948-1	Dimensional Outline, Three Bay Chassis
948-3-5	Table Top Mounting Enclosure
948-9-5(TAB)	Panel Mount Enclosure
948A-2-GEL	Front Panel Dimensional Outline
948A-2-5	Blank Panel Assembly
GEL 948-10	Panel Adapter, Dimensional Outline
92-7005(TAB)A	Mating Connector Drawing
50-195	Cable Drawing

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Appendix C. - Bill of Materials

Part Number	Description
945A-100	Wide Range Area Monitoring System
977-210	Detector Preamp, Ion Chamber
977-210-5	Bill of Materials, Detector Main Assembly
977-210-35	Bill of Materials, Assembly, Detector Cover
977-210-105	Bill of Materials, Assembly, Chamber
977-210-95	Bill of Materials, Preamplifier Assembly
977-210-10	Bill of Materials, Preamplifier HV/Interface Printed Circuit Board
977-200-15	Bill of Materials, Preamplifier Electrometer Board Assembly
977-210-100	Bill of Materials, Harness Assembly
946A-200	Bill of Materials, UDR
946A-200-5	Bill of Materials, Main Assembly
946A-100-4	Bill of Materials, Connector Mating
942-100-70	Bill of Materials, Relay Board Assembly
942-200-80	Bill of Materials, Option Rs232
946-200-10	Bill of Materials, Ratemeter Main Circuit Board
946A-100-20	Bill of Materials, Front Panel Assembly
956-100-15	Bill of Materials, Front Panel Circuit Board Assembly
946A-100-30	Bill of Materials, Rear Panel Assembly
942-100-70	Bill of Materials, Relay Circuit Board Assembly

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Appendix D. - Coaxial Cable Termination Instructions

The procedures/instructions in Appendix D are provided for your reference.

Document	**Description**
AMP, Inc. IS 7593	AMP Circular Plastic Connectors (CPC) Assembly Procedure.

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Appendix E. - Communications Option Board Manual

This section contains the 942-200-80-1, Communications Option Board Manual.

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Appendix F. - Supplemental Data (customer specific)

Appendix E contains all technical information pertaining to a specific UDR part number or modification. If the basic UDR was ordered, then this section will not contain any information.

NOTE

If you need additional copies of drawings or other technical information, please contact the Fluke Biomedical RMS Customer Service Department at (440) 248-9300 for assistance.

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