

955A

Area Monitoring System

Instruction Manual



CardinalHealth

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SECTION 1

GENERAL INFORMATION

1.1 PRODUCT SPECIFICATION

The Victoreen Model 955A is a single-channel area radiation monitoring system capable of operating over the ranges of 0.01 to 10³ mR/h, 0.1 to 10⁴ mR/h, or 1 to 10⁵ mR/h, depending on the detector selected. The system monitors gamma radiation over a 5-decade range and provides indication when the radiation level decreases below a fail threshold, exceeds a warn setpoint, exceeds a high setpoint, or exceeds an over range setpoint. The over range feature provides two significant benefits. First, it prevents the system from displaying an on-scale, but inaccurate, reading should the detector become saturated. Second, it lessens the risk of damaging the detector by disabling it during an overrange condition. Relay outputs are available to activate alarm annunciators. Analog outputs are available for trend display on a strip chart recorder or computer. In addition, the monitoring system has an integral check source to verify operational integrity. The system consists of a Model 897A Series Geiger-Mueller (G-M) Tube Detector with integral preamplifier and the Model 956A-201 Universal Digital Ratemeter (UDR). A more detailed description of each piece of equipment can be found in the following paragraphs.

The Model 956A-201 Readout and 897A Series G-M detectors have been successfully subjected to seismic and environmental qualification testing per IEEE 344-1975 and IEEE-323-1983. In addition, EMI/RFI testing per the requirements of EPRI TR-102323-R1, MIL-STD-461D, and EN 61000-6-1:2001 has also been successfully performed. Please consult the factory for specific details of the qualification-testing program.

The 956A-201 operation described herein is based on the use of EPROM P/N 94095603, Rev. 3.

Geiger-Mueller Detector, Model 897A-Series

Victoreen 897A-Series G-M detectors use a thin walled Geiger-Mueller tube to detect ionizing radiation. Each 897A-Series detector has a G-M tube, a check source, and a preamplifier. The check source is a low-level radioactive source actuated by a + 15 Vdc meter movement. The preamplifier provides the pulse conditioning and cable driving capability necessary to drive a Victoreen 956A-201 Series digital ratemeter.

All 897A-Series detectors are functionally identical. They differ only in housing material, tube type, and range. The 897A Series detectors operate in the voltage range of 500 - 650 Vdc. An example of the detector plateau, based on different high voltages, is located in Figure 1-1. Refer to the specifications for all 897A-Series G-M detectors for further information.

NOTE

The 897A Series G-M detectors contain an eight-microcurie ³⁶Cl check source. Nuclear Regulatory Commission regulations define this source as an exempt quantity.

Application

The Model 897A G-M Detector is designed to operate with the Victoreen Model 956A-201 Universal Digital Ratemeter (UDR) or with other Victoreen readouts. Each detector measures a five-decade range. Three measurement ranges are available: low, medium, and high. The low range covers 0.01 to 10³ mR/h, the medium covers 0.1 to 10⁴ mR/h, and the high covers 1 to 10⁵ mR/h. The Model 897A detector may also be used with the Victoreen Model 960 Digital Radiation Monitoring System equipment or the Victoreen Model 856 Analog Readout.

1.2 SPECIFICATIONS, G-M DETECTOR, MODEL 897A SERIES

Dimensions (Approximate)	7 1/8 x 3 inches (18.1 x 7.6 cm)
Weight (Approximate)	2.5 lbs.
Housing Material 897A-210, 897A-220, 897A-230 897A-211, 897A-221, 897A-231	Aluminum, weatherproof Stainless Steel, weatherproof
Fill Gas: 897A-210, 897A-211 897A-220, 897A-221 897A-230, 897A-231	Neon/Argon/Halogen Helium/Neon/Halogen Helium/Neon/Halogen
G-M Tube Wall Thickness: 897A-210, 897A-211 897A-220, 897A-221 897A-230, 897A-231	40 mg/cm ² 80 mg/cm ² 80 mg/cm ²
Mounting	Wall mount
Mating Connectors	897A-2x0: 92-7005-17A, 12 Pin Female 92-7005-12A, Bushing 92-7005-9A, Clamp 897A-2x1 (stainless steel): 92-7005-15A, 12 Pin Female (stainless steel) 92-7005-12A, Bushing 92-7005-13A, Bushing
Required Cable	Victoreen P/N 50-100 or substitute with two coaxial conductors, two twisted pairs, and overall shield.
External Pressure Limit	30 psig
Storage Temperature	-10° to 122°F (-23° to 50°C)
Operating Temperature	-10° to 122°F (-23° to 50°C)
Relative Humidity	0 to 95% non-condensing
Operating Voltage	500 – 650 Vdc (supplied by digital ratemeter)
Plateau Length	100 – 150 Vdc
Plateau Slope: 897A-210, 897A-211 897A-220, 897A-221 897A-230, 897A-231	0.1%/V 0.2%/V 0.3%/V
Dead Time (Approximate) 897A-210, 897A-211 897A-220, 897A-221 897A-230, 897A-231	45 microseconds 28 microseconds 20 microseconds

Detector Element Life	Exceeds 1000 hours at full-scale
Energy Dependence of Reading	+/- 15% from 80 keV to 1.5 MeV
Detector Accuracy	± 20% of actual dose for Cs-137
Radiation Detected	Gamma rays, X-rays

1.3 SPECIFICATIONS, G-M DETECTOR CHECK SOURCE, MODEL 897A SERIES

Radionuclide	³⁶ Cl
Source Activity:	8 microcuries
Scale Reading (Approximate) 897A-210, 897A-211 897A-220, 897A-221 897A-230, 897A-231	10-150 mR/h, Typical 10-50 mR/h, Typical 10-50 mR/h, Typical
Voltage	12 – 15 Vdc
Encapsulation	Brass, high temperature soldered

1.4 SPECIFICATION, DETECTOR PREAMPLIFIER (INTERGRAL)

Input Impedance	>100 k-ohms
Output Impedance	50 ohms
Output Pulse Polarity	Positive
Output Signal (50 ohm terminated)	+ 5 Vdc square-wave
Low Voltage*	+ 15 Vdc (Optional + 10 Vdc is Jumper Selectable)
Power Requirements	+ 15 Vdc @ 120 mA
Maximum Cable Length	2000 feet
Electronic Exposure Life	Approximately 10 ⁵ rads
Discriminator Level	Adjustable from 0 to 1.5 Vdc (nominal value =1.00 Vdc)
Anti-Jam Level	Adjustable from 0 to + 3 Vdc
Anti-Jam Oscillator Frequency	Approximately 50 kHz
Pre-divide*	Jumper Selectable
Analog & Digital Monitor Configuration	Divide by 2, Square wave output
Optional Monitor Configuration	Raw pulse output

* Preamplifier low voltage and pre-divide are selected with jumpers. Refer to the preamplifier circuit description for more information. Standard Configuration for a 955A system is +15 Vdc Divide by 2.

1.5 SYSTEM PART NUMBER DESCRIPTION

955A-XXYYZ

XX=Range/Material/Power/Detector

- 10 0.01 to 1E3 mR/h, Aluminum, 120 Vac, 897A-210
- 20 0.1 to 1E4 mR/h, Aluminum, 120 Vac, 897A-220
- 30 1.0 to 1E5 mR/h, Aluminum, 120 Vac, 897A-230
- 11 0.0 to 1E3 mR/h, Stainless Steel, 120 Vac, 897A-211
- 21 0.1 to 1E4 mR/h, Stainless Steel, 120 Vac, 897A-221
- 31 1.0 to 1E5 mR/h, Stainless Steel, 120 Vac, 897A-231

YY=Local Alarm Option, P/N Description/Voltage/Range/Material

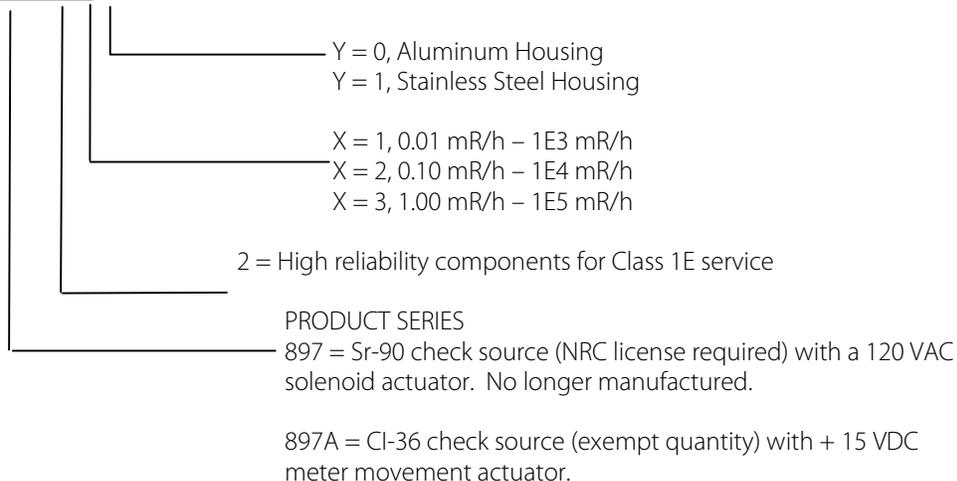
- 00 No local alarm
- 10 Model 958A-40, Local Alarm/No Indicator, Painted Steel
- 20 Model 958A-X0, Local Alarm/Meter, Painted Steel
- 30 Model 958A-41, Local Alarm/No Indicator, Painted Steel
- 40 Model 958A-X1, Local Alarm, Meter, Painted Steel

Z= Special Options/Modifications

- Blank 110 Vac
- 1 220 Vac (future)
- MX Special Modifications (X = the modification number)

1.6 DETECTOR PART NUMBER DESCRIPTION

897A-2 XY



1.7 READOUT PART NUMBER DESCRIPTION

956A-20X-MX

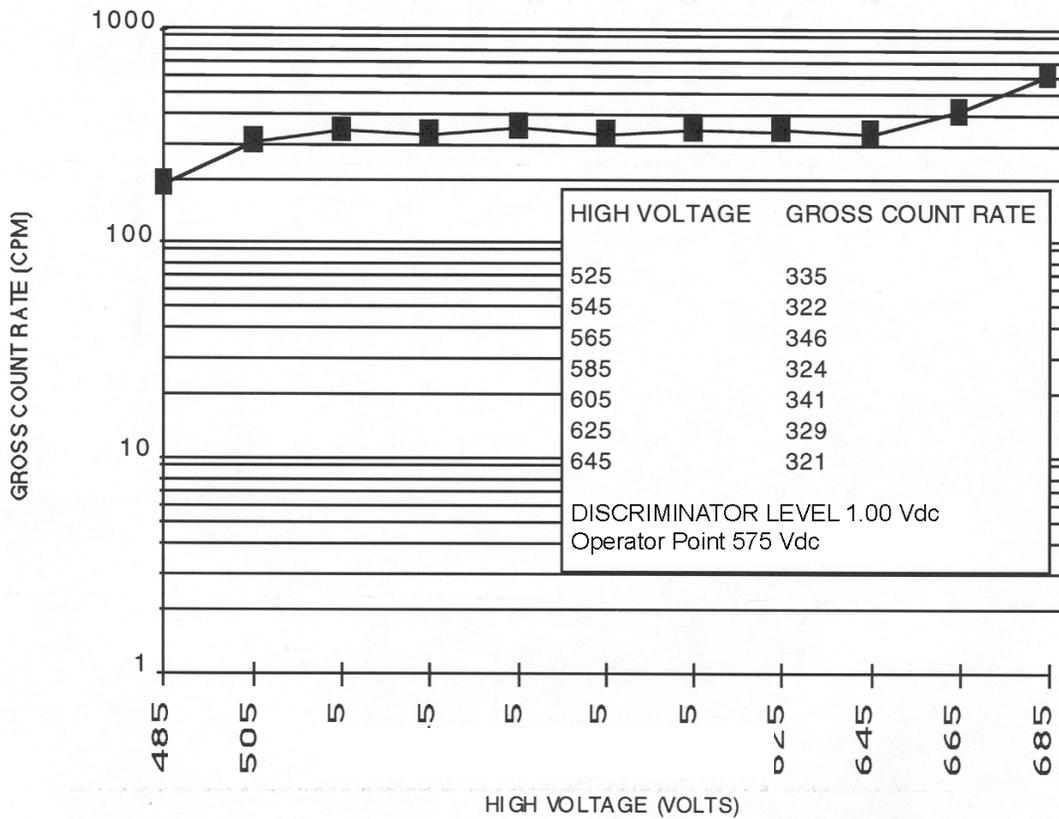
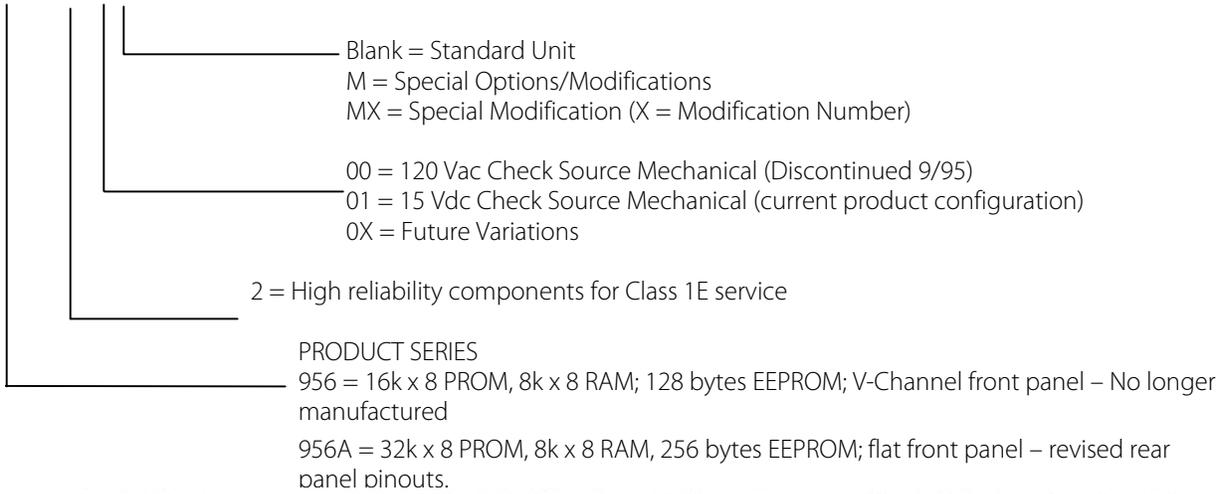


Figure 1-1. Detector Plateau (typical)

Figure 1-1 Detector Plateau (typical)

1.8 UNIVERSAL DIGITAL RATEMETER, MODEL 956A-201

The Victoreen Model 956A-201 Universal Digital Ratemeter (UDR), when connected to a Victoreen Model 897A-2XY Geiger-Mueller (G-M) tube detector, comprises a monitoring system that operates over a five-decade range. The UDR provides display, control, and annunciation functions for the monitoring system, and will display readings in the range of 0.01 to 10^5 mR/h. Refer to Figure 1-2 for view of the 956A-201 front panel.

Standard features for the instrument consist of a three-digit display of the radiation value, in units of mR/h, R/h, or kR/h, and a multi-colored bargraph indicator that covers the entire range of the UDR. The bargraph will change color in the event of an alarm condition (green for normal, amber for warning, and red for high). Front panel alarm indicators and rear panel relay outputs for alarm annunciation are also included. Front panel pushbuttons are provided to apply power, display alarm limit setpoints, acknowledge alarms, and to activate the check source.

Analog outputs of 0 - 10 Vdc (1) and 4 - 20 mA (2) are provided for recording and computer monitoring. The outputs may also be used to drive a remote meter or a local (i.e. near the detector) indicator.

All electronics required to interface with the VICTOREEN 897A Series G-M detector are included within the 956A-201 UDR. The electronics consist of a high voltage power supply, low voltage DC power supply and the hardware/software required for UDR operation. The system also includes an overrange indicator to preclude the possibility of on-scale readings when the radiation field is beyond the range of the detector.

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 INPUT OPTION BOARD - (Generally not used for normal operation with the 956A-201 UDR, however, it is used if the UDR is part of a simulator) Contains four (4) separate channels for analog inputs. 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 to 19200 baud. An asynchronous communication interface adapter is utilized to format the data and control the interface.

The VICTOREEN 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 RS-232 format, and utilizes Victoreen's proprietary VICO loop protocol. For maximum external noise protection, a six-conductor communications cable is used.

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. 5942-200-95M1: 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 mVdc, 0 - 50 mVdc, 0 - 100 mVdc, 0 - 500 mVdc, or 0 - 1 Vdc.
5. S157033A2 Line Filter/Surge Suppressor Assembly Designed to provide EMI/RFI protection for two 956A Series digital ratemeters and 897A Series G-M detectors. The assembly consists of two (2) separate and independent line conditioning circuits that provide filtered AC power to each 956A Series ratemeter. The S157033A2 is designed to mount in the center section of the 948B-1A-5 dual module rack chassis, to provide EMI/RFI protection for two (2) 956A Series ratemeters. The major active components of the S157033A2 are two (2), 960SS-200 Surge suppressor circuit boards, two (2), 92-9015-A Line Filters, and two (2) 14-235 ferrite cubes. The S157033A2 also contains AC line and neutral fuses to protect the internal circuitry from over current conditions.

To meet the requirements of EPRI TR-102323-R1, for radiated fields above 80MHz, the low discriminator in the detector preamplifier must be set to 1.0 volts. This setting has been incorporated into the factory calibration of all 897A Series G-M detectors.

1.9 APPLICATION

The Model 956A-201 UDR is used with all Victoreen 897A Series G-M Detectors. The detector specific setpoints for the 956A-201 UDR are configured by the user for the range of the particular detector supplied. The detector/preamp, when connected to a UDR, will function as a single channel digital area monitoring system. For additional information on various applications, please contact Cardinal Health at 440.248.9300 or Fax at 440.5423682.

1.10 SPECIFICATIONS MODEL, 956A-201

General specifications for the 956A-201 UDR are listed below. The 956A-201 is designed for nuclear applications, and any repairs to it by personnel not qualified may void the nuclear rating. If a problem develops, the UDR can either be returned to the factory for service or repaired by a qualified technician.

Main Display	Seven segment – three digits with backlighted radiation units display, floating decimal point and exponential setpoint entry
Bargraph Display (Dynamic Range)	Three segments per decade, .01 to 10 ⁶ mR/h (24 segments) (green for norm, amber for warn, and red for high)
Alarm Indicators	HIGH Alarm (Red LED) – Flashing until acknowledged WARN Alarm (Amber LED) – Flashing until acknowledged FAIL Alarm (Red LED) – Does not flash, automatically resets RANGE Alarm (Red LED), overrange/underrange – Does not flash, automatically resets
Display Selection (Momentary Pushbuttons)	HIGH, High Alarm Setpoint WARN, Warn Alarm Setpoint
Check Source	Activates radioactive Check source and associated green LED indicator. Momentary, non-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 set point. Internal jumper causes alarms to be reset automatically when radiation level drops below set point (no operator input required).
Power ON/OFF	Alternate action pushbutton for AC power.
Relay Outputs (Fail-safe operation)	HIGH Alarm – DPDT rated 5 A @ 120 Vac (one set 120 Vac powered for use with optional local alarm) WARN Alarm – DPDT rated 5 A @ 120 Vac FAIL Alarm – DPDT rated 5 A @ 120 Vac DC rating for all relays is 5 A @ 29 Vdc
High Voltage Output	300 Vdc – 1800 Vdc @ 0.4 mA
Detector Check Source Power	+15 Vdc @ 20 mA
Analog Outputs	4 to 20 mA (2) (500 Ω load each, max.) and 0 to 10 Vdc (1 KΩ load min.), logarithmic. May be scaled for any one decade (minimum) or to the full range of the detector (maximum).
Remote Alarm Ack Input	Optically isolated DC input

Detector Input	Digital Pulse, Up to 2000 feet from UDR, 50 ohm input impedance
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 99% non-condensing
Compatible Detector	897A Series, G-M (Geiger Mueller tube)
Heat Loading	Approximately 96 BTU/hr

1.11 AUXILIARY EQUIPMENT

Auxiliary Equipment	
Model	Description
Model 848-8	Field Calibrator (100 mCi)
Model 848-8A	Field Calibrator (10 mCi)
Model 848-8B	Field Calibrator (20 mCi)
Model 848-8-105	897A Adapter (all types)
Model 848-8-400	897A Stainless Steel Detector Adapter, 897A-2x1
Model 942TS	UDR Test Set
Model 958A-40	Local Alarm, without meter
Model 958A-10, -20, -30	Local Alarm, with meter
Model 948-1	Rack Chassis, 3 Channel
Model 948A-2	Blank Panel
Model 948-3	Table Top Enclosure
Model 948-10	Panel Adapter
Model 50-100	Interconnecting Cable
Model S157033A2	Line Filter/Surge Suppressor
Model 948B-1A-5	Dual Channel Rack Chassis

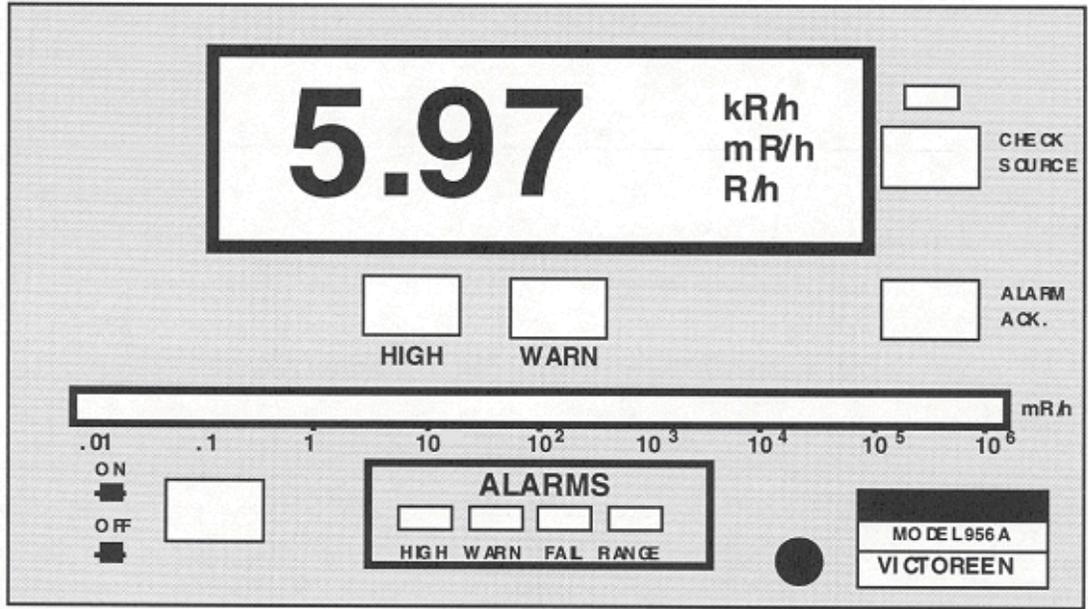


Figure 1-2. Front Panel, Model 956A-201 Universal Digital Ratemeter (not to scale)

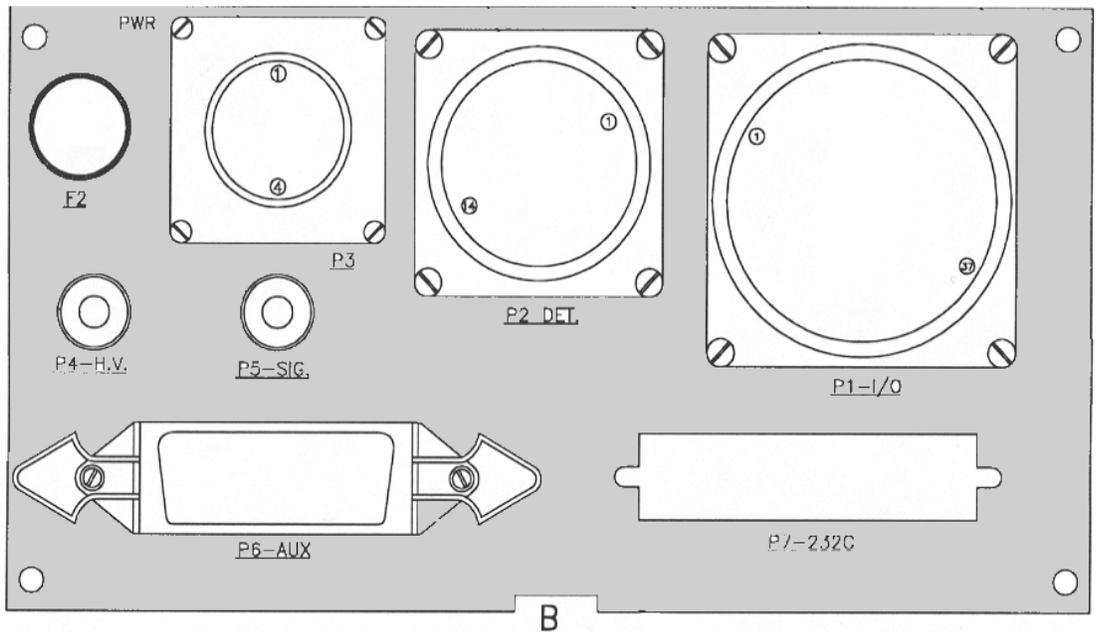


Figure 1-3. Rear Panel, Model 956A-201, Universal Digital Ratemeter (not to scale)

1.12 956A-201 MODIFICATIONS

A number of application specific modifications to the 956A-201 Universal Digital Ratemeter are available for customer use. For further information contact Cardinal Health at 440.248.9300 or Fax at 440.542.3682.

1.13 RECOMMENDED SPARES

Table 1-2 lists the recommended spare parts for the 955A Radiation Monitoring System.

Table 1-2. Recommended Spare Parts List

897A Detector		
Part Number	Description	Used On
46-77	"O"-Ring, Detector Housing	897A-2X0
857-211-15	Gasket, Detector Housing	897A-2X1
857-211-19	Mounting Strap	897A-2X1
857-211-18	Detector Mounting Bracket	897A-2X1

956A-201 UDR		
Part Number	Description	Used On
92-7027-1A	Fuse F2, 2 Amp, main AC power	All
19-62	Fuse F1, 50 mA, anti-jam circuit	All
92-9042-A	Jumper Block (10 required)	All
942-200-50	Power Supply	All
82-73-1	Relay	All

1.14 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 Cardinal Health at 440.248.9300 or Fax at 440.542.3682.
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 Cardinal Health at 440.248.9300 or Fax at 440.542.3682.

1.15 STORAGE

Instruments storage 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.

Instruments storage 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

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SECTION 2

OPERATION

2.1 INSTALLATION

Installation consists of selecting suitable mounting sites for the detector and ratemeter, mounting the equipment, making the required electrical connections, and entering the desired setpoints. Installation drawings are provided in Appendix B of this manual.

CAUTION

Remove all power prior to installing the UDR or detector.

2.2 G-M DETECTOR MOUNTING

The 897A Series G-M detectors can be mounted to any suitable structure e.g. a wall or post, using the mounting bracket (P/N 843-6-26) included with the detector. The maximum distance between the detector and ratemeter is 2000 feet (610 meters). The detector should be mounted above normal head height with the detector connector facing away from the area being monitored. For additional information refer to the applicable engineering drawings, provided in Appendix B, for detector mounting dimensions.

To protect the monitor from EMI/RFI transients, the detector must be earth grounded through its wall-mounting bracket.

2.3 G-M DETECTOR SETUP

The low voltage power supply input for the preamplifier is jumper selectable. This allows the use of either a +10 Vdc or +15 Vdc supply for detector power. If the detector is used in a 955A digital system, the standard +15 Vdc position is used. If the detector is used in an analog radiation monitoring system, the +10 Vdc position is used. Jumper configurations are listed in Table 2-1.

Table 2-1 Input Voltage Jumper Position

Jumper	Position	Input Voltage
J3	AB	+ 15 Vdc (factory set), digital readout
J3	BC	+ 10 Vdc, analog readout

The G-M tube output pulse is conditioned with a divide by 2 pulse shaping circuit to transmit a square wave from the detector. The conditioning also permits use of the detector with analog readouts, using a diode pump counting circuit. For use with fast rise time scalers, a jumper is provided to output the detector pulse directly. Jumper configurations are listed in Table 2-2.

Table 2-2 Divide Options Jumper Position

Jumper	Position	Divide Option
J1, J2	AB	2, square wave output (factory set)
J1, J2	BC	1, direct coupled

2.4 UDR MOUNTING

The UDR is a self-contained unit that 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.

NOTE

Where 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 Cardinal Health at 440.248.9300 or Fax at 440.542.3682.

NOTE

To protect the monitor from EMI/RMI transients, the Rack Chassis must be connected to an earth ground.

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 948A-2, is available to cover unused mounting positions. Refer to drawing GEL-948-1 for mounting dimensions.

Where EMI/RFI compliance is required, the Model 948B-1A-5 Dual Channel rack chassis is available. The Model 948B-1A-5 is designed to accept two Model 956A UDR's, mounted in the left and right side positions. The center position is used to mount a Model S157033A2 Line Filter/Surge Suppressor Assembly. AC power for each channel is routed to the surge suppressor, which then feeds the AC power to the 956A UDR's. Refer to GEL-948B-1A for mounting dimensions.

2. The second mounting consists of a single channel tabletop enclosure, Victoreen Model 948-3. Dimensions for the enclosure are 4.5 inches high by 6.8 inches wide by 14.9 inches deep. 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. 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 956A-201 UDR into an existing Victoreen analog ratemeter rack chassis such as those used for the Victoreen 842 series analog ratemeter. Refer to drawing GEL-948-10 for mounting dimensions.

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

2.5 ELECTRICAL INTERFACE

WARNING

Ensure all power is off prior to connecting the field wiring

Electrical interconnections at the detector are made via the mating "MS" style connector supplied with the detector and loop drawing 956A-201-106.

Electrical interconnections to the UDR are implemented with the mating connector kit, P/N 942A-100- 4 (supplied with the readout) by using the connector input/output assignments provided in Tables 2-3 through 2-10, and loop drawing 956A-201-106, provided in Appendix B. Termination instructions for coaxial connections can be found in Appendix D. A service loop of a minimum of 12 to 16 inches should be provided to permit partial withdrawal of the UDR for setpoint adjustment and troubleshooting.

Connector pins should be soldered to the cable using 60/40-tin/lead resin core solder and a soldering iron of 50 watts or less.

To protect the monitor from EMI/RFI transients, the mounting chassis must be earth grounded.

Table 2-3. Rear Panel Connections

Connector	Function
P1	Relay/Output, Remote Alarm Acknowledge
P2	Detector Connector
P3	AC Power Input
P4	Detector High Voltage (SHV)
P5	Detector Signal Input (BNC)
P6	Auxiliary outputs 0 – 10 Vdc & 4 – 20 mA DC
P7	RS232C, Optional

Table 2-4. Connector P1 – Input/Output

Pin	Signal	Internal Connection
1	Spare	Relay Board K1-A
2	Spare	Relay Board K1-B
3	Spare	Relay Board K1-C
4	Spare	Relay Board K1-D
5	Spare	Relay Board K1-F
6	Spare	Relay Board K1-E
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

Pin	Signal	Internal Connection
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 - 37	Spare	Not Used

n.o. = normally open, n.c. = normally closed, Relays shown in shelf, or de-energized state.

Table 2-5. Connector P2 – Detector Connector

Pin	Signal	Internal Connection
1	Detector + 15 Vdc Supply	Power Supply + 15 Vdc
2	Not Used	Power Supply – 15 Vdc
3	Supply Ground	Power Supply Ground
4	+ 15 V C/S On	Relay K2
5	- 15 V C/S Off	Relay K2
6	Not Used	-
7	Not Used	-
8	Not Used	-
9	Not Used	-
10	0 – 10 Vdc*	Main Circuit Board J5-10
11	Ground	Main Circuit Board J5-9
12	Not Used	-
13	120 Vac (Neutral)	120 Vac (N)
14	Alarm N.C (Switched Line)	Relay Board K5-E (L)

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

Table 2-6. 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 2-7. Connector P4 – Detector High Voltage

Pin	Signal	Internal Connection
MHV	Detector High Voltage	Direct

Table 2-8. Connector P5 – Detector Signal Input

Pin	Signal	Internal Connection
BNC	Detector Signal	Direct

Table 2-9. Connector P6 – Auxiliary I/O

Pin	Signal
1	4 – 20 mA Output #1 (+)
2	4 – 20 mA Ground (-)
3	4 – 20 mA Output #2 (+)
4	4 – 20 mA Ground (-)
5	0 – 10 V* (+)
6	Ground (-)
7	Analog Output Option (+)
8	Ground (-)
9 through 24	Not used

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

Table 2-10. Connector P7 – RS232C Option

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

Table 2-11. 897A Detector Connection

Pin	Signal
K	Protective Ground
H	Check Source
J	Check Source
E	High Voltage
MTG Screw	Chassis Ground
C	+ Voltage In
G	Signal Output

2.6 SETUP

Table 2-12 summarizes the jumper selectable configuration options. To place the system in operation, the following steps should be performed:

NOTE

Ensure you have read and fully understand Section 3 prior to continuing.

1. Verify that jumpers and DIP switches, on the UDR and detector, are set for the operational features desired. Refer to Section 3, Table 3-2. The 897A Detector jumpers are preset at the factory per Tables 2-1 and 2-2, and should not be changed.
2. Apply power to the unit. The bargraph will illuminate momentarily followed with a momentary actuation of the digital value display. The unit will then begin to display the ambient radiation at the detector location.

NOTE

The default setpoints in the UDR memory are for an 897 A-22X detector (1.00E-1 mR/h to 1.00E4 mR/h); verify the appropriate setpoints for the actual detector are entered per Section 3 (Parameter Entry).

NOTE

Calibration constant and detector deadtime value are obtained from the factory calibration data sheet for each detector.

3. Detector dependent set points such as analog outputs, High/Low scale values, Range, Underrange, Overrange limit, calibration constant, and detector deadtime may now be verified and if required, modified using the procedures outlined in Section 3.
4. Channel dependent set points such as alarm limits may be verified, and if required, modified using the procedures outlined in Section 3.
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 Section 4 should be performed.

Table 2-12. Model 956A-201 Option Jumpers

Jumper	Function	Position	Operation
JP1	Microprocessor Reset	Out In	Normal Operation (factory) Momentary connect to reset microprocessor without cycling AC power Not Applicable
JP2	PROM Type	1-2 2-3	PROM 27128 PROM 27256 (factory)
JP3-1/JP3-2	Statistical Accuracy (Note: This accuracy refers only to the statistical interpretation of detector counts, and not detector accuracy)	Out/Out Out/In In/Out In/In	2% Accuracy – Not Implemented 5% Accuracy – Not Implemented 10% Accuracy – Not Implemented Fixed one second display update (factory)
JP3-3	Alarm Acknowledge	In Out	Manual Acknowledge (factory) Automatic
JP3-4	Fail Alarm	In Out	Enable No Counts Fail Alarm (factory) Inhibit No Counts Fail Alarm
JP3-5	Check Source Alarm	In Out	Alarm Inhibited (factory) Alarm Enabled
JP4	Shield Polarity Selection	1-2 2-3	Negative Input Pulse (Other Detectors) Positive Input Pulse (G-M Detectors) (factory)
JP5	Shield Polarity Selection	1-2 2-3	Shield for Negative Pulse Shield for Positive Pulse (G-M) (factory)
JP-6	Anti-Jam Fuse Selection	1-2 2-3	Enable for Normal Operation (factory) Anti-Jam Circuit fuse bypassed (testing)
JP7	Detector Type for Anti-Jam Circuit Timing	1-2 2-3 Out	Scintillation G-M Tube (factory) Anti-Jam Circuit Disabled (for testing only)

THEORY OF OPERATION

3.1 OPERATION

This section describes the operation and set up of the Model 955A-XX Digital Area Monitoring System. The system consists of a Model 956A-201 UDR and a Model 897A Series G-M Detector. The detector preamplifier provides the electronics interface between the detector and the UDR. The preamplifier provides input pulse discrimination, pre-divide capability, anti-jam circuitry, pulse amplification and output drive capabilities. The output of the preamplifier is transmitted to the UDR. The 956A-201 UDR uses this information to generate the dose rate display, error codes, alarms, and analog outputs.

Operation of the 956A-201 UDR consists of operator functions and configuration functions. All operator functions are performed using the front panel shown in Figure 1-2. Configuration functions are performed using internal switches and/or jumpers, which are accessible with partial removal of the UDR from the mounting enclosure. Calibration involving trim pots is described in Section 4.

For applications where EMI/RFI compliance is required, the S157033A2 Line Filter/Surge Suppressor Assembly, designed to provide EMI/RFI protection for the 956A Series digital ratemeter and 897A Series G-M detectors, is available. The assembly consists of two (2) separate and independent line conditioning circuits that provide filtered AC power to each 956A Series ratemeter. The S157033A2 is designed to mount in the center section of the 948B-1A-5 dual module rack chassis, to provide EMI/RFI protection for two (2) 956A Series ratemeters.

3.2 DETECTOR OPERATION, MODEL 897A-2XX

The Model 955A Area Monitor uses a Model 897A-2XX G-M tube as a gamma radiation detector. The tube is filled with a mixture of gases, one of which acts as a quenching agent, while the others tend to support ionization. Electrically, it consists of a positive electrode (anode), which is maintained at a steady potential of 500/650 Vdc and a negative electrode (cathode) that is near ground potential.

When a gamma photon penetrates the shield encasing the G-M tube, an ionizing event occurs. An ion pair is produced, triggering an avalanche of ion pairs. The current pulses produced (one pulse per ionizing event) are independent of the energy of the initiating particle. Multiple discharge, caused by the release of electrons from the cathode due to excess energy, is eliminated after a short time (called dead time, typically 20-45 microseconds) by a quenching gas within the tube. The resulting pulses are conditioned and transmitted to the preamplifier.

The integral detector preamplifier provides input pulse discrimination and amplifies pulses received from the G-M tube to 5 Vdc amplitude. The current drive output of the preamplifier will drive a signal up to 2000 feet through a 50-ohm transmission line, without signal degradation.

Should a very high intensity radioactive source be detected, the G-M tube may become saturated (i.e. pulses are separated by a period less than the dead time of the tube). This would have the effect of holding the preamplifier output at a relatively constant output voltage, resulting in count loss at the readout. Anti-Jam circuitry in the preamplifier produces a full-scale output square wave signal, providing a full-scale indication at the readout.

G-M Detector Response Time

The response time of the system to a step change in radiation value is 60 seconds, due to the operation of the pulse counting algorithms. The detector radiation value displayed is the result of a rolling average of the latest 60, one-second values, and is updated once per second. An alarm will be initiated within one second after the current one-minute average exceeds the alarm setpoint.

Check Source

A manual check source may be initiated from the UDR by the operator to check detector operation. The Check Source push-button is a momentary contact switch, and is active as long as the pushbutton is depressed. Upon initiation and removal of the check source request, the internal counting registers are cleared and the display value will be based on the number of new values received. After 60 seconds, the display value will reflect the average of the past 60 values. During check source activation, analog outputs are muted (forced to zero). The High and Warn alarms are normally inhibited during check source operation, but may be enabled by removing Jumper JP3-5, on the UDR main printed circuit board (see Table 2-12). The counters are cleared upon exiting Check Source mode, resulting in a display of 0.00. After one minute, the current radiation value will be displayed.

3.3 UDR OPERATION, MODEL 956A-201

Operation of the 956A-201 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 that are accessible via 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 value will be displayed as a three digit number: N.NN, where N = 0 to 9. A backlit insert will display engineering units in mR/h, R/h, or kR/h. The bargraph will display the value on the fixed mR/h scale and any indicator lights that are on should be green, providing the operator with a visual indication of normal operation. The analog outputs will track the displayed value, and the alarm outputs will be active. The Warn, High, and Fail relays operate in the Fail Safe Mode.

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 a firmware option at time of purchase.

The UDR can be configured to automatically reset the alarm relays and alarm indicators, or it can hold the alarm relays de-energized and flash the alarm indicators until the alarm acknowledge (ALARM ACK) pushbutton is pressed. If the ALARM ACK pushbutton is pressed while the alarm condition still exists, the indicators will go to a steady state, and the relays will remain de-energized until the alarm condition returns to normal. Upon resumption of normal operation, the relays will energize and alarm indicators will extinguish. 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 (minimum range of the detector used), the front panel display will indicate 0.00 mR/h, the bargraph will indicate the actual radiation value, and the RANGE alarm indicator will illuminate in red. The minimum range is adjustable by the underrange setpoint, and is defaulted to 1.00E-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 begin.

There are three ranges for the ratemeter, one for each detector range (low, medium, & high). The specific range for each detector is established by operator-entered setpoints (refer to "Setpoint Entry" for actual entry procedures). The detector range for each specific detector is shown below.

Detector	Detector Range	Underrange Setpoint	Overrange Setpoint
897A-210/211	0.01 to 10E3 mR/h	1.00E-2	1.00E3
897A-220/221	0.1 to 10E4 mR/h	1.00E-1	1.00E4
897A-230/231	1 to 10E5 mR/h	1.00E0	1.00E5

If the measured radiation field goes above the overrange setpoint, the RANGE alarm indicator will illuminate and the front panel display will indicate EEEEE mR/h, the bargraph will illuminate in red, and the analog output will be set to full scale. The maximum range of the detector used is determined by the overrange setpoint. 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.

NOTE

In addition to the display of EEEEE when in Overrange, the **mR/h** engineering units will be displayed if the HIGH or WARN front panel set point display pushbuttons have been accessed. If desired, the **mR/h** units display may be cleared by either pressing the **ENTER** pushbutton, or cycling the UDR power OFF/ON. The mR/h unit's display, however, does not affect the operation of the Overrange function.

In the event the detector output exceeds the electronic anti-jam circuit trip level, the anti-jam fuse will open and the fail relay will change state to indicate a monitor not in service condition. Replacement of the anti-jam fuse (F1) will be required in order to return the rate meter to normal operation.

Fail Alarm

Detector failure, detector overrange, or 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 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.

To return the channel to normal operation after a FAIL alarm, the condition that caused the alarm must be located and corrected. Upon correction of the failure condition, the Fail alarm will automatically close.

Check Source

The check source pushbutton and electronics are provided to verify detector operation. To operate the check source, press the CHECK SOURCE pushbutton and hold it down. The Check Source LED will illuminate, and the radiation value will increase. Releasing the check source pushbutton will allow normal UDR operation. An internal configuration jumper (JP3-5) allows alarms to be activated or deactivated in the check source mode. The analog outputs are forced to their low scale value during a check source operation.

Firmware Version

This system requires a PROM for UDR operation. For the part number and the latest revision of the PROM, see the Factory Test Data Sheet. Operation as described in this manual pertains to the PROM defined in Section 1.1.

3.4 OPERATIONAL MODES

Normal Operation, Mode

The UDR is in normal operation when the UDR function switch is in any position except 8, and the Check Source button is OFF. During normal operation, the display shows the dose rate data received from the preamplifier in mR/h, R/h, or kR/h. The bargraph will also show 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 and all alarms are enabled.

Data Entry Mode

Data Entry Mode is selected by pressing the ENTER pushbutton while the rotary FUNCTION switch is in a valid setpoint position (**see Setpoint Description**). The selected setpoint is displayed in exponential format (e.g. 1.00E2) with the left most digit flashing. Setpoints are entered in exponential format (e.g. X.XXEN), where X is the mantissa and N is the exponent. The X value may be any integer value between 0 and 9. A positive exponent is entered by selecting the "E" symbol, and a negative exponent is entered by selecting the "-" symbol. The N value may be any integer value between 0 and 9. If the FUNCTION switch is not in a setpoint position, pressing the ENTER button has no effect. Refer to Table 3-3 for FUNCTION switch positions.

In the Data Entry Mode, the bargraph and analog outputs remain active.

Alarm Inhibit Mode

Alarms are inhibited in situations where an alarm trip would be meaningless because the UDR 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.

Check Source Mode

The check source pushbutton and electronics are provided to verify detector operation. To operate the check source, press the CHECK SOURCE pushbutton and hold it down. The check source relay will energize, the check source indicator will illuminate (green), and the check source mechanism will expose the check source (sealed capsule of ³⁶Cl) to the G-M tube by positioning the source over an access on the detector printed circuit board. The counters will be cleared and radiation values displayed on the front panel will reflect the average of the new values received. Releasing the check source pushbutton will return the source capsule to its shielded position, clear the radiation value stored in the UDR counter and extinguish the check source indicator, allowing normal UDR operation to resume. After approximately 60 seconds, the displayed value will indicate the average of the previous 60 one-second values stored. An internal configuration jumper (JP3-5) allows alarms to be activated or muted if alarm limits are exceeded by the check source radiation value.

The bargraph operates normally during Check Source operation.

The front panel Alarm and Warn status indicators are disabled during Check Source operation.

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

Calibration (scaler) Mode Operation

Calibrate mode for the UDR is entered by turning the rotary setpoint switch to position 8 and pressing the ENTER button.

The current calibration time setpoint is displayed in seconds, with the first digit flashing to indicate the edit mode. The bargraph will turn off, the analog output will remain fixed at their value just prior to entering Calibrate, the Fail LED will illuminate, the radiation unit backlights will turn off, the High and Warn alarm conditions will clear, and the fail safe High, Warn and Fail relays will change state. The calibration setpoint may be edited, but will reset to 60 seconds whenever the unit is turned off or the functional switch is moved from position 8.

Once the desired calibration time is set, momentarily pressing the ENTER button again will start the calibration. The display will go to zero and the unit's backlight will begin to flash. The UDR will count for the entered calibration time, displaying the current summation of counts each second. When the calibration is completed, the final summation of counts for the calibration time is displayed and the unit's backlights will be steady on.

Another calibration can then be executed by pressing the ENTER key, and the system will again display the calibration time for editing. Pressing the Enter button again will start the Calibrate timer. A calibration in process can be stopped by pressing the ENTER key or by moving the rotary switch to a position other than position 8. The calibration mode is exited by moving the rotary function switch out of position 8. The UDR will reset, the fail safe High, Warn, and Fail relays will energize, and the UDR will continue normal operation.

NOTE

When the calibrate mode is initiated (i.e. rotary setpoint switch at position 8 and the Enter button is pressed), the Alarm, Warn, and Fail relays change state to indicate the monitor is in a non-operational state.

The calibration mode can also be entered with the UDR in the check source mode of operation. Move the rotary switch to position 8 and press the check source button. While holding down the check source button, press the ENTER button. This will turn the Check Source LED on, actuate the check source relay, and lock the Check Source function on. The Check Source button may now be released and the Check Source will remain on. Pressing the enter button again will start the calibration. The check source light will remain on, indicating that the check source relay is energized. The check source condition will clear when the calibrate mode is exited.

In Calibrate mode, the analog outputs are frozen at their last value, prior to entering the Calibrate mode.

In Calibrate mode, any High and Warn alarms are cleared, the Fail LED is turned on, and the failsafe Alarm, Warn and Fail relays change state, to indicate the unit is not monitoring radiation.

In Calibrate mode, the bargraph display is blanked.

3.5 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 3.

Alarm Logic Types

Alarm logic defines whether the alarm is reset manually or automatically and 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 RANGE and FAIL alarm. Failsafe operation is also standard.

Auto reset for the 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-Failsafe 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 setpoint 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, and the HIGH alarm relay coil de-energizes. When the alarm is acknowledged, the HIGH alarm indicator goes steady on.

The HIGH alarm relay will change state (i.e. energize) after the Acknowledge push button is pressed and the radiation value drops below the setpoint.

The HIGH alarm is normally inhibited in Check Source mode. By removing jumper PJ3-5, the HIGH and WARN alarms may be enabled in check Source mode.

The firmware will not accept a High setpoint that is lower than the Warn setpoint.

WARN Alarm

The WARN alarm condition is "true" when the display dose rate is greater than or equal to the WARN alarm setpoint 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 normally inhibited in Check Source mode. By removing jumper JP3-5, the HIGH and WARN alarms may be enabled in Check Source mode.

The firmware will not accept a Warn setpoint that is higher than the High setpoint.

RANGE Alarms

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 Alarm, Warn, and Fail relays are not affected by the underrange alarm.

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

The OVERRANGE is true when the dose rate is greater than or equal to the overrange setpoint or the Model 897A preamplifier is sending an output pulse greater than the detector preamplifier Anti-Jam circuit setpoint. The condition is false when neither of the conditions are true.

When the OVERRANGE 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 OVERRANGE alarm setpoint is operator adjustable.

NOTE

In addition to the display of **EEEE** when in Overrange, the **mR/h** engineering units will be displayed if the HIGH or WARN front panel set point display pushbuttons have been accessed. If desired, the **mR/h** units display may be cleared by either pressing the **ENTER** pushbutton, or cycling the UDR power OFF/ON. The mR/h unit's display, however, does not affect the operation of the Overrange function.

The OVERRANGE alarm must be reset by pressing the acknowledge pushbutton when the overrange condition is false (i.e. radiation level returns to a value below the overrange setpoint). The OVERRANGE alarm will not reset automatically, at a later time, after the acknowledge pushbutton is pressed as it does for the HIGH and WARN alarms. If auto reset is selected for HIGH and WARN alarms, these will reset automatically, but the overrange display will remain until the acknowledge pushbutton is pressed.

In addition, if the detector output is above the electronic anti-jam circuit threshold of the UDR, the anti-jam circuit will be activated, opening the anti-jam fuse on the UDR. This causes the fail LED to turn on, the fail relay to change state, and the detector High Voltage power supply to turn off indicating a non-operational mode. After the anti-jam condition has cleared, to return to normal operation, the 956A UDR must be powered off, the anti-jam fuse replaced, and the power turned back on.

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 956A-201 UDR:

1. NO COUNT Failure
2. POWER Failure
3. MPU Failure (hardware)
4. Anti-Jam Trip

No Count Failure

If no pulses are received by the UDR for five minutes, a no count failure is detected. A no count alarm usually indicates a failure in the detector or UDR detector high voltage supply. The UDR display, however, may read zero for five minutes or more without a low signal fail alarm. This is because the re-amplifier is reporting a non-zero dose rate that is below the low range value. The No Count failure alarm can be disabled by removing jumper JP3-4 from the UDR main board.

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 checks the MPU (main processor) function, is allowed to time out (because of a hardware failure), a failure condition will be indicated.

Anti-Jam Trip

Should the detector output exceed the UDR anti-jam circuit threshold, the anti-jam fuse opens the detector high voltage is shut down the fail FAIL LED will illuminate, and the Fail relay will de-energize.

3.6 JUMPER SELECTABLE CONFIGURATION FUNCTIONS

The UDR contains a series of eleven hardware jumpers and nine user specified setpoints that affect operation of the unit.

The jumpers are designated as JP1 and JP2, JP3-1 through JP3-5, and JP4 through JP7. Refer to the main circuit board assembly drawing located in Appendix B of this manual for jumper locations. The functions affected by JP1 through JP7 are described in the following paragraphs and shown in Table 3-2.

NOTE

The unit will only read jumper selection on power-up; therefore, the unit must be turned off when changing jumpers.

Microprocessor Reset

Jumper JP1 permits local reset of the microprocessor without cycling AC power.

PROM Type

Jumper JP2 must be installed in position 2-3 for use with the 27256 PROM installed.

Count Time Selection (Statistical Accuracy)

The statistical accuracy jumpers JP3-1 & JP3-2, are not implemented. This statistical accuracy, count time and consequently, the update time of the display are fixed. The unit is shipped from the factory with both JP3-1 and JP3-2 installed, resulting in a displayed value that is the sum of 60, one second values, updated once per second.

Alarm Reset (Acknowledge)

1. JP3-3 OUT - The unit resets alarm indicators and alarm relays after the radiation value falls below the setpoint without regard to the alarm acknowledge pushbutton.

2. JP3-3 IN - The unit maintains the alarm indicators and alarm relays in the alarm state until the alarm acknowledge pushbutton has been pressed and the radiation value falls below the setpoint. If the alarm acknowledge pushbutton is pressed while the radiation value is still above the setpoint, the flashing indicator will go to a steady state ON condition.

The UDR is normally shipped from the factory with JP3-3 installed.

No Counts Fail Alarm

1. JP3-4 IN - The unit will go into a FAIL mode after five minutes with no counts from the detector.
2. JP3-4 OUT - The unit will not go into a FAIL mode when there are no counts from the detector.

The UDR is normally shipped from the factory with JP3-4 installed.

Inhibit Alarms (Check Source Operation)

1. P3-5 OUT - The alarms will become active during check source operation if alarm limits are exceeded.
2. JP3-5 IN - Alarms are inhibited during check source operation, but if the unit is in an alarm condition when the check source is activated, it will remain in the alarm condition.

The UDR is normally shipped from the factory with JP3-5 in.

Input Pulse Selection

Jumper JP4 is set to position 2-3 for G-M detector inputs. Position 1-2 is provided for use with other detectors.

Input Shield Polarity

Jumper JP5 is set to position 2-3 for G-M detector inputs. Position 1-2 is provided for use with other detectors.

Anti-Jam Selection

Jumper JP6 is normally installed in position 1-2. Position 2-3 bypasses the anti-jam fuse for test purposes.

Detector Type

Jumper JP7 is set to position 2-3 for a G-M detector input. Position 1-2 is provided for use with a scintillation detector. Removing the Jumper disables the anti-jam circuit for test purposes.

Table 3-2. Model 956A-201 Option Jumpers

Jumper	Function	Position	Operation
JP1	Microprocessor Reset	Out IN	Normal Operation (factory) Momentary connect to reset microprocessor without cycling AC power Not Applicable
JP2	PROM Type	1-2 2-3	PROM 27128 PROM 27256 (factory)
JP3-1/JP3-2	Statistical Accuracy (Note: this accuracy refers only to the statistical interpretation of detector counts, and not detector accuracy)	Out/Out Out/In In/Out In/IN	2% Accuracy – 9604 Target Counts, Not implemented 5% Accuracy – 1537 Target Counts, Not implemented 10% Accuracy – 384 Target Counts, Not implemented Fixed one second display update of 60 one second values (factory)
JP3-3	Alarm Acknowledge	In Out	Manual Acknowledge (factory) Automatic
JP3-4	Fail Alarm	In Out	Enable No Counts Fail Alarm (factory) Inhibit No Counts Fail Alarm
JP3-5	Check Source Alarm	In Out	Alarm Inhibited (factory) Alarm Enabled
JP4	Input Pulse Selection	1-2 2-3	Negative Input Pulse (Other Detectors) Positive Input Pulse (G-M Detectors) (factory)
JP5	Shield Polarity Selection	1-2 2-3	Shield for Negative Pulse Shield for Positive Pulse (G-M) (factory)
JP-6	Anti-Jam Fuse Selection	1-2 2-3	Enable for Normal Operation (factory) Anti-Jam Circuit fuse bypassed (testing)
JP7	Detector Type for Anti-Jam Circuit Timing	1-2 2-3 Out	Scintillation G-M Tube (factory) Anti-Jam Circuit Disabled (for testing only)

3.7 POWER UP PROCEDURE

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

1. Verify that the UDR configuration jumpers are properly selected. Refer to Section 3.6 "**Configuration Functions**" for addition information if required.
2. Verify that the UDR Function switch, located on the front right section of the UDR main board, is in a position other than 8.
3. Verify that the detector and UDR are properly connected.
4. Apply power to the system. If all connections are good, the UDR will power up and will begin to monitor the ambient radiation level.

NOTE

The appearance of error codes E0002 or E0008 may indicate that the setpoint memory has not been initialized. To initialize the setpoint 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).

5. Detector dependent setpoints (i.e. analog output High/Low scale values, range, underrange, overrange, calibration constant, detector deadtime) and channel dependent setpoints, (i.e. as alarm limits), may be entered using the procedure described in this section. The UDR contains default values for all setpoints to permit power-up prior to user-defined values being entered.

NOTE

Ensure the setpoints entered are within the normal range of expected operation before entry, or spurious alarms may be generated.

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 year. If the unit has been in storage for more than one year, the electronic calibration described in Section 4 should be performed.

3.8 UDR FUNCTION SWITCH AND PARAMETER ENTRY

Table 3-3 shows the UDR Function Switch positions and the function.

Table 3-3. UDR Function Switch Positions/Function

Switch Position	Function
0	Selects HIGH Alarm Setpoint
1	Selects WARN Alarm Setpoint
2	Selects Resolving Time (Detector Dead Time)
3	Selects Analog Full Scale Limit
4	Selects Overrange Limit
5	Selects Conversion Constant
6	(Not Used)
7	Selects Analog Low Scale
8	Selects Calibrate Mode
9	Selects Underrange Value

Parameter Entry

Parameter entry is accomplished using a sixteen position rotary switch labeled FUNCTION and three momentary pushbutton switches labeled ENTER, VALUE, and DIGIT. These switches are located on the right side of the main circuit board about two inches behind the front panel and are accessible by partially removing the unit from its mounting case.

The FUNCTION switch is used to select the parameter to be entered. It is located on the right side of the main board, directly in front of the power supply. Table 3-4 defines the switch positions and a description of each parameter can be found in the following paragraphs.

Table 3-4. Function Switch Entry Parameters

Switch Position	Setpoint	Units	Detector 897A-21X	Detector 897A-22X	Detector 897A-23X	Default Value
0	High Alarm Limit	mR/h	**	**	**	1.00E3
1	Warn Alarm Limit	mR/h	**	**	**	1.00E1
2	Resolving Time (Dead Time)	minutes	*	*	*	0.00E0
3	Analog Full Scale Value	mR/h	1.00E3	1.00E4	1.00E5	1.00E4
4	Overrange Limit	mR/h	1.00E3	1.00E4	1.00E5	1.00E4
5	Conversion Constant	mRh/CPM	*	*	*	1.00E-2
6	Not Used	N/A	E0007	E0007	E0007	E0007
7	Analog Low Scale Value	mR/h	1.00E-2	1.00E-1	1.00E0	1.00E-1
8	Calibration Mode/Time	seconds	**	**	**	6.00E1
9	Underrange Limit	mR/h	1.00E-2	1.00E-1	1.00E0	1.00E-1
A through F	Not Used	-	E0007	E0007	E0007	E0007

* Detector unique, provided with the detector/detector calibration sheet.

** User Selected (detector range dependent).

To enter or display a parameter, the FUNCTION switch is set to the desired position and the following steps are performed:

NOTE

In the event it is necessary to re-enter all of the default setpoints, the UDR EPROM memory may be reinitialized by turning the UDR power off, then depressing the ENTER pushbutton at the same time the power on switch is depressed. Releasing the ENTER pushbutton and momentarily depressing the ENTER pushbutton again to exit the setpoint entry mode and return to normal operation.

1. Press the ENTER pushbutton. The current value of the parameter, selected by the FUNCTION switch will be displayed on the front panel. The leftmost digit of the value will be flashing. The value is displayed in the format shown below.

M.MMEN

This format expresses the form of M.MMEN, where M is a whole number from 0 to 9, E designates a positive exponent, and N represents the exponent value from 0 to 9. A negative exponent is expressed as a minus (-) character in the E position. Pressing the Enter button again enters the value currently displayed into non-volatile setpoint memory.

2. The value of the flashing digit can be incremented by pressing the VALUE pushbutton.
3. The flashing digit can be moved one place to the right by pressing the DIGIT pushbutton.
4. When the desired value has been entered into the display, pressing the ENTER pushbutton causes the displayed value to be entered into non-volatile memory for permanent storage. The new parameter value is now effective.
5. Refer to Table 3-4 for a listing of function switch setpoint descriptions.

6. The firmware in the UDR checks alarm, and analog range setpoints for invalid conditions, and will not accept an invalid setpoint (i.e. Warn alarm greater than High alarm, High alarm less than Warn alarm) as defined in Setpoint Descriptions, Section 3.8. After a setpoint has been changed, the operator must re-display the setpoint, to verify the new setpoint has been accepted.
7. During setpoint entry, the bar graph and analog outputs function normally. Once the setpoint is entered, the impact of the changed value, if any, will be seen.

3.9 SETPOINT DESCRIPTIONS

High Alarm Limit, Setpoint 0

This setpoint is entered in units of mR/h in the exponential format X.XXEN. The high alarm limit setpoint can be set to any value desired. When the display value exceeds this limit, the UDR will go into a HIGH alarm state. 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, Setpoint 1

This setpoint is entered in units of mR/h in the exponential format X.XXEN. The warn alarm limit setpoint can be set to any value desired, but must be lower than the high alarm limit setpoint. When the displayed value exceeds this limit, the UDR will go into a WARN alarm state. 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.

Resolving Time (Dead Time), Setpoint 2

This setpoint is entered in units of minutes per count. The actual value to be entered is a function of the individual detector and is stated on the calibration data sheet supplied with the detector. If a complete system is purchased (i.e. 955A-100), this setpoint is entered at the factory.

Analog Full Scale Value, Setpoint 3

This value is the dose rate at which the analog output is set to full scale (i.e. 10 volts or 20 mA). This value must be an even power of 10 that is at least 1 decade higher than the analog low scale value. An even power of 10 is a number of the form 1.00EX, where E indicates a positive exponent, a (-) sign indicates a negative exponent, and X equals a number between 0 and 9. This parameter is entered in units of mR/h and sets the upper value of the analog outputs. This value must be set to exact decade values. Example: 1.00E4 is acceptable, 2.00E4 is not. A setpoint that is other than 1.0 will not be accepted by the UDR. If the analog Full Scale value is equal to the Low Scale Value, Error Code E0008 is displayed. If the Full Scale Value is less than the Low Scale Value, the setpoint is not accepted.

Overrange, Setpoint 4

This setpoint is entered in units of mR/h. It is normally set for the upper limit value of the detector used (for the 897A-210 it is 1.00E3, for the 897A-220 it is 1.00E4, and for the 897A-230 it is 1.00E5). When the measured radiation value exceeds this setpoint, the unit goes into a range alarm state. The overrange limit must be greater than or equal to the HIGH or WARN setpoints.

Conversion Constant, Setpoint 5

This setpoint is a detector dependent value that is used to convert the detector output, counts per minute (CPM) to mR/h. The actual value to be entered is stated on the detector calibration data sheet. The units are mR/h per counts per minute. If a complete system is purchased (i.e. 955A-100), this setpoint is entered at the factory.

Setpoint 6

Not used.

Analog Low Scale Value, Setpoint 7

This value is the dose rate at which the analog output is set to low scale (i.e. 0 volt or 4 mA). This value must be an even power of 10 that is at least one (1) decade lower than the analog full-scale value. An even power of 10 is a number of the form 1.00EX, where E indicates a positive exponent and a (-) sign indicates a negative exponent, and X equals a number between 0 and 9. This parameter is entered in units of mR/h and sets the lower range of the analog outputs. This value must be set to exact decade values. Example: 1.00E-1 is acceptable, 2.00E-1 is not. A setpoint that is other than 1.0 will not be accepted by the UDR. If the analog Low Scale value is equal to the High Scale Value, Error Code E0008 is displayed. If the Low Scale Value is higher than the High Scale Value, the setpoint is not accepted.

Calibrate Mode, Setpoint 8

This function permits use of the UDR as a scaler, by entering a fixed counting time, and displaying the integrated counts during this period. The units are entered in seconds.

Underrange Limit, Setpoint 9

This setpoint is normally set to the low range limit of the detector used, and is entered in mR/h. 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. When the measured radiation value is less than this value, the unit goes into a RANGE alarm state.

3.10 SETPOINT ERROR CODES

If, after entering a setpoint or upon power-up, an error code is displayed, it may be due to incorrect setpoints. Refer to Table 3-5 for a listing of error codes.

Code **E0001** indicates that the display value is negative. Usually this means that the setpoint PROM is bad or needs to be initialized. To initialize the setpoint memory to the default values, power up the UDR with the ENTER button held down. If initializing the setpoint memory does not help, then the setpoint PROM is defective or there is a hardware malfunction.

Code **E0007** indicates that the specific function is not implemented, and that no setpoint may be entered. E0007 may be cleared by pressing the ENTER pushbutton, and then rotating the function switch to another position.

Code **E0008** indicates that the analog output setpoints are invalid. When the analog Full Scale or Low Scale are set equal to each other, E0008 is displayed. E0008 will continue to be displayed until a valid setpoint is entered, by pressing the enter pushbutton, and editing the setpoint to an acceptable value.

When an Invalid setpoint is entered, the UDR will accept the value entered, and then apply the validity check. If an invalid setpoint is identified, E0008 will be displayed approximately two (2) seconds after the setpoint is entered.

If E0008 is displayed after a setpoint is entered, a valid setpoint must be re-entered to remove the error message. After a new setpoint is entered, E0008 may momentarily be displayed, while a new validity check is made, prior to the display returning to normal.

If the analog Full Scale is initially set below the analog Low Scale, or the analog Low Scale is initially set above the analog Full Scale, the setpoint is invalid, and will not be accepted. After entry of a new setpoint, it is recommended that entry of the new setpoint be verified by displaying the new setpoint value.

Code **EEEE** indicates that the monitored radiation field is greater than the maximum range of the detector.

Error codes are cleared automatically when the initiating event is corrected.

Table 3-5. Model 956A-201 Error Codes

Error Codes	Function
E0001	Negative display data
E0002	Invalid setpoint value (s) (Not implemented)
E0007	Invalid Function
E0008	Invalid analog scale values
EEEE	Overrange Condition

NOTE

For PROM version 94095603, the display of Error Codes E0002 invalid setpoint is not enabled. When an invalid setpoint is selected, and the ENTER pushbutton is pressed, the invalid setpoint is not accepted, and an error code is not displayed. It is recommended that after any setpoint change is made, the operator rechecks the setpoint value, to ensure the desired value has been entered.

3.11 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 3 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). Output current or voltage is calculated using the following equations (shown below):

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

and

$$V = P(V_{Max} - V_{Min}) + V_{Min} \quad \text{or} \quad I = P(I_{Max} - I_{Min}) + I_{Min}$$

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

V_{max} = Maximum voltage available (usually 10Vdc)

I_{max} = Maximum current available (usually 20 mA)

V_{min} = Minimum voltage available (usually 0 Vdc)

I_{min} = 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:

$$\begin{aligned} \text{Assume: } LSV &= 1E-1, FSV = 1E7, R = 1E3, I_{Max} = 20 \text{ mA, and } I_{Min} = 4 \text{ mA,} \\ \text{Then: } P &= \frac{[\log (1E3/1E-1)]}{[\log (1E7) - \log (1E-1)]} \\ &= \frac{\log (1E4)}{\log (1E8)} \\ &= 4/8 = 0.5 \\ \text{and: } I &= 0.5 (20 \text{ mA} - 4 \text{ mA}) + 4 \text{ mA} \\ &= 0.5 (16 \text{ mA}) + 4 \text{ mA} \\ &= 12 \text{ mA} \end{aligned}$$

To aid in calibrating the analog output, the high scale or low scale setpoint may be set to force the output high or low. If the low scale setpoint is set above the displayed value, the analog output will be forced to low scale. If the high scale value is set below the displayed value, the analog output will be forced to full scale. The procedure for calibrating the analog outputs is contained in Section 4.

3.12 SOFTWARE CALCULATIONS

The 956A-201 UDR requires setpoints to be entered which are inherent to each particular detector. The following explains the calibration constant and resolving time.

Conversion Constant

The first of these setpoints is the conversion constant. The conversion constant converts the detector pulse rate into an mR/h value, using the following equation:

$$D = (\text{CPM} \times K)$$

Where: D = the calculated value in mR/h (used for alarm setpoint limit checks)
CPM = the current, corrected, count rate in CPM (the sum of the 60 most recent one (1) second values, corrected for Tau)
K = the conversion constant in mR/h/CPM

The value of K is supplied on the detector calibration data sheet.

Resolving Time (Dead Time)

This constant is a correction for the resolving time of the detector. As the radiation field that the detector is viewing increases, the detector cannot count every pulse, because some are in coincidence or are so close together that two pulses may look like one. To correct for this non-linearity, the resolving time is corrected for by the following equation:

$$\text{CPM} = \frac{R_o}{1 - (R_o \times \text{Dead Time})}$$

Where: CPM = the true count rate
R_o = the observed count rate (*the sum of the 60 most recent one (1) second values*)
Dead Time = the resolving time in minutes/count

The value of Dead Time is supplied with the detector and is found on the detector calibration data sheet. This value identified as TAU on the data sheet.

3.13 FUNCTIONAL DESCRIPTION, MODEL 897A G-M DETECTOR

The 955A-XXYYZ consists of a Model 897A-2XX Detector, a Model 956A-201 Digital Readout, and an interconnecting cable. Optional Model 958A local analog display and audible/visual alarm units may also be provided. The following describes the Model 897A-2XX. Separate manuals are provided for the Model 958A Local Alarm Units.

897A Series Detector

Functionally, the detector is divided into the G-M tube and the preamplifier. The high voltage power supply for the detector is located in the 956A-201 Universal Digital Ratemeter. The block diagram for the 897A Series Detectors is shown in Figure 3-1. For additional information, refer to the applicable drawings located in Appendix B. The following versions of the Model 897A detector are available:

Model Number	Range	Material
897A-210	0.01 to 1.00E3 mR/h	Carbon Steel Housing
897A-211	0.01 to 1.00E3 mR/h	Stainless Steel Housing
897A-220	0.10 to 1.00E4 mR/h	Carbon Steel Housing
897A-221	0.10 to 1.00E4 mR/h	Stainless Steel Housing
897A-230	1.00 to 1.00E5 mR/h	Carbon Steel Housing
897A-231	1.00 to 1.00E5 mR/h	Stainless Steel Housing

The 897A Series detector is a thin walled, electronic tube composed of a negative electrode (cathode) and a positive electrode (anode). The tube is filled with a mixture of one or more noble gases, plus a small amount of an additional gas that acts as a quenching agent.

Circuit Description

Quad comparator Z1 consists of two (2) circuit configurations with four states. Three of the four states are comparators (Z1A is an input comparator, Z1B is an output comparator, and Z1C is an anti-jam comparator). The fourth state, Z1D, is an oscillator for the anti-jam circuitry.

Transistors Q3 and Q4, with associated circuitry, provide a divide by 2 function, for use with Victoreen analog and digital area monitor readouts.

When ionizing radiation is not present at the G-M detector, the input level of Z1A (pin 9) is higher in potential than the voltage level at pin 8. Using discriminator bias control R44, the amount of potential difference can be adjusted between these inputs, allowing input pulse discrimination. Under the above condition, the output of Z1A is in a high state. R23, R20, and R30 create a voltage divider that biases pin 7 of Z1B to 7.5 Vdc. R24 and R36 bias pin 6 to 5 Vdc, causing the output of Z1B to go high. This action allows Q1 to conduct, causing a low state to exist at the output.

When an ionizing event occurs, the G-M tube produces a negative pulse that is coupled through C10 to input comparator Z1A. Pin 9 is now at a lower voltage potential than pin 8 forcing the output of Z1A to a low state. The voltage at pin 7 of Z1B is reduced to 2.5 Vdc, causing a low output state. This action causes Q2 to conduct, presenting a +10 Vdc signal at the output (unterminated).

If saturation occurs, the detector provides a high dc current. The current flows through R25, inducing a voltage at pin 11 of Z1C. When the potential at Z1C is higher than the anti-jam setpoint (R41), the output is forced from a low state (normal operating condition) to a high state. Two (2) events occur when a saturation condition exists:

1. Q5, normally off, enters saturation, clamping the output of Z1A to a low state. The potential at pin 5 of Z1D is reduced to 2.5 Vdc.
2. CR6 is reverse biased, enabling anti-jam oscillator Z1D. A square wave pulse of approximately 40,000 Hz is produced at pin 6 of Z1B that has an amplitude that is approximately 5.0 Vdc. Since pin 7 was previously biased to 2.5 Vdc, an output anti-jam square wave signal is generated and coupled to the readout.

The low voltage power supply input for the preamplifier is jumper selectable. This allows the use of either a +10 Vdc or +15 Vdc supply for detector power. If the detector is used in a 955A system, the + 15 Vdc position is used. If the detector is used in an 855 analog area monitoring system, the + 10 Vdc position is used. Jumper configurations are listed below.

Jumper	Position	Input Voltage
J3	AB	+ 15 Vdc (factory set), digital readout
J3	BC	+ 10 Vdc, analog readout

The divide by 2 (or binary stage) converts the G-M tube pulse output into a pure square wave, at a frequency exactly one half of the value of the input pulse frequency. This circuit provides more reliable signal transmission to the readout electronics. The output pulse conditioning is required for use with the diode pump circuitry used on older analog readouts. The optional jumper position, to use the detector pulse directly (divide by 1), is provided for use with high-speed pulse counting scalars. Jumper configurations are listed in below.

Jumper	Position	Divide Option
J1, J2	AB	2, square wave output (factory set)
J1, J2	BC	1, Direct coupled

Anti-Jam Setpoint

Adjustment of the anti-jam setpoint (R41) is performed during factory calibration. If replacement of the G-M tube is required, the detector should be returned to the factory for proper determination of the anti-jam setpoint voltage, the dead time correction, and the count conversion factor.

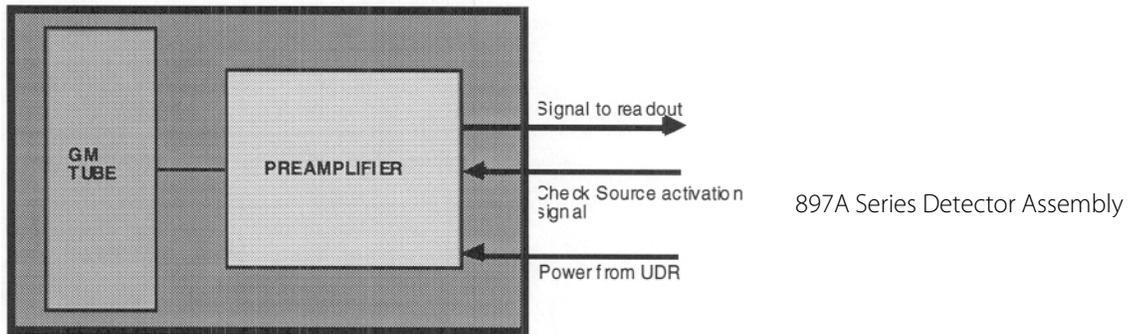


Figure 3-1. 897A Series Detector Block Diagram

Low Level Discriminator

In order to reduce electronic noise and the counting of spurious signals, an adjustable low-level discriminator circuit is provided. To reduce the potential for radiated electromagnetic emissions from being counted, the discriminator is factory set at 1.0 Vdc R44 is used to adjust this value.

Check Source Operation

The check source is provided to ensure that the G-M tube and the preamplifier are functional. The check source consists of an 8-microcurie ³⁶Cl source attached to a D'Arsonval meter movement. Upon actuation of the Check Source function, +15 Vdc is applied to the meter movement. This causes the check source pan to move over the access hole in the printed circuit board, exposing the source to the detector. The G-M tube then responds to the radioactivity present, resulting in an increase in the UDR display. Releasing the check source pushbutton applies + 15 Vdc to the meter movement, moving the check source to its de-activation, or rest position.

3.14 FUNCTIONAL DESCRIPTION UNIVERSAL DIGITAL RATEMETER (UDR), MODEL 956A-201

The Model 956A-201 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. Figure 3-2 is the system block diagram.

Main Circuit Board

The main circuit board contains the microprocessor, memory, analog output, signal input, and control circuitry. Some of the circuitry located on the circuit board may not be installed depending on the model. The following paragraphs explain the operation of the circuits in detail. Figure 3-3 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 3-4 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 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 non-maskable 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.

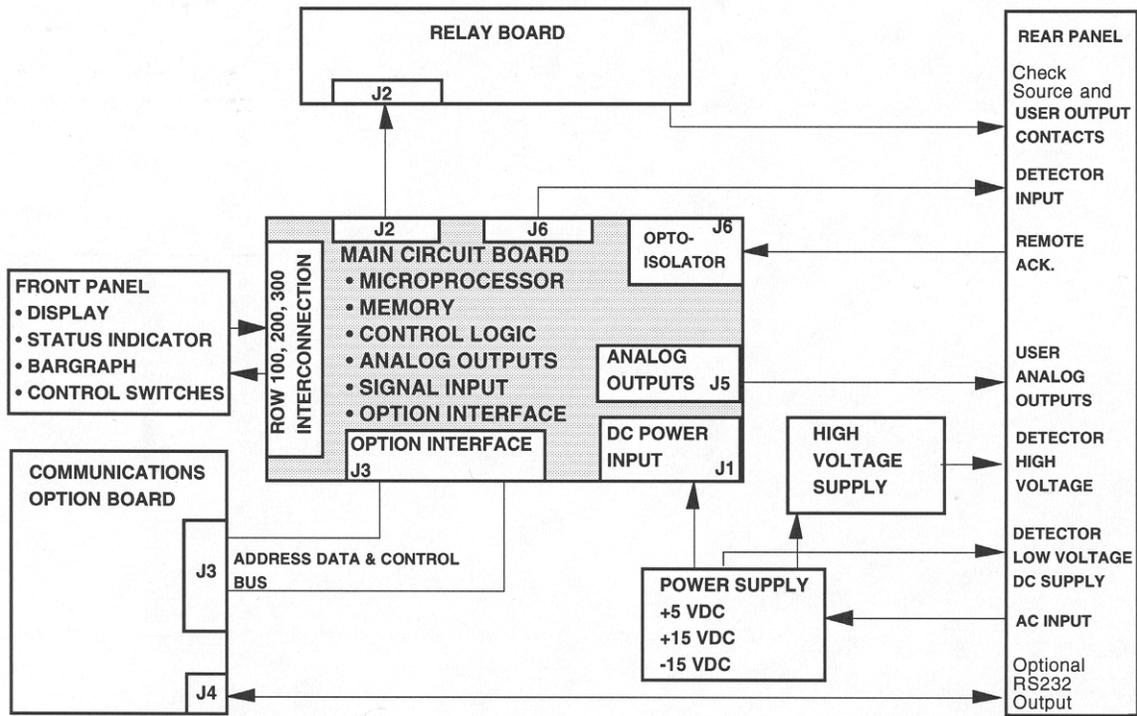


Figure 3-2. System Block Diagram

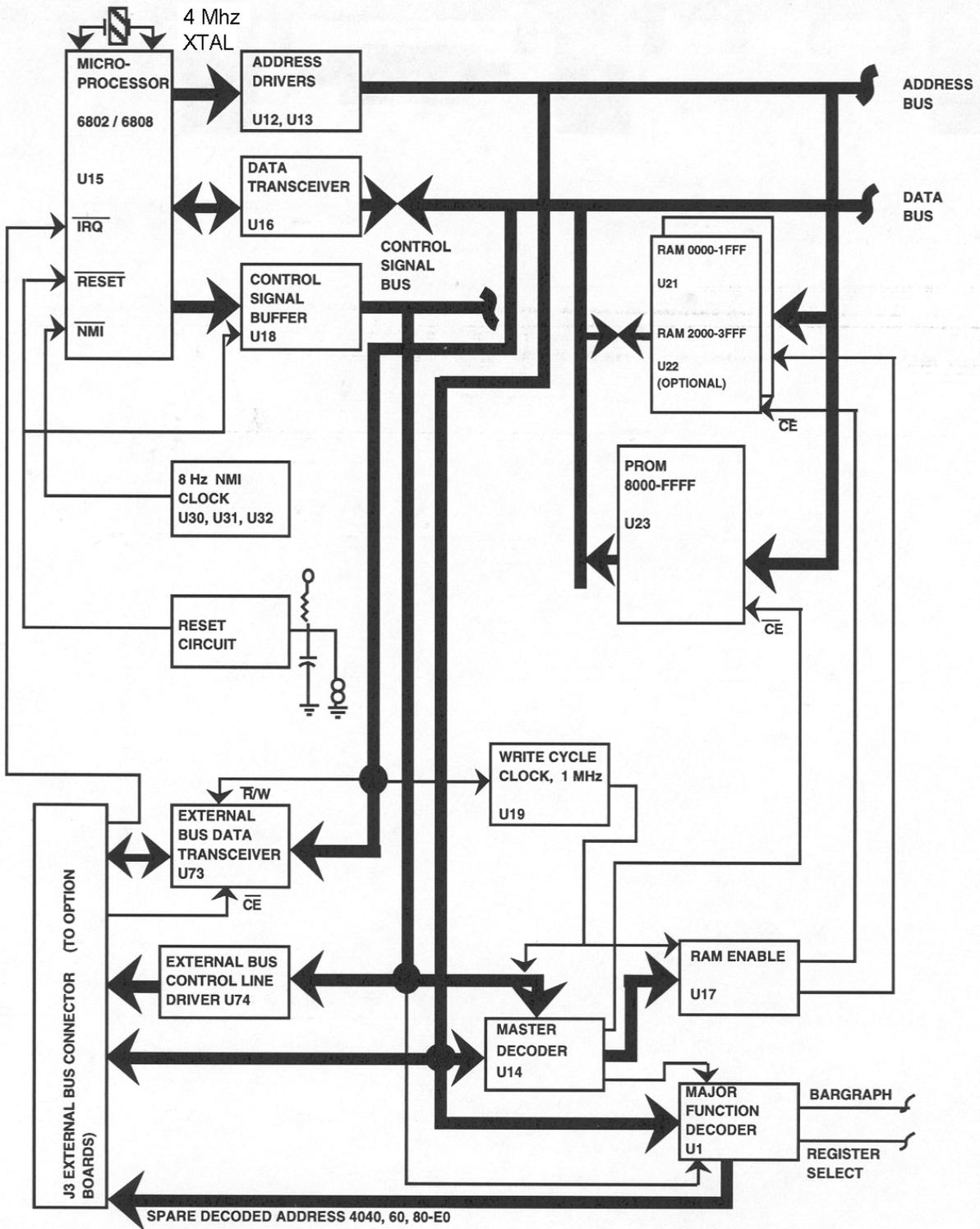


Figure 3-3. Page 1 of 3 Block Diagram – Main Circuit Board

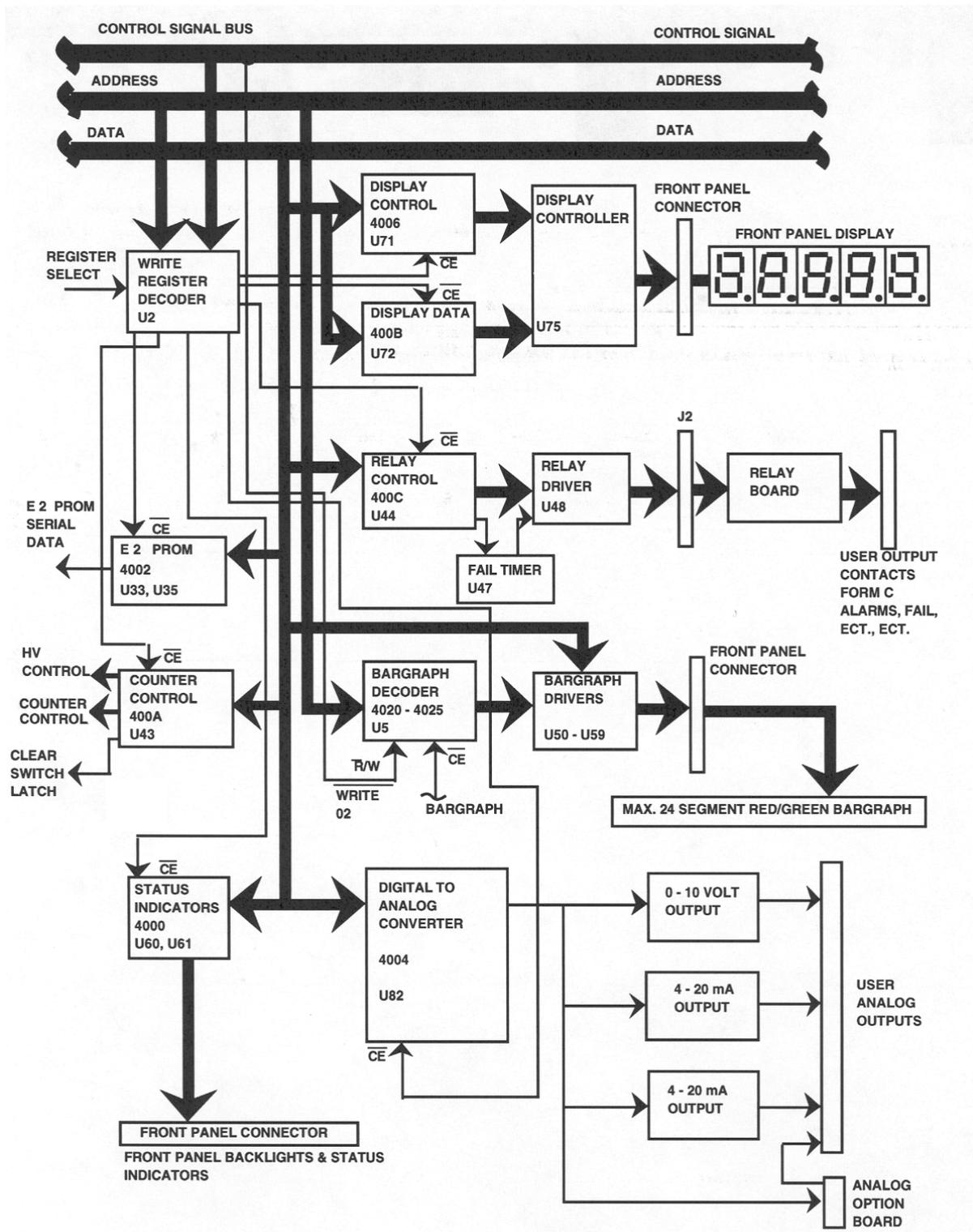


Figure 3-3. Page 2 of 3 Block Diagram – Main Circuit Board

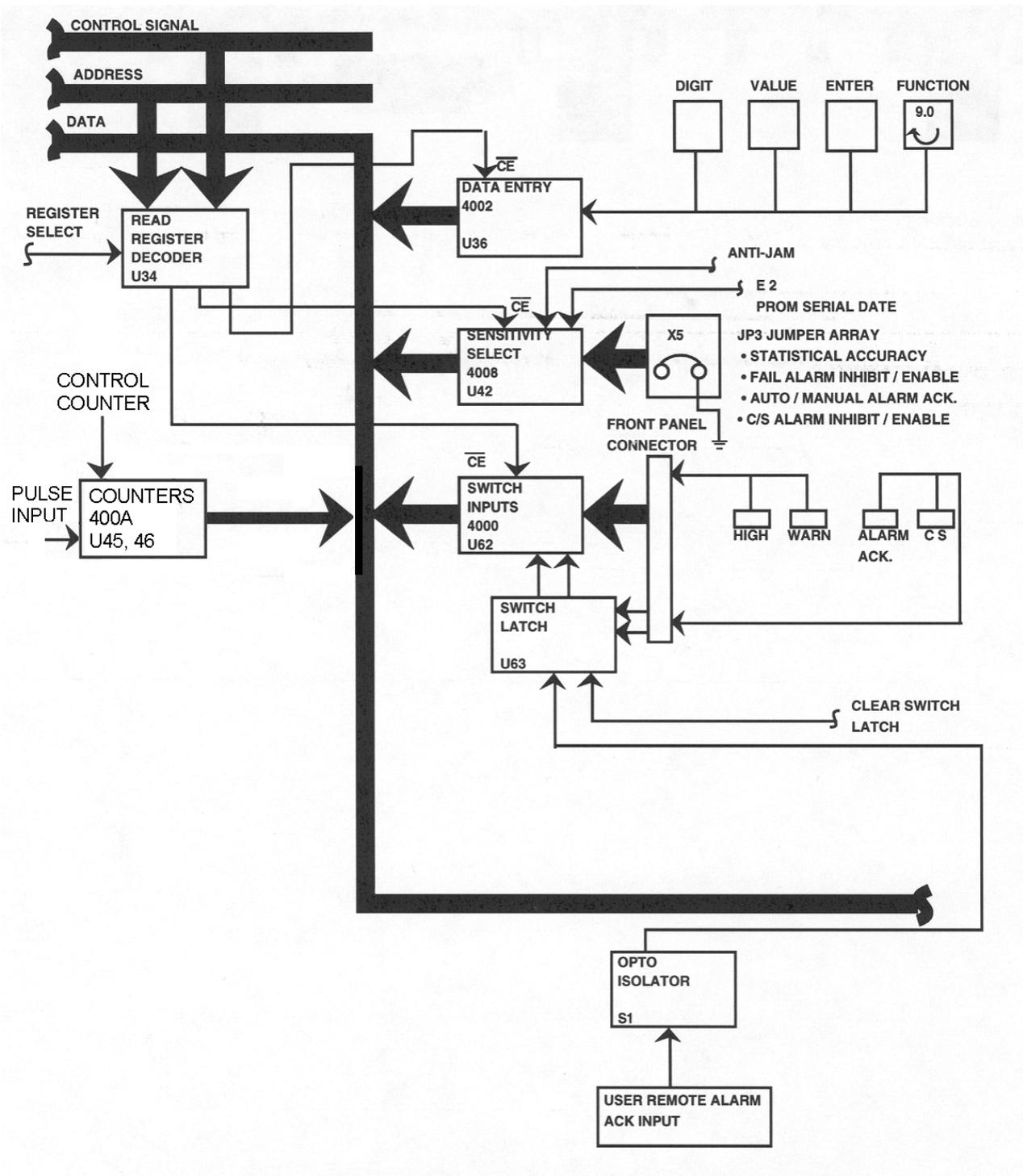


Figure 3-3. Page 3 of 3 Block Diagram – Main Circuit Board

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	μ S
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}	160	---	100	---	50	---	ns
		t_{AV2}	---	270	---	---	---	---	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

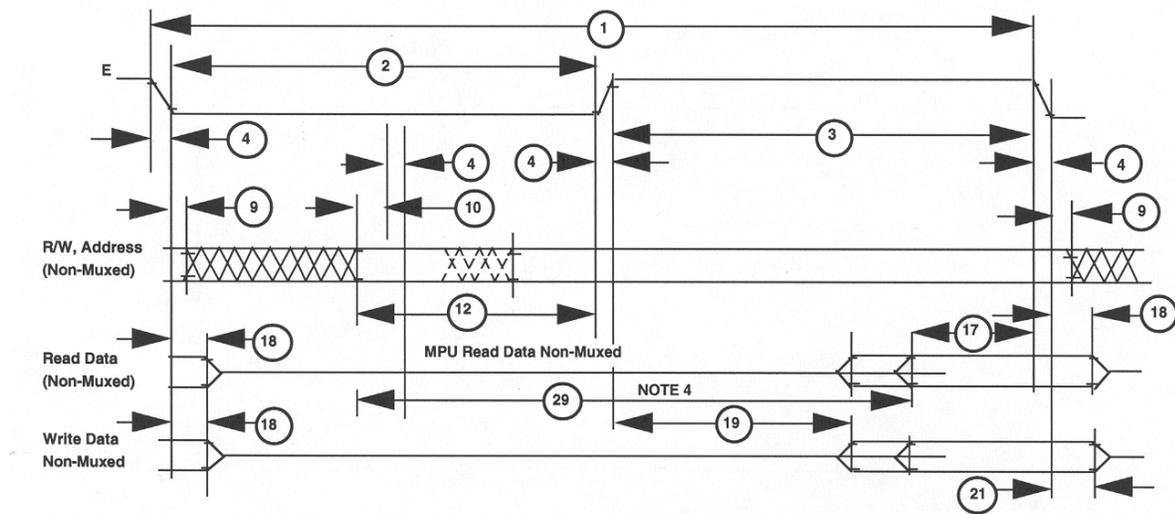


Figure 3-4. Read/Write Timing Diagram

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: $12 + 3 + 4 - 17$.

- 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.

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 are 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 VA 13 for a -225 ns delay from the falling clock edge. The second stage of U 19 produces a 225 ns output pulse width. Figure 3-5 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 that are used by the system.

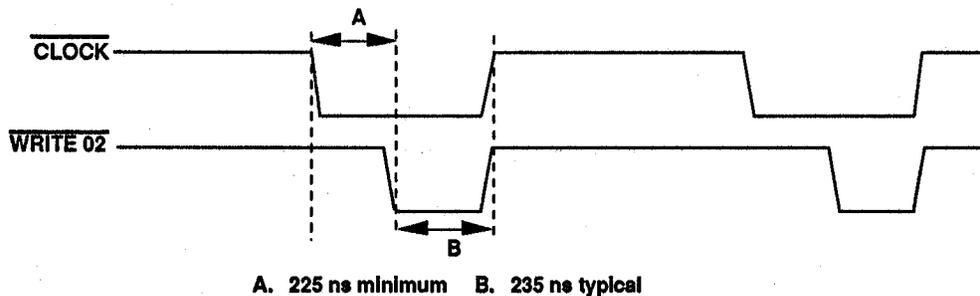


Table 3-5. Write Cycle Clock Timing Diagram

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 that 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 3-6 lists the output signals from U14.

Table 3-6. Output Signal (U14)

U14 PIN	Signal Name	Address	Read/Write
9	PROM 8000	8000-FFFF	Read Only
7	Spare	Spare	
6	RAM 2000 (future)	2000-3FFF	Read/Write
5	RAM 0000	0000-1FFF	Read/Write
4	I/O	4000-4FFF	Read/Write
3	RAM Write	0000-3FFF	Write Only
2	RAM Read	0000-3FFF	Read Only
1	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 that is a 1 of 8 decoder. U1 utilizes address lines A5, A6, A7, and A8 as well as Clock to generate outputs that are decoded in 32 hex blocks starting at address 4000. Table 3-7 lists U1 outputs, their functions and addresses.

Table 3-7. U1 Outputs

ADDRESS STATE				ADDRESS	FUNCTION
A8	A7	A6	A5		
0	0	0	0	4000	Register Select
0	0	0	1	4020	Bargraph
0	0	1	0	4040	ACIA (Communication Interface, optional)
0	0	1	1	4060	SCA (Analyzer, optional)
0	1	0	0	4080	GPIB (General Purpose Interface Bus)
0	1	0	1	40A0	Analog Input Option
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) is provided to the optional interface connector for use by external option circuit boards.

PROM

The Programmable Read Only Memory is typically a 27256 that is a UV erasable 32K x 8-bit PROM. U23, which responds to address 8000-FFFF, 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 that allows the use of a 27256 PROM (32K x 8).

RAM

Dynamic Random Access Memory (U21) is utilized for temporary data storage. U21, which responds to address 0000-1FFF (8K x 8 bit), is always present. Data stored in the RAM is lost on power down.

E²

Sixteen monitor specific, operator entered setpoints are stored in 64 bytes of non-volatile electrically erasable memory (E²). U33 provides storage for the setpoints (256 bytes max.). U35 is an 8-Bit control register.

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 falling 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) is latched by the falling edge of RAM 000. Data is stored into RAM on the falling 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 3-8 lists write registers, their assigned function and address.

Table 3-8. 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 3-9 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 3-9. Counter Control Register Write Functions

DATA BIT	FUNCTION
D0	Counter Clear
D1	Counter Enable
D2	HV Shutdown
D3	HV Select
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 3-10 lists relay control write functions.

Table 3-10. 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 (not used)

With the exception of the fail bit (DO), all outputs are applied to U48, which is an inverting open collector driver. The outputs of U48 drive (via the J2 connector) up to five (5) electromechanical relays located on the relay circuit board, P/N 942-100-70. The relays are used to indicate a High, Warn Fail, or Auxiliary (Rate) alarm and to operate a remote check source.

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 **watchdog timer** 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. U48 also drives the remote indicator (when used) on the front panel.

Bargraph (Write Only)

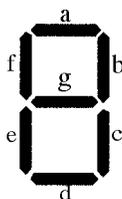
The bargraph addresses are decoded by U5, which is a 1 of 8 decoder. Control line inputs to U5 are R/W, Write 02, and Bargraph. When the bargraph address is selected (4020-4025), U5 further decodes the addresses listed in Table 3-11.

Table 3-11. Bargraph Write Address

ADDRESS STATE			HEX ADDRESS	Function	Driver
A3	A2	A1			
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 3-11. U50-U59 is BCD-to-7 segment latch/decoder/drivers. Each drives five segments (either red or green) with the exception of U54 and U59 that 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 3-12.

Table 3-12. Status Indicator Write Functions

Data Bit	Function
D0	Check Source Indicator
D1	Rate
D2	Overrange Indicator
D3	Warn Indicator
D4	High Alarm Indicator
D5	R/hr Backlight
D6	kR/h Backlight
D7	mR/h Backlight

U60 outputs, when high, control U61 inverter/driver to activate the appropriate front panel status indicators. U60 outputs, 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 (D0-03). 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



Data inputs D0-D3 and the decimal point, supplied by U72, are used to enter data in the selected digit as shown in Table 3-13.

Table 3-13. 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 Cutout Circuitry (Write Only)

The D/A converter (U82) is an 8-bit buffered multiplying device that responds to address 4004. Data is written and latched by U82 when CS (Clear to Send) and WR (Write) 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 (Read/Write) (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 3-14 lists the READ register, the assigned function and the address.

Table 3-14. Control Signal Address Decoding (U34)

Address State			Hex Address	Function
A3	A2	A1		
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 3-15. The function switch logic is shown in Table 3-16

Table 3-15. 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 3-16)
D5	(16 position function switch, see Table 3-16)
D6	(16 position function switch, see Table 3-16)
D7	(16 position function switch, see Table 3-16)

Table 3-16. Function Switch Logic

Hex Data	D7	D6	D5	D4	Position	Function
F	1	1	1	1	0	High
E	1	1	1	0	8	Calibrate Mode
D	1	1	0	1	1	Warn
C	1	1	0	0	9	Undefined
B	1	0	1	1	4	Overrange
A	1	0	1	0	C	Undefined
9	1	0	0	1	5	Conversion Constant
8	1	0	0	0	D	Undefined
7	0	1	1	1	2	Tau
6	0	1	1	0	A	Undefined
5	0	1	0	1	3	Full Scale Value
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	Low Scale Value
0	0	0	0	0	F	Undefined

Gross Counter (Read Only)

The gross counter is a 16-bit configuration. Octal buffer/drivers U40 (4004) and U41 (4006) interface the low and high counter bytes to the data bus from U45 and U46 respectively. Dual module 16 counters (U45, U46) accumulate counts from the signal processing circuitry over a program controlled sample period and make this data available to the MPU. A high level on U45 pins 2 and 12, and U46 pins 2 and 12 cause the counters to clear in anticipation of a sample being initiated. A low level activates the counters to accept pulses from the signal processing circuitry. Maximum count for a sample period is 32,768. When this count is achieved, U46 pin 8 goes high which causes the pulse counting to stop. This condition is recognized by the MPU as an indication of counter overflow.

Option Jumper Select (Read Only)

Octal buffer U42 functions as an interface to provide the status of the option jumpers for operating mode, anti-jam bit data, and serial data from E²PROM to the internal data bus and MPU. U42 responds to address 4008. The option jumper read functions are listed in table 3-17.

Table 3-17. Option Jumper 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 no counts (OUT) Does not fail
D5	JP3-3	(OUT) Auto alarm acknowledge, after counts return to normal (IN) Manual Reset (factory setting)
D6	JP3-2	IN/IN, Fixed 1 second update
D7	JP3-1	IN/OUT, 384 Target Counts, 10% accuracy OUT/IN, 1537 Target Counts, 5% accuracy OUT/OUT, 9604 Target Counts, 2% accuracy

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 3-18.

Table 3-18. Switch Input Bit Assignments (U62)

Data Bit	Function
D0	Alarm Acknowledge
D1	Check Source
D2	(Spare)
D3	(Spare)
D4	Rate-of-Rise (not used)
D5	Warn Alarm
D6	High Alarm
D7	High Voltage (not used)

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.

Signal Input Circuitry

Detector input pulse circuitry consists of an input buffer, high/low discriminators, signal detection, anti-jam and signal multiplexer circuits. The following paragraphs describe circuit operation in detail.

Buffer Amplifier

The detector input is connected to J6. The input impedance is 50 ohms to match the signal cable and the detector's output impedance. Jumpers JP4 and JP5 are used to select the proper pulse polarity as shown below.

Jumper	Function	Remarks
JP4 1-2	Pulse Polarity (Input)	For negative input
JP4 2-3	Pulse Polarity (Input)	For positive input (factory set)
JP5 1-2	Pulse Polarity (Shield)	For negative input
JP5 2-3	Pulse Polarity (Shield)	For positive input (factory set)

The detector input signal (with appropriate polarity jumpers installed) is applied to unity gain buffer amplifier U90. VR8 is used to fine adjust for unity gain. Regardless of input signal polarity, U90-6 outputs positive going pulses. VR9 is a zero offset adjust for U90. The buffer amplifier output is provided to the J7 connector (for use by analyzer option circuitry) as well as the high and low discriminators. TP-Pulse is available as a test.

Discriminators

The low level discriminator is comprised of comparator U91 device 2 and associated circuitry. VR11 is used to set the trip threshold. The adjustment range is 50 mV to 1 volt, which can be measured at the low discriminator test jack. As the positive pulse, applied to the input, passes through the trip threshold, the output (U91-6) is forced low. When the pulse returns through the trip threshold, the output U91-6 returns high and is ready to accept another input pulse. Pulses below the trip threshold do not trigger the output.

The high discriminator is comprised of comparator U91 device 1 and associated circuitry. VR10 is used to set the trip point. The adjustment range is 3.5 to 7.5 volts, which can be measured at the high discriminator test jack. As the positive pulse, applied to the input, passes through the trip threshold, the output (U91 device 1) is forced low. When the pulse returns through the trip threshold, the output (U91 device 1) returns high and is ready to accept another input pulse. Pulses below the trip threshold do not trigger the output.

The normal factory settings are:

- Low Disc.: 0.500 Vdc
- High Disc.: 7.000 Vdc

Figure 3-6 shows signal "A" below both discriminators, signal "B" between discriminators, and signal "C" above discriminators.

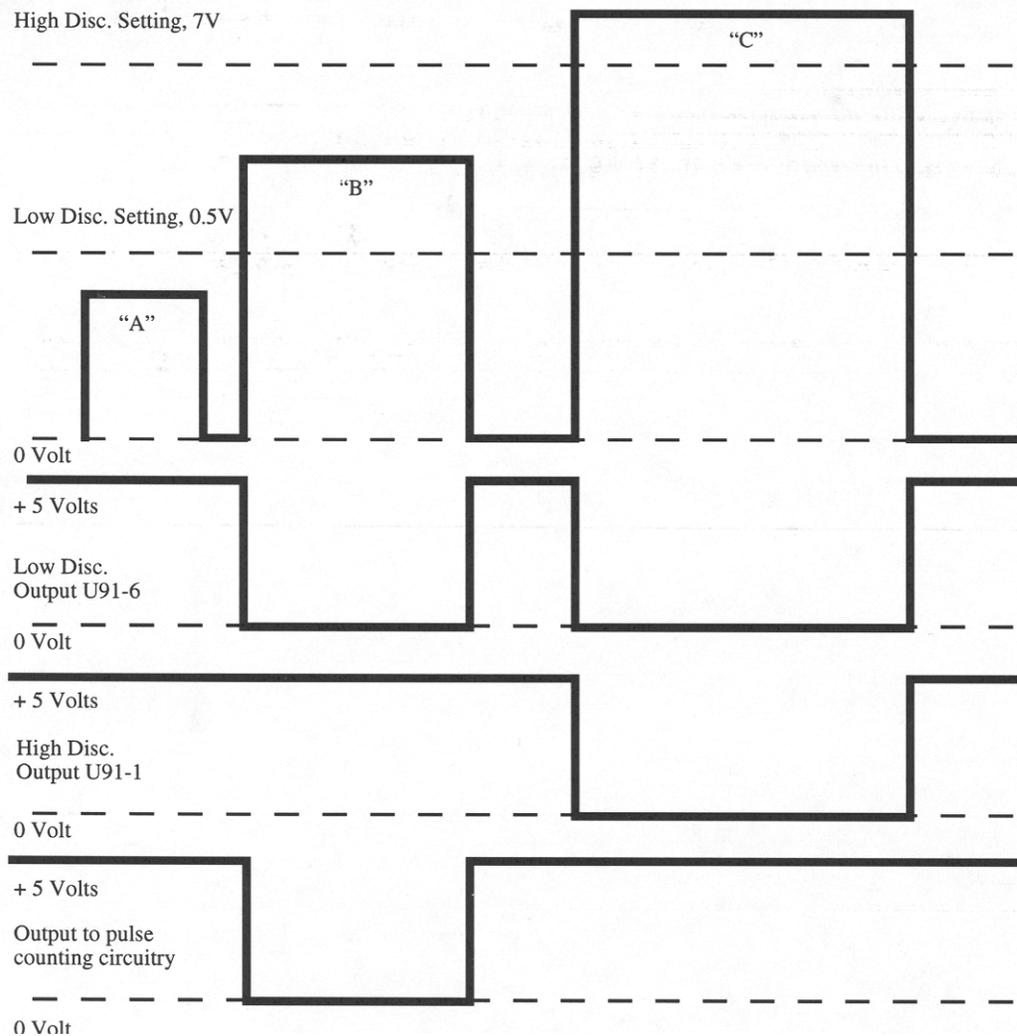


Figure 3-6. Discriminator Operation

- a. This pulse is below the low discriminator voltage and is not passed.
- b. This pulse is above the low discriminator voltage and below the upper discriminator voltage, and is passed to the counters.
- c. This pulse is above the upper discriminator and is not passed.

Signal Detection

The circuitry comprised of flip-flop U93 and inverters U11 and U94 utilize the low discriminator and high discriminator outputs to ensure that only input signals which peak between the discriminators are made available to the gross counters.

When U93-2 counter enable is brought high, under software control to initiate a sample period, and the low discriminator threshold is exceeded, a positive going edge on U93-3 clocks a high into flip-flop U93-5. Assuming the high discriminator has not been exceeded, when the input pulse returns through the low discriminator threshold, a positive going edge on U93-11 clocks the high on U93-12 to the output U93-9. A delayed positive pulse produced by the R/C network (R80/C35) on U93-13 allows the flip-flop output U93-9 to remain high until the delayed pulse on U93-13 returns low, which resets the output U93-9 low. U93-9 is connected to the signal multiplexer circuitry as described below.

When an input pulse exceeds both the high and low discriminators, the high (U93-5) clocked by the transition through the low discriminator is reset by the low (U91-1) resulting from the transition through the high discriminator. This action causes no pulse to be generated at U93-9.

Signal Multiplexer

The signal multiplexer comprised of U101, U102, and U94 allows the MPU to select either the radiation pulse or the frequency output representing the high voltage to be input to the gross counters. When counter enable is active (high), the signal detection circuit output (representing radiation) is routed to the gross counters. When HV select is active (high), the HV frequency is routed to the gross counters. The outputs connected to pull-up resistor R81, are open collectors allowing the most significant bit of the counters to force this node low, effectively terminating the pulse input to the counters and indicating an overflow condition.

Anti-Jam Circuitry

The anti-jam circuitry allows for the detection of rapid increase in pulses (due to a rapid increase in radiation at the detector) and provides a bit to the sensitivity select register. A detector will reach a point, in a very high radiation field, when it will no longer provide pulses, but conducts continuously. The absence of pulses would normally indicate a low radiation field, when in actuality this is not the case. The purpose of the anti-jam circuit is to detect that this situation is about to occur, and to indicate it to the MPU. The MPU will then shut down the high voltage.

The input to the anti-jam circuit is provided by the low discriminator output (U91-6). JP7 selects detector type, 1-2 for scintillation detectors and 2-3 for G-M type. Q3 turns ON/OFF with input pulses, which allows C39 to charge to an average DC level. VR12 (adjustment range 0 to 1.6 volts) is used to adjust the trip threshold on comparator U92-2. When the repetition rate of the input pulse causes C39 to charge and the DC level to exceed the threshold, comparator output U92-1 (low in normal operation) is forced high. When this occurs, U96-2 goes high (U96-1 is high after power-up) U93-3 goes low and U96-4 goes high. Diode D9 effectively latches this circuit in the jam mode. That is, if C39 discharges (due to absence of input pulses) and U92-1 goes low, D9 becomes forward biased which holds U92-2 high. The high, now on U96-4 causes Q4 to turn on driving Q5 on, forcing U96-8, & 9 node to ground. In normal operation, JP6 is in position 1-2 allowing high current flow through F1 (1/20 Amp fuse) causing it to blow. R82 will now hold U96-8, & 9 node at ground, causing U96-10 (anti-jam bit) to be active (high). At this point, normal operation can only be achieved by replacing fuse F1. Jumper JP6 -position 2-3 is for test purposes only and allows fuse F1 to be removed from the circuit and R79 provides pull-up to + 5 volts. In this mode, cycling of power resets the anti-jam circuit. R93/C41 on U96-1 provides a delay from power-up to inhibit false tripping of the anti-jam circuit.

High Voltage Supply

The high voltage is utilized by a G-M detector (typical range 500 volts to 650 volts). The adjustment range of the HV supply is 300 Vdc to 1800 Vdc. The HV output is short circuit proof in that it will current limit the oscillator section within ten seconds of the output being shorted. The board plugs into the main circuit board at the J8 connector.

R5 and associated circuitry provide the DC voltage adjustment to U1 device 3. The output U1-8 will vary under control of R5.

Operation amplifier U1 device 1 drives transistor Q1 that in turn drives the oscillator section transistor Q2, the transformer primary and feedback windings, and associated circuitry. As R5 is adjusted to increase the high voltage, U1-8 voltage increases which causes U1 device 1 to increase transistor Q1 base current. This increases the emitter/collector current, raising the voltage on the emitter. As this control voltage increases, the voltage developed across the transformer primary also increases. The transformer secondary increases in voltage, which causes the high voltage output to increase. The voltage quadrupler operation is illustrated in Figure 3-7.

R2 is a 1000:1 voltage divider that provides feedback to control the high voltage. U1-2 is used as a buffer between the 1000:1 divider and the 1000:1 output signal. This output signal is also utilized by U1-1 to regulate the high voltage and is sent to the HV test jack. The shutdown signal (provided by the controller) when low has no effect on the high voltage. When the shutdown signal goes high, Q3 conducts causing Q1 to turn off. This action forces the oscillator to turn off, effectively shutting down the high voltage.

Short circuit protection is provided by the positive temperature coefficient thermistor (PTC). The PTC resistance in normal operation is nominally 5 ohms. When the high voltage output is shorted, the control circuitry U1 device 1 attempts to maintain regulation by increasing the base drive for transistor Q1. Excessive current flows through the PTC, causing the internal temperature to increase. As the temperature increases, the PTC resistance also increases dramatically. The effect is that the control voltage to the oscillator is decreased to a minimum level. The response of the PTC is approximately ten seconds. Removal of the short circuit condition results in restoration of the high voltage to the preset level.

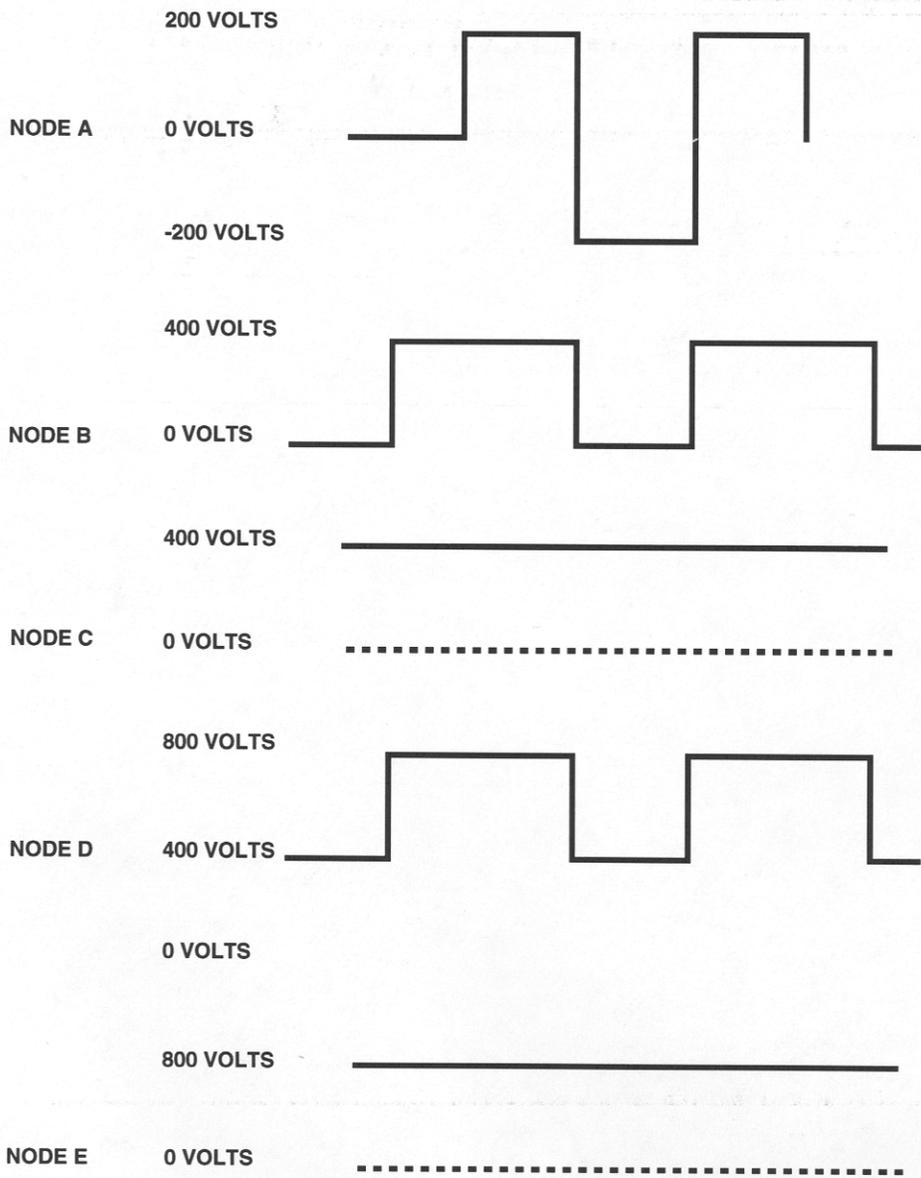
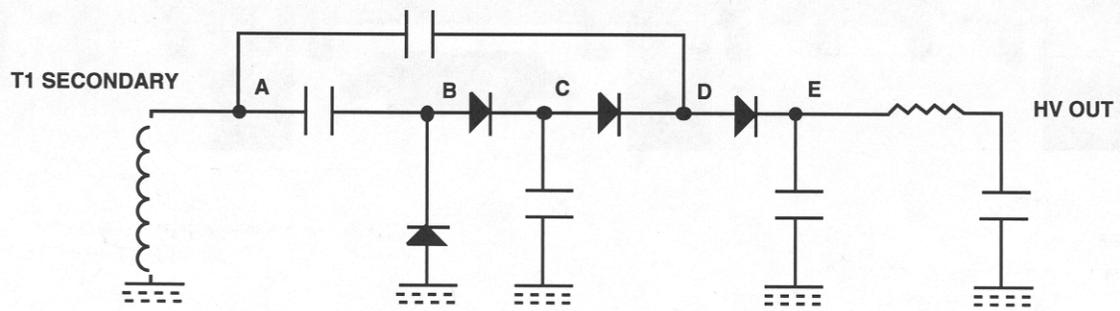


Figure 3-7. High Voltage Output (800Vdc)

Relay Circuit Board

The relay circuit board contains five independently controlled electromechanical relays, High alarm, Warn alarm, Auxiliary (Rate) alarm, Fail, and Check Source. Each relay provides two Form C sets of contacts with the exception of the check source and alarm relays that provide a single Form C set of contacts for customer use. 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
- 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 3-7 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".

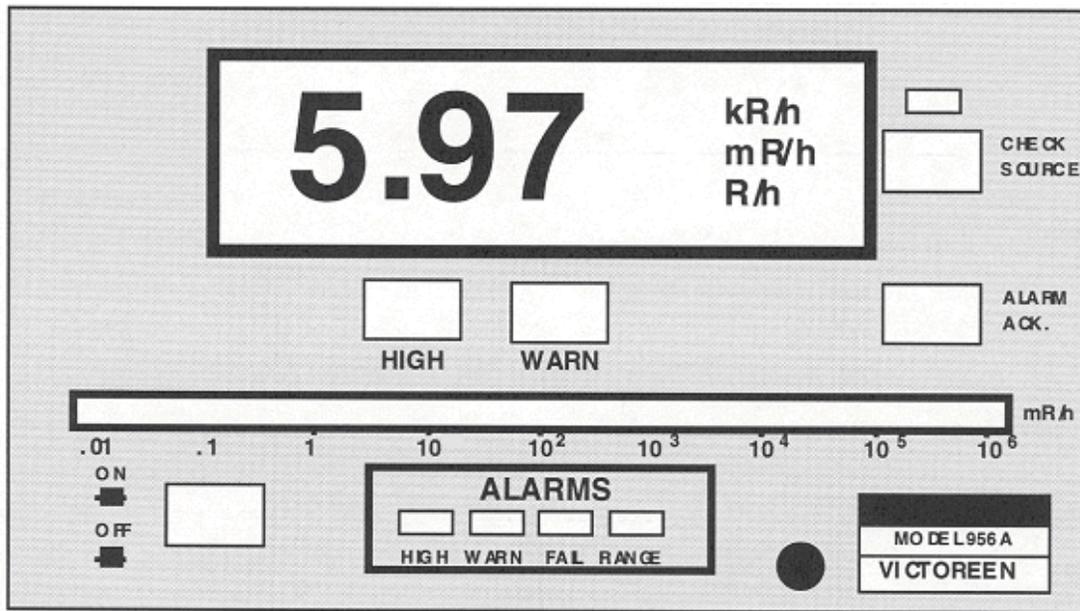


Figure 3-8. Front Panel, Model 956A-201

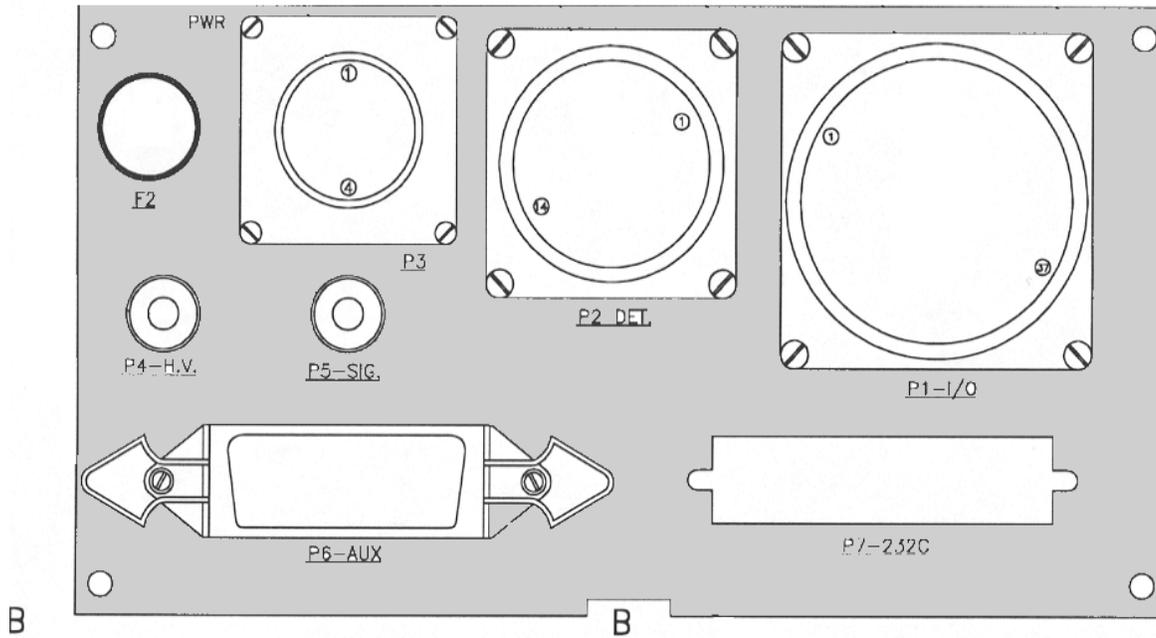


Figure 3-9. Rear Panel, Model 956A-201

Power Supply

The U DR power supply is rated at +5 volts @ 3 amps, + 15 volts @ 2.0 amps, and -15 volts @ .5 amps. The input is user selectable at 115 Vac (92 to 132 Vac) or 230 Vac (180 to 264 Vac). The power supply is designed to meet safety requirements UL/CSA/VDE. EMI emissions comply with FCC/Class B requirements.

The AC input to the power supply may range from 90 to 204 Vac @ 50.60 Hz. The 956A, however, must be configured for use at 125 Vac, 50/60 Hz as a factory option.

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 1-1 for currently available modifications and to Appendix C for the Bill of Materials.

1. 942-200-75: ANALOG INPUT OPTION BOARD - (Generally not used for normal operation with the 956A-201 UDR, however, it is used if the UDR is part of a simulator.) Contains four (4) separate channels for analog inputs. 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 between VICTOREEN's ratemeter and a user computer system or CRT terminal, with baud rates ranging from 50 to 19200 baud. An asynchronous communication interface adapter is utilized to format the data and control the interface.

The VICTOREEN communications interface option board also provides the necessary circuitry to allow interconnecting to a VICTOREEN proprietary serial communication port. This interface allows multiple UDRs to share a common six-wire cable to a main central processor unit.

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 -1 0 mV dc, 0 -50 mVdc, 0 -100 mVdc, 0 -500 mVdc, or 0 -1 Vdc.

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MAINTENANCE AND CALIBRATION

4.1 MAINTENANCE

The 955A Area Monitoring System is designed to operate for extended periods of time with no scheduled maintenance required. However, periodic inspections may be performed to verify system integrity and calibration have not changed. If a problem develops, verify system calibration per section 4, or trouble shoot the system per section 5 and the drawings in Appendix B.

NOTE

If a maintenance question arises, please contact Cardinal Health at 440.248.9300 or Fax at 440.542.3682.

4.2 CALIBRATION

The 897A G-M Detector is factory calibrated on a ^{137}CS range. A $\pm 20\%$, 8 point NIST traceable factory calibration performed to obtain the calibration factor and dead time correction for the detector. The calibration factor and dead time correction (referred to as TAU) are stated on the factory calibration data sheet, and are adjusted via setpoint numbers 5 and 2 on the 956A UDR. A field test source, P/N 848-8, is available as an option to verify detector operation. The detector, with integral preamplifier, should be returned to Cardinal Health for recalibration whenever performance degradation is noticed (i.e. detector response is not within $\pm 30\%$ of the decayed source value in either the closed or open position).

4.3 CALIBRATION/ELECTRONIC ADJUSTMENT

Table 4-1 lists the electronic adjustments for the 956A, while Table 4-2 lists electronic adjustments for the 897A detector. The procedures for making these adjustments are contained in the factory calibration and test procedures. Note that test firmware is required to perform most of the critical adjustments. Refer to Section 5 for a description of user-performed adjustments.

NOTE

The adjustments listed in Table 4-1 and Table 4-2 is for standard equipment. If an analog output option board has been furnished with the ratemeter, refer to the analog output option board instruction manual for additional adjustment instructions.

Table 4-1. *Electronic Adjustments, UDR*

Adjustment	Purpose	Type
VR1	Zero Adjust/0 – 10 Volt Analog Output	Field
VR2	Gain Adjust/0 – 10 Volt Analog Output	Field
VR4	20 mA Adjust/4 – 20 mA Volt Analog Output #1	Field
VR5	20 mA Adjust/4 – 20 mA Volt Analog Output #2	Field
VR6	4 mA Adjust/4 – 20 mA Volt Analog Output #2	Field
VR7	4 mA Adjust/4 – 20 mA Volt Analog Output #1	Field
VR8	Gain Adjust/Signal Input Op Amp	Factory
VR9	DC Offset Adjust/Signal Input Op Amp	Factory
VR10	High Discriminator Adjustment	Field
VR11	Low Discriminator Adjustment	Field
VR12	Anti-Jam Threshold Adjust	Factory
VR13	Write Cycle Clock Adjust	Factory
HV Supply R5	High Voltage Adjust	Field
VR51	+ 5 Vdc Power Supply	Field

Table 4-2. *Electronic Adjustments, Detector*

Adjustment	Purpose	Type
R44	Detector Input Discriminator	Factory
R41	Anti-Jam Threshold (Factory Adjustment Only)	Factory

The following factory calibration and test procedures are included for reference at the end of this section:

<u>Document</u>	<u>Description</u>
CAL-GM6	Factory Calibration Procedure, 897A G-M Detector
TP897A	Factory Test Procedure, 897A G-M Detector
TP956A-201-3	956A-201 Digital Ratemeter Factory Test Procedure
TP956A/897A-21 X	Loop Test Procedure -Low Range Detector
TP956A/897A-22X	Loop Test Procedure -Medium Range Detector
TP956A/897A-23X	Loop Test Procedure -High Range Detector

4.4 955A SYSTEM FIELD CALIBRATION

A field test source is available to verify the response of the detector to a known radioactive field in a fixed geometry. The following test sources are available:

Model	Activity
848-8	100 mCi Cs-137
848-8A	10 mCi Cs-137
848-8B	20 mCi Cs-137

848-8 Test Source provides three data points when used with the 897A-22X or 897A-23X detector. Two points are available when used with the 897A-21X, low range detector. Should a third data point be required for the 897A-21 X detector, use of the 848-8A Test Source is required.

The following adapters are required to use the above test sources:

Detector	Adapter
897A-210	848-8-105
897A-220	848-8-105
897A-230	848-8-105
897A-211	848-8-105 & 848-8-400
897A-221	848-8-105 & 848-8-400
897A-231	848-8-105 & 848-8-400

WARNING

Extreme care must be used when testing a system that has power applied. A 600 Vdc potential exists on terminal P1-E of the detector and P4 of the 956 UDR. This potential will exist for one minute after power is removed.

CAUTION

For WARNINGS and CAUTIONS pertaining to the use of the Model 848-8 field calibrator, refer to the applicable field calibrator instruction manual.

NOTE

Voltages can be measured as soon as power is turned on, but further alignment should not be attempted until the instrument has had at least one hour to stabilize after startup.

NOTE

The following procedure applies only to an 897A series detector that has been previously calibrated and is functioning normally.

NOTE

If a question arises on the use of the field calibrator or the adapter, refer to the applicable instruction manual for the calibrator or adapter.

NOTE

By using two field calibrators in three positions each (open, closed, and intermediate) a total of six different exposure levels can be obtained

1. To use the test source, determine the current radiation intensity for the closed, intermediate, and open positions from the decay curves on the field calibrators. Determine upper and lower tolerance limits by taking 75% and 125% of each intensity level.

NOTE

Do not turn the key of the field calibrator, until instructed to do so. Failure to comply may result in radiation exposure to the operator.

2. Insert the applicable adapters into the field test source.
3. Insert the applicable 897A detector, small end down, into the field source adapter.
4. Insert the key, **DO NOT** turn.
5. Record the displayed value (this is the **CLOSED** position).

NOTE

To put the field calibrator in the open position, the detector must be installed in the calibrator. Insert the key and turn it. Rotate the hand knob fully. The detector is fully exposed to the radiation source. This is the OPEN position.

To put the field calibrator in the intermediate position, start from the closed position and hold a counter-clock-wise pressure on the key while rotating the knob to the open position. A stop will be felt before the open position is reached. This is the Intermediate Position.

6. Turn the key, and rotate the control lever until the Intermediate position stop is felt. Record the reading.

NOTE

The detector cannot be removed until the field calibrator is put back to the closed position and the key is removed.

7. Turn the control lever to the full counter-clockwise, or OPEN position. Record the reading.
8. Remove the detector from the field calibrator.
9. The values recorded in steps 5, 6, and 7 should be between the values calculated in step 1.

NOTE

If the values recorded are not within the calculated range, then the detector is out of calibration. Return the detector to Cardinal Health for evaluation and determination of proper course of action. Do not attempt to change the conversion constant to "fit" the readings.

4.5 DETECTOR CALIBRATION

Plateau Verification

NOTE

Plateau verification does not need to be performed if the detector is supplied with a calibration data sheet, identifying the factory high voltage setting. It may, however, be performed as a preventative maintenance test for monitoring changes in the length of the detector plateau over time. It should be performed if the detector calibration data sheet is not available. If the detector is a replacement part, the high voltage should be set to the value shown on the calibration data sheet supplied with the detector.

To determine the optimum high voltage setting for the G-M detector, perform the following:

1. Connect an electrostatic voltmeter to the high voltage section of the readout. Adjust the high voltage to 500 Vdc.
2. Connect a counter to the input pulse circuitry at the readout. Adjust the counter for a 1-minute time base.
3. Place a source near the detector and position it so that a reasonable count rate will be displayed on the readout.
4. Using the counter, take a 1-minute count. Record the high voltage setting and the gross count rate.

CAUTION

Do not exceed 650 Vdc under any condition. Damage to the G-M tube will occur.

5. Repeat step 4, increasing the voltage in 20 Vdc increments until the maximum operating voltage is reached.
6. Plot the resulting data, gross count rate vs. high voltage. Locate the plateau where the slope is minimized (between the minimum voltage of 500 Vdc and the maximum voltage 650 Vdc). The operating point should be the mid point of this plateau. Figure 4-1 is an example of the detector plateau.
7. If the plateau is not within the 500 Vdc to 650 Vdc range, return the unit to Cardinal Health for G-M tube replacement and factory NIST source range calibration.

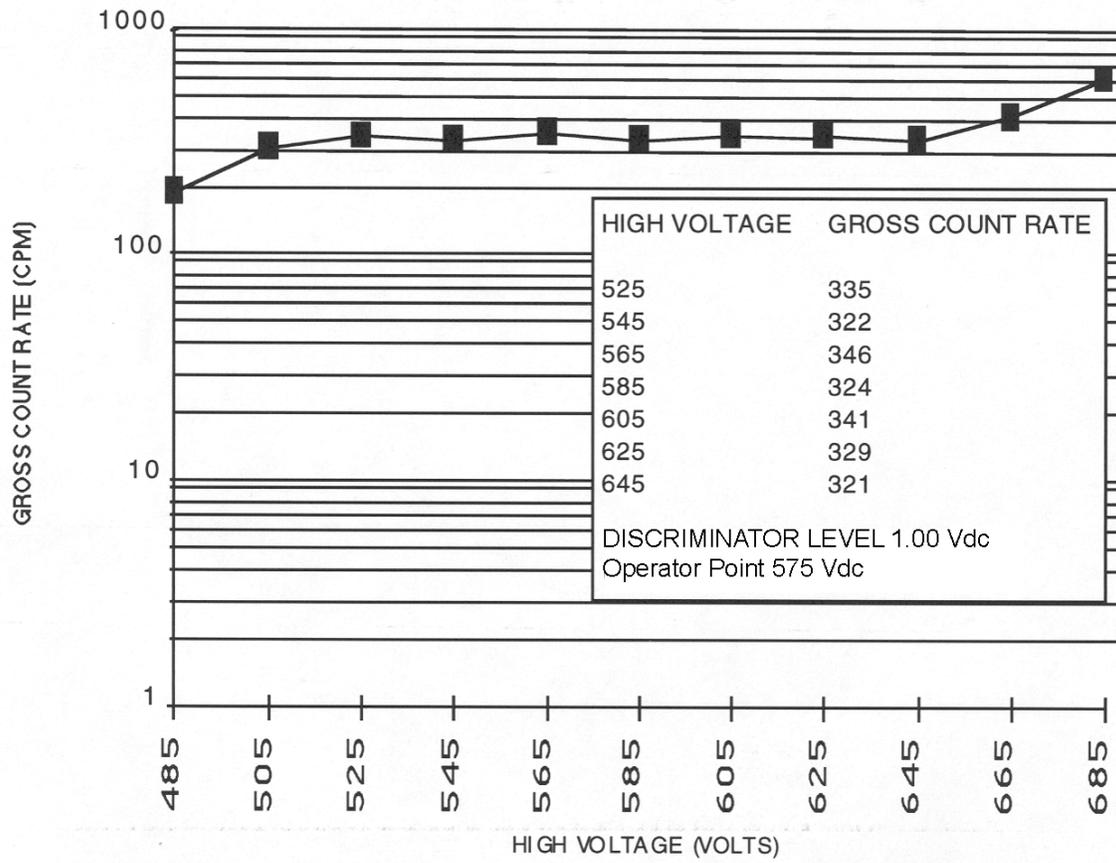


Figure 4-1. Detector Plateau (Typical)

TROUBLESHOOTING

5.1 TROUBLESHOOTING

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 an invalid analog output low scale value, and analog output high scale value resulting in the display of error Message E0008.

If a problem develops, verify that the voltages at connection point inputs and outputs are present and that all wiring is secure, for both the detector and UDR. Refer to Appendix B and C for drawings and parts lists. If a PROM requires replacement, specify the PROM part number, PROM revision letter, and unit model number. The PROM part number and revision is marked on a label attached to the top surface of the PROM. Refer to Section 4 for calibration and electronic adjustments.

Troubleshooting is required for the detector/preamplifier when the measured output of the test source shows a marked change in the count rate observed at the UDR while high voltage remains constant, or when an error code is displayed on the UDR. Check for visible signs of physical damage.

A fault that cannot be isolated to the detector/preamplifier must be in the wiring between the detector/preamplifier and the UDR, or in the UDR itself.

If the fault has been isolated to the detector preamplifier, the unit should be returned to Cardinal Health for repair and recalibration on an NIST traceable calibration range. If desired, the following procedure, along with the applicable drawings, may be used to identify the faulty component. The high voltage power supply should be disconnected at this time. The UDR is to remain connected to provide the low voltage power supply and proper termination of the preamplifier. If the fault is isolated to the UDR, the UDR should be returned to Cardinal Health for repair. To troubleshoot the UDR, a test PROM and special test set, P/N 942TS-100, is required.

Refer to Appendix B and C for all applicable schematics, drawings, TP locations, and Bill of Materials.

Periodic Field Test

WARNING

There is 120 VAC present at the low voltage DC power supply and 600 Vdc at the high voltage power supply P.C. board. Use extreme care when performing the following tests.

The following tests may be performed on the UDR to check its operation. In addition to these tests, alarm circuit and relay operation may be verified via use of a field test source, or the detector check source. Resetting of the alarm trip points to a level before the expected response may be required to perform this test.

Equipment Required

- Digital voltmeter
- Small flat blade screwdriver
- Signal generator

Test Procedure, 955A-XXYYZ System

Check Source Response

1. Depress and hold the Check Source pushbutton for approximately two (2) minutes. Record the average mR/h value displayed. The value displayed will normally be within $\pm 25\%$ of the value recorded on the factory data sheet. For slightly more precise data, subtract the ambient background value from the gross check source value.
2. Verify the following conditions are met for proper check source operation:
 - A. Properly connected detector to 956A-201 UDR
 - B. +15 Vdc power is present from the 956A-201 UDR
 - C. Proper discriminator adjustment in the 956A-201 UDR
 - D. Proper G-M tube high voltage is supplied from the 956A-201 UDR
 - E. Fully functional detector preamplifier (located within the detector outer housing)
 - F. Fully functional G-M tube (located within the G-M detector housing)

WARNING

Item (a) may be verified by physical inspection of the detector to 956A-201 UDR interconnecting cable.

Items (b - d) may be verified by the 956A-201 UDR readout tests provided herein.

Items (e - f) require return of the detector assembly to Cardinal Health for repair and recalibration.

3. For ALARA considerations, disassembly of the detector to observe, or attempt to correct check source operation is not recommended. There are no user serviceable parts on the check source mechanism.

DC Voltage Checks, 956A-201 UDR

1. Using a digital voltmeter set to read DC volts, measure the voltages listed in Table 5-1

Table 5-1. DC Voltage Test Points

Test Point	DC Power Supply Voltages	Potentiometer
TB-1	-15 Vdc, ± 0.75 V	N/A
TB-2	Ground DC	N/A
TB-3	Ground DC	N/A
*TB-4	+ 5.0 Vdc, ± 0.10 V	VR1 (or power supply)
TB-5	+ 15 Vdc, ± 0.75 V	N/A

- * The only adjustable voltage is the +5.0 Vdc supply. The other voltages are regulated by the +5.0 Vdc supply. If the +5.0 Vdc supply is out of tolerance, adjust VR 1 on the power supply
2. If any voltage does not meet the tolerance after adjusting the +5.0 Vdc supply, the unit should be returned to Cardinal Health for replacement of the DC power supply.

Discriminator Check, 956A-201 UDR

1. Set the digital voltmeter to DC volts and measure the upper and lower discriminator voltages using the values listed in Table 5-2.

Table 5-2. Discriminator Test Points

Test Point	Description	Expected Voltage	Potentiometer
GND	Ground	N/A	N/A
LO	Low Discriminator	0.50 Vdc ± 0.01 V	VR11
HI	High Discriminator	7.000 Vdc ± 0.01 V	VR10

2. If either voltage is out of tolerance, it may be brought into tolerance by adjusting the appropriate potentiometer.
3. If the proper adjustments cannot be achieved, return the unit to Cardinal Health for repair.

High Voltage Check, 956A-201 UDR

1. With the digital voltmeter set to read DC voltage, measure the detector high voltage as listed in Table 5-3.

Table 5-3. High Voltage Test Points

Test Point	Description	Expected Voltage	Potentiometer
GND	Ground	N/A	N/A
HV Test	HV, 1000:1	897A-210 $0.575\text{ V} \pm .01\text{ Vdc}$ 897A-220 $0.575\text{ V} \pm .01\text{ Vdc}$ 897A-230 $0.550\text{ V} \pm .01\text{ Vdc}$	R5 R5 R5

2. If the 1000:1 voltage is out of tolerance, adjust R5 as required.
3. If the proper HV adjustment cannot be achieved, return the unit to Cardinal Health for repair.

Analog Output Check, 956A-201 UDR

1. To adjust the low scale output, enter 1.00E2 (a value greater than the background reading) into setpoint 7, Analog Low Scale setpoint.
2. Adjust the appropriate zero adjust potentiometer as listed in Table 5-4 as required. The output signals may be measured at the terminals as listed in Table 5-5.

Table 5-4. Analog Output Test Points

Description	Expected Output	Potentiometer
0-10 V Output, Zero	$0.00\text{ V} \pm 0.01\text{ V}$	VR1
0-10 V Output Span	$10.00\text{ V} \pm 0.01\text{ V}$	VR2
4-20 mA Output #1, Zero	$4.00\text{ mA} \pm 0.05\text{ MA}$	VR7
4-20 mA Output #1, Span	$20.00\text{ mA} \pm 0.05\text{ MA}$	VR4
4-20 mA Output #2, Zero	$4.00\text{ mA} \pm 0.05\text{ MA}$	VR6
4-20 mA Output #2, Span	$20.00\text{ mA} \pm 0.05\text{ MA}$	VR5

Table 5-5. Analog Output Test Terminals

Description	Terminals
0-10 V Output (+)	P6-5
0-10 V Output (-)	P6-6
4-20 mA Output #1 (+)	P6-1
4-20 mA Output #1 (-)	P6-2
4-20 mA Output #2 (+)	P6-3
4-20 mA Output #2 (-)	P6-4

3. Return the setpoint to its normal value,
4. To adjust the Analog Full Scale setpoint, enter 1.00E-1 (a value less than the background reading) into setpoint 5, Analog Output Full Scale setpoint.
5. Adjust the appropriate full scale adjust potentiometer per the Analog Output Test Points table as required. The output signal may be measured at the terminals listed in the Analog Output Test Terminals table shown above.
6. Return Setpoint 3 to its normal value.
7. If adjustments are required, repeat steps 1 through 6 as required to ensure both measurements remain within the required tolerance.

8. When a local indicator is provided, the mechanical meter zero adjustment screw may be adjusted to obtain a true "zero" reading. (The power to the readout should be turned off to obtain a true zero.)
9. To adjust the full-scale response of the local indicator, repeat steps 4 through 6. Potentiometer R1, located inside the local indicator enclosure, may be adjusted as required to obtain full-scale meter deflection.
10. If the proper voltages cannot be achieved, return the unit to Cardinal Health for repair.

Counter Test

1. Set-up signal generator as follows:
 - a. Square Wave pulse
 - b. Volt peak positive pulse
 - c. DC offset: at ground reference
 - d. 10 Hz
2. Connect the signal generator to connector J5 on the 956A readout.
3. Set the conversion constant on the readout, function switch position 5, to 1.00EO
4. Adjust the signal generator to the following frequencies and verify the 956A readout display.

Signal Generator Output	956A Readout Display Value
0.01 Hz	.600 mR/h \pm 5%
0.10 Hz	6.00 mR/h \pm 5%
1.00 Hz	60.0 mR/h \pm 5%
10.0 Hz	.600 R/h \pm 5%
100.0 Hz	6.00 R/h \pm 5%
1000.0 Hz	60.0 R/h \pm 5%

897A-2XX G-M Detector Test

The only field test to verify G-M Detector and preamplifier operation is the check source test described earlier for the 955A-XXYYZ system.

Detector Troubleshooting

The following section describes the internal adjustments and troubleshooting information for the 897A Detector. Since internal adjustments or component replacement will usually require detector calibration on a NIST range, field disassembly and troubleshooting is not recommended.

Detector Disassembly (Factory only)

WARNING

An 8 μ Ci chlorine Cl-36 radioactive check source is mounted inside of the check source housing. Safety glasses must be worn to protect the eyes when close visual contact with the preamplifier circuit board is necessary. Consult the facility radiation safety officer prior to disassembly of the detector to ensure the appropriate radiation safety procedures are observed.

WARNING

Ensure that the detector power has been removed prior to disassembly.

1. Disconnect the interconnection cable at the detector.
2. Remove the six (6) screws around the circumference of the housing.
3. Extract the preamplifier assembly, taking care no to damage the detector-housing gasket.

Detector Assembly (Factory only)

1. Place the preamplifier assembly in the protective housing and re-align the detector-housing gasket or o-ring. Replace gasket or o-ring if damaged or brittle.
2. Replace the screws around the circumference of the housing.
3. Connect the interconnection cable.

Discriminator Setpoint Adjustment (Factory Adjustment Only)

This adjustment provides discrimination of input pulses that are below a user specified value. The nominal setpoint value (factory set) is +1.0 Vdc. If a value other than +1.0 Vdc is desired, adjustment can be made by connecting a DVM to the node of R38 - R39 (+) and R44 (-). Turn potentiometer R44 to the level of pulse discrimination. The adjustment is then complete.

5.2 HV POWER SUPPLY ADJUSTMENT

R5 adjusts the detector high voltage, and the HV test jack allows a 1000:1 voltage measurement to be read. For the Model 956A-201 Universal Digital Ratemeter, refer to the appropriate detector calibration data sheet included with each detector for specific high voltage settings.

Anti-jam Setpoint Adjustment (Factory Adjustment Only)

When the detector is used in a digital system, the parameters (dead time correction, count conversion, and anti-jam setpoint) are determined during factory calibration. Therefore, no customer adjustments are required. If the G-M tube fails, the detector must be returned to the factory for repair and re-calibration.

DC Power Supply, Detector (Factory Test Only)

WARNING

AC voltage is present on the printed circuit board (pads J & H). Exercise caution when making measurements near this area.

1. With cable connected to the UDR, turn on the UDR to provide a low voltage power supply to the detector. High voltage is to be disconnected.
2. Using a DVM, measure the voltage at pad A (+ DC input Voltage) and pad c; chassis ground (-). The reading should be +10 Vdc (analog readouts) or +15 Vdc (digital readouts). If proper voltage is obtained, measure the voltage present across C1. The reading should be 10 Vdc \pm 0.2 V for the 10-volt power supply. If channel power is 15 Vdc and the reading obtained in this step is greater than +10.5 V, check jumper J3 for proper placement (i.e. A/B, 15 V; B/C, 10 V). If voltage is not present at pad A, remove the connector at the detector and inspect the cable assembly for broken or cut wires.

3. Measure the +15 Vdc power supply at the UDR to ensure that the UDR is functional. If not, refer to the applicable drawings for the UDR so that the appropriate troubleshooting procedure can be used.
4. If +10 V is not present across capacitor C1, preamplifier circuitry failure has occurred. Using the schematic diagram as a guide, analyze and replace the faulty components.

Signal Transmission, Detector (Factory Test Only)

WARNING

High voltage is to be disconnected for this procedure. Channel power is to remain on. Refer to schematic 897A-210-13.

1. Using a DVM, measure the discriminator voltage between pin 9 and pin 8 of Z1. Zero to +2 V should be obtained by adjustment of R44. If not, zener diode CR11 or Z1 may be faulty.
2. Connect a pulse generator to the junction of R17-C10 and ground. Adjust the pulse generator output for a 50-microsecond pulse of -5 V amplitude with a frequency of 1 kHz.
3. Using an oscilloscope, verify pulse transmission. Pulses should be present at Z1 pin 14, R23, Z1 pin 7 and pad G. If not, locate the point where pulse transmission is terminated and replace the defective component.

CAUTION

Before continuing, measure the anti-jam setpoint voltage at pin 10 of Z1 and ground. Record this value. If a malfunction is found in this section, the faulty component should be replaced and the setpoint readjusted to its original value.

4. Remove the pulse generator. Connect a DC power supply across R25 (+) and ground (-). Connect a DVM at pin 13 of Z1. The output should be low. Increase the power supply slowly until pin 13 changes from the low to the high state. If this does not occur, Z1 is defective.
5. If the above output state change is present, connect the oscilloscope to pin 2 of Z1. A square-wave of approximately 50 kHz should be observed when the output of Z1, pin 13 is high. If not, isolate the faulty component and replace it.
6. Set the high voltage to the operating point of the G-M tube. Using an electrostatic voltmeter, measure the high voltage at the pad labeled HV with respect to chassis ground. If high voltage is not present, check for broken wiring or a high voltage supply failure at the UDR.
7. If all previous steps indicate the electronics are functional, the G-M tube needs replacement. This requires that the detector be sent to the factory for recalibration.

Check Source, Detector (Factory Test Only)

If the check source meter movement does not operate, perform the following steps.

NOTE

This test requires continuous activation of the check source control at the UDR.

1. Using a DVM, measure the DC line (+15 Vdc) at pads J and H. If 15 Vdc is not present, check cable connectors for broken wires. Detector pad H is on when the check source is actuated. Pad J is on when the check source is not actuated. Also determine if the check source circuitry at the UDR is functional.
2. If the DC voltage is available, the meter movement, with integral check source capsule should be replaced.

NOTE

The check source meter movement assembly contains an 8 μCi , ^{36}Cl radioactive source. Consult your Radiation Safety Officer to ensure proper radiation safety procedures are observed when removing the radioactive source or meter assembly.

NOTE

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 4, please contact the Cardinal Health at 440.248.9300 or Fax at 440.542.3682.

Digital Ratemeter Troubleshooting

The digital ratemeter incorporates a multi-wire main circuit board. Replacement of components on this board must only be performed by personnel familiar with this type of construction. The following describes adjustments that may be performed to verify operation:

UDR Electronic Adjustments

Analog Output Adjustments (REFER TO PERIODIC FIELD TEST)

Signal Input DC Offset and Gain Adjustment (Factory Adjustment Only)

1. Disconnect the detector signal input.
2. Set the DVM to the 1-volt range.
3. Connect the positive lead of the DMV to TP-1 and the negative lead to the ground test jack.
4. Short the signal input connector on the rear panel (P5).
5. Adjust VR9 for a DVM reading of 0.000 volts.
6. Disconnect the DVM and connect an oscilloscope (to channel 2) positive lead to TP-1 and the negative lead to the ground test jack.
7. Disconnect the short on the signal connector, on the rear panel (P5).
8. Connect a signal generator to P5.
9. Connect an oscilloscope to channel 1 to monitor the signal generator output.
10. Adjust the signal generator output to obtain a 10 microsecond negative or positive going pulse (depending on input selection), with a +1 volt amplitude at a 1 kHz repetition rate.
11. Adjust VR8 to obtain unity gain. A +1 volt input should produce a +1 volt output pulse.

High and Low Discriminator Adjustments

The low discriminator should be set to +0.5 volt +/- 0.01 Vdc, while the high discriminator should be set to +7.0 +/- 0.01 Vdc unless otherwise specified in the detector calibration.

The following factory adjustments are included for general information and should not be performed in the field.

Anti-jam Threshold Adjustment (Factory Adjustment Only)

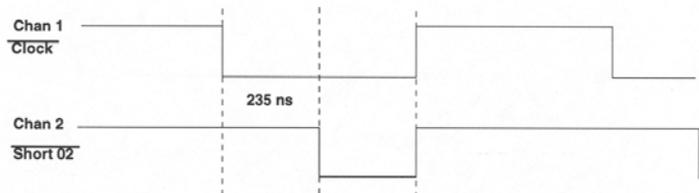
This adjustment is dependent on the type of detector used. Potentiometer VR12 is used to adjust the DC level measured at R94. Table 5-6 shows the DC adjustment values necessary for each detector type unless otherwise specified.

Table 5-6. Anti-Jam Threshold Adjustment

Test Pulse Width	Detector Type	DC Value at R94	Equivalent mR/h	Jumper J7
10 microsecond (50 kHz square wave)	897A Series	0.740 V	897A-21X	3.16×10^3
	G-M Detector Family		897A-22X	2.14×10^4
			897A-23X	2.50×10^5
				2 to 3

Write Cycle Clock Adjustment (Factory Adjustment Only)

1. Connect the channel 1 oscilloscope (x10 probe) to U19-2 (clock).
2. Connect the channel 2 oscilloscope (x10 probe) to U19-12 (short 02).
3. Adjust VR13 to obtain:



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CONNECTOR DESIGNATIONS

A.1 CONNECTOR DESIGNATIONS

Table A-1. Rear Panel Connections

Connector	Function
P1	Relay/Output, Remote Alarm Acknowledge
P2	Detector Connector
P3	AC Power Input
P4	Detector High Voltage (SHV)
P5	Detector Signal Input (BNC)
P6	Auxiliary Outputs; 0-10 VAC & 4-20 mA DC
P7	RS232C Option

Table A-2. Connector P1 – Input/Output

Pin	Signal	Internal Connection
1	Spare	Relay Board K1-A
2	Spare	Relay Board K1-B
3	Spare	Relay Board K1-C
4	Spare	Relay Board K1-D
5	Spare	Relay Board K1-F
6	Spare	Relay Board K1-E
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

Pin	Signal	Internal Connection
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

Pin	Signal	Internal Connection
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 are shown in their shelf, or de-energized state.

Table A-3. Connector P2 – Detector Connector

Pin	Signal	Internal Connection
1	Detector + 15 Vdc Supply	Power Supply +15 Vdc
2	Not Used	Power Supply -15 Vdc
3	Supply Ground	Power Supply Ground
4	+ 15 V C/S On	Relay K2
5	+ 15 V C/S Off	Relay K2
6	Not Used	-
7	Not Used	-
8	Not Used	-
9	Not Used	-
10	* 0 – 10 Vdc	Main Circuit Board J5-10
11	Ground	Main Circuit Board J5-9
12	Not Used	-
13	120 VAC (Neutral)	120 VAC (N)
14	Alarm N.C. (Switched Line)	Relay Board K5-E (L)

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

Table A-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 A-5. Connector P4 – Detector High Voltage

Pin	Signal	Internal Connection
MHV	Detector High Voltage	Direct

Table A-6. Connector P5 – Detector Signal Input

Pin	Signal	Internal Connection
BNC	Detector Signal	Direct

Table A-7. Connector P6 – Auxiliary I/O

Pin	Signal
1	4-20 mA Output #1 (+)
2	4-20 mA Ground (-)
3	4-20 mA Output #2 (+)
4	4-20 mA Ground #2 (-)
5	0 – 10 V * (+)
6	Ground
7	Analog Output Option (+)
8	Ground (-)
9 through 24	Not Used

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

Table A-8. RS232C Option

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 (DCD)
20	Data Terminal Ready

Table A-9 Model 956A-201 Option Jumpers

Jumper	Function	Position	Operation
JP1	Microprocessor Reset	Out IN	Normal Operation (factory) Momentary connect to reset Not Applicable
JP2	PROM Type	1-2 2-3	PROM 27128 PROM 27256 (factory)
JP3-1/JP3-2	Accuracy (it should be noted that this accuracy refers only to the statistical interpretation of detector counts, and not detector accuracy)	Out/Out Out/In In/Out In/In	2% Accuracy – 9604 Target Counts, Not implemented 5% Accuracy – 1537 Target Counts, Not implemented 10% Accuracy – 384 Target Counts, Not implemented Fixed one second display update of 60 one second values (factory)
JP3-3	Alarm Acknowledge	In Out	Manual Acknowledge (factory) Automatic
JP3-4	Fail Alarm	In Out	Enable No Counts Fail Alarm (factory) Disable No Counts Fail Alarm
JP3-5	Check Source Alarm	In Out	Alarm Inhibited (factory) Alarm Enabled
JP4	Input Pulse Selection	1-2 2-3	Negative Input Pulse Positive Input Pulse (factory)
JP5	Shield Polarity Selection	1-2 2-3	Shield for Negative Pulse Shield for Positive Pulse (factory)
JP-6	Anti-Jam Fuse Selection	1-2 2-3	Enable for Normal Operation (factory) Disabled for testing only
JP7	Detector Type for Anti-Jam Circuit Timing	1-2 2-3 Out	Scintillation G-M Tube (factory) Anti-jam circuit disabled (test purposes only)

Table A-10 Model 897A Option Jumpers

Jumper	Function	Position	Operation
JP1, JP2	Divide Option	AB BC	Divide by 2 square wave output (factory setting) Direct coupled, (optional)
JP3	DC Voltage Selection	AB BC	+ 15 Vdc (factory setting, digital readout) + 10 Vdc (analog readout)

Table A-11 Model 897A Detector Connection

Pin	Signal
K	Protective Ground
H	Check Source
J	Check Source
E	High Voltage
MTG Screw	Chassis Ground
C	+ Voltage In
G	Signal Output

APPLICABLE DRAWINGS

B.1 APPLICABLE DRAWINGS

Drawing No.	Description
956A-201-106	Loop Diagram
958-1-24	Interconnection Diagram, Local Alarm
958A-1-24	Interconnection Diagram, Local Alarm
GEL897A-2X0	Detector Dimensional Outline
897A-TAB-5	Detector Main Assembly, Stainless Steel Housing
897A-TAB-5A	Detector Main Assembly, Aluminum Housing
843-6-26	Wall Support, Detector
897A-211-30	Check Source MTG Assembly
857-210-30	Check Source Assembly
897A-210-10	PC Board Assembly
857-210-20	Tube Assy, Low Range
857-220-20	Tube Assy, Medium Range
857-230-20	Tube Assy, High Range
897A-210-13	Schematic, Detector
GEL897A-2X1	Detector Dimensional Outline
857-211-18	Bracket, Detector
857-211-20	Tube Assy, Low Range
857-221-20	Tube Assy, Medium Range
857-231-20	Tube Assy, High Range
956A-201-GEL	Dimensional Outline, Readout
956A-201-5	Assembly, Digital Readout
942-200-13	Schematic Diagram
956A-100-20	Assembly, Front Panel
956-100-15	Assembly, Front Panel PC Board
942A-100-30	Assembly, Rear Panel
956A-201-55	Assembly, Power Supply
942A-100-70A	Harness Assembly
942-100-70	Assembly, Relay PC Board
942-200-50	Power Supply
956-200-10	Main PC Board Assembly

Drawing No.	Description
942-200-60	Assembly, High Voltage Board
942-100-35A	Harness, Power Supply
942-100-35B	Harness, Main PC Board to Relay Board
942A-100-35C	Harness, Analog output
942-100-35D	Harness, Detector Power Supply
942-100-35E	Harness, AC Power
GEL948-1	Dimensional Outline, 3-Bay Chassis
948-3-5	Table top Mounting Enclosure
948-9-5	Panel Mount Enclosure
948A-2-5	Blank Panel Assembly
Gel-948-10	Panel Adapter, Dimensional Outline
50-100-TAB	Multi-conductor Cable
848-8-105	Test Fixture Adapter
848-8-400	Test Fixture Adapter, Stainless Steel
GEL-958A	Dimensional Outline -Remote Alarm
MB95-1008	Maintenance Bulletin, Check Source Replacement

BILL OF MATERIALS

C.1 BILL OF MATERIALS

Part Number	Description
897A-210	Bill of Materials, Detector Assembly, Low Range
897A-220	Bill of Materials, Detector Assembly, Medium Range
897A-230	Bill of Materials, Detector Assembly, High Range
897A-210-5A	Bill of Materials, Detector Main Assembly, Low Range
897A-220-5A	Bill of Materials, Detector Main Assembly, Medium Range
897A-230-5A	Bill of Materials, Detector Main Assembly, High Range
843-6-26	Bill of Materials, Wall Support, Detector
897A-211-30	Bill of Materials, Check Source MTG Assembly
857-210-30	Bill of Materials, Check Source Assembly
897A-210-10	Bill of Materials, PC Board Assembly
857-210-20	Bill of Materials, Tube Assy, Low Range
857-220-20	Bill of Materials, Tube Assy, Medium Range
857-230-20	Bill of Materials, Tube Assy, High Range
897A-211	Bill of Materials, Stainless Steel Detector Assy, Low
897A-221	Bill of Materials, Stainless Steel Detector Assy, Medium
897A-231	Bill of Materials, Stainless Steel Detector Assy, High
897A-211-5	Bill of Materials, Stainless Steel Detector Main Assy, Low
897A-221-5	Bill of Materials, Stainless Steel Detector Main Assy, Medium
897A-231-5	Bill of Materials, Stainless Steel Detector Main Assy, High
857-211-20	Bill of Materials, Tube Assy, Low Range
857-221-20	Bill of Materials, Tube Assy, Medium Range
857-231-20	Bill of Materials, Tube Assy, High Range
956A-201	Bill of Materials, Readout Assembly
956A-201-5	Bill of Materials, Assembly, Digital Readout
956A-100-20	Bill of Materials, Assembly, Front Panel
956-100-15	Bill of Materials, Assembly, Front Panel PC Board
942A-100-30	Bill of Materials, Assembly, Rear Panel
956A-201-55	Bill of Materials, Assembly, Power Supply
942A-100-70A	Bill of Materials, Harness Assembly
942-100-70	Bill of Materials, Assembly, Relay PC Board

Part Number	Description
956-200-10	Bill of Materials, Main PC Board Assembly
942-200-60	Bill of Materials, Assembly, High Voltage
942-100-35A	Board Bill of Materials, Harness, Power Supply
942-100-35B	Bill of Materials, Harness, Main PC Board to Relay Board
942A-100-35C	Bill of Materials, Harness, Analog output
942-100-35D	Bill of Materials, Harness, Detector Power Supply
942-100-35E	Bill of Materials, Harness, AC Power
948-1	Bill of Materials, 3-Bay Chassis
948A-2-5	Bill of Materials, Blank Panel Assembly
948-10	Bill of Materials, Panel Adapter, Dimensional Outline

APPLICABLE DOCUMENTS

D.1 DOCUMENTS

Document	Description
CAL-GM6	Factory Calibration Procedure, 897A G-M Detector
TP897A	Factory Test Procedure, 897A G-M Detector
TP956A-201-3	956A-201 Digital Ratemeter Factory Test Procedure
TP956A/897A-21 X	Loop Test Procedure -Low Range Detector
TP956A/897A-22X	Loop Test Procedure -Medium Range Detector
TP956A/897A-23X	Loop Test Procedure -High Range Detector

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COAXIAL CABLE TERMINATION INSTRUCTIONS

E.1 COAXIAL CABLE TERMINATION INSTRUCTIONS

The procedures/instructions in Appendix D are provided for your reference. Cardinal Health may purchase BNC connector 30-4 from AMP, Inc. or Amphenol. Before beginning the BNC assembly procedure, verify the connector supplied with your UDR and use the appropriate assembly procedure. The high voltage connector is a Kings MHV connector (Cardinal Health P/N 30-92-1).

Also included in this appendix is the (CPC) assembly procedure,

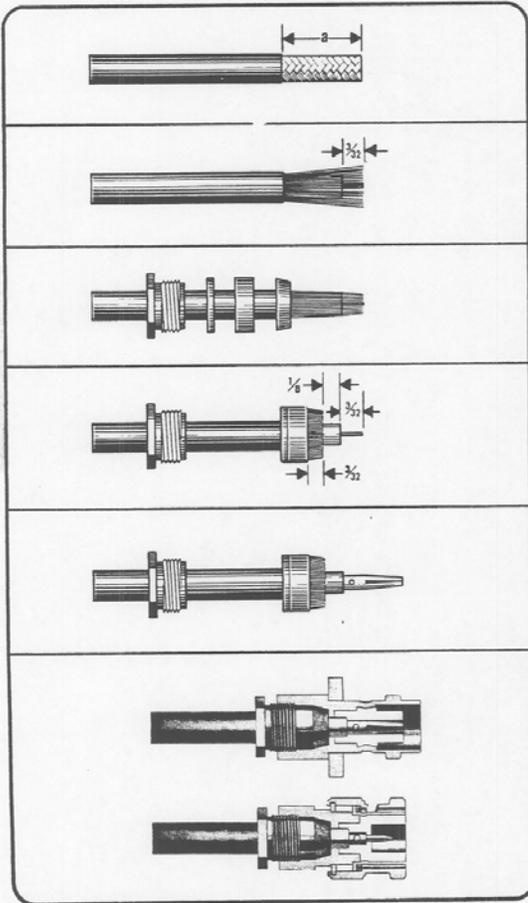
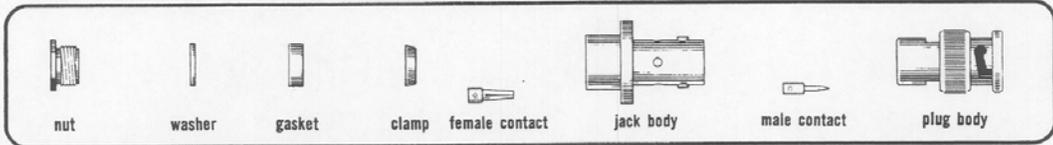
<u>Document</u>	<u>Description</u>
Amphenol BNC-18	UG Standard BNC Coaxial Connectors Assembly Instructions
Amphenol BNC-19	Improved BNC Coaxial Connectors Assembly Instructions
AMP, Inc. IS 6917	AMP Coaxial 50-Ohm RF Series BNC Connectors Assembly Instructions
AMP, Inc. IS 7593	AMP Circular Plastic Connectors (CPC) Assembly Procedure.
Kings CP-1000	MHV Cabling Procedure

coaxial connectors

assembly instructions



UG standard



Cut jacket to correct dimension.

RG-/U cable	dimension a
55, 71, 142, 221	$\frac{3}{16}$
58, 140, 141	$\frac{3}{32}$
59, 62	$\frac{1}{8}$

Fray shield and strip inner dielectric $\frac{3}{32}$ ". Tin center conductor.

Taper braid and slide nut, washer, gasket and clamp over braid. Clamp is inserted so that its inner shoulder fits squarely against end of cable jacket.

With clamp in place, comb out braid, fold back smooth as shown and trim $\frac{3}{32}$ " from end.

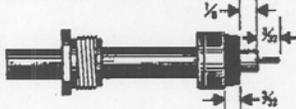
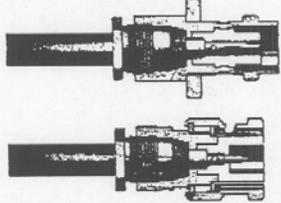
Slip contact in place, butt against dielectric and solder. Remove excess solder from outside of contact. Be sure cable dielectric is not heated excessively and swollen so as to prevent dielectric from entering into connector body.

Push assembly into body as far as it will go. Slide nut into body and screw in place with wrench until tight. For this operation, hold cable and shell rigid and rotate nut.

RFORM 1508B



BNC-18

	<p>Fray shield and strip inner dielectric $\frac{1}{32}$". Tin center conductor.</p>
	<p>Taper braid and slide nut, washer, gasket and clamp over braid. Clamp is inserted so that its inner shoulder fits squarely against end of cable jacket.</p>
	<p>With clamp in place, comb out braid, fold back smooth as shown and trim $\frac{3}{32}$" from end.</p>
	<p>Slip contact in place, butt against dielectric and solder. Remove excess solder from outside of contact. Be sure cable dielectric is not heated excessively and swollen so as to prevent dielectric from entering into connector body.</p>
	<p>Push assembly into body as far as it will go. Slide nut into body and screw in place with wrench until tight. For this operation, hold cable and shell rigid and rotate nut.</p>

RFORM 1508B



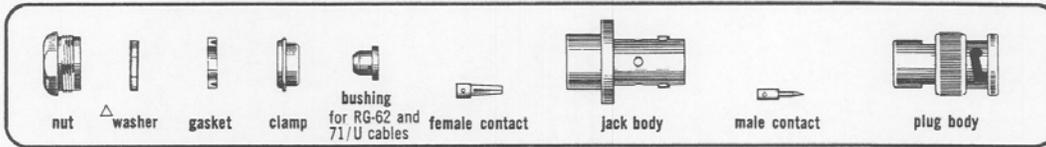
BNC-18



coaxial connectors

assembly instructions

improved



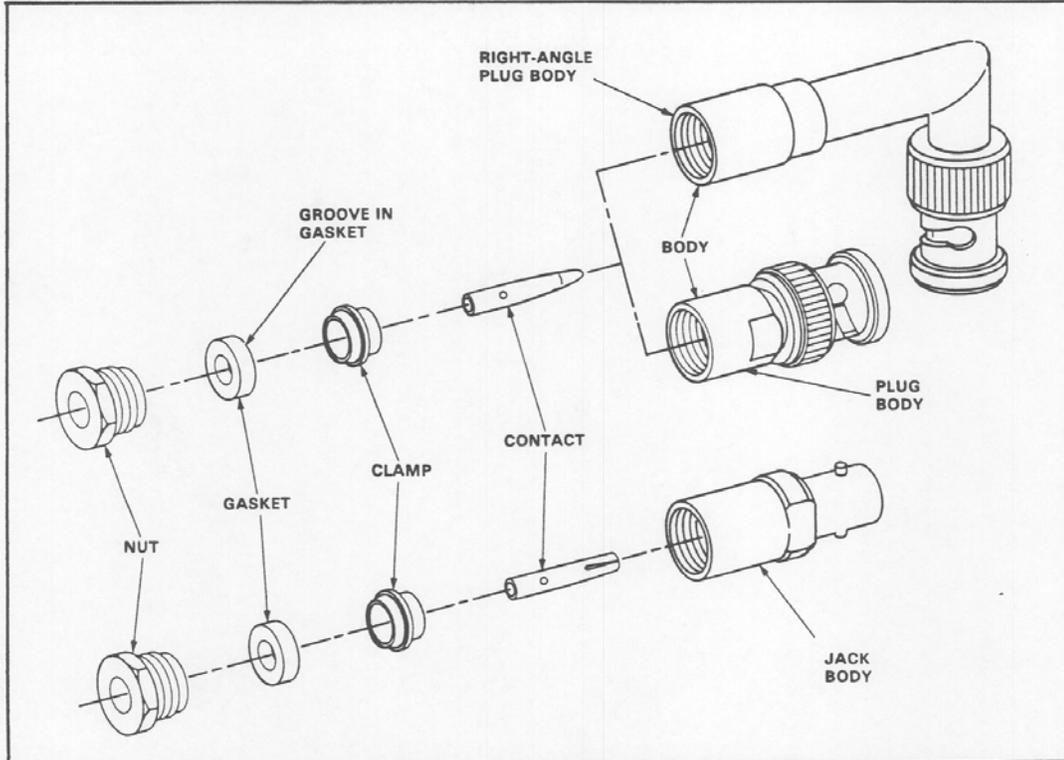
Δ only the 31-2XXX and 31-3XXX connectors contain this washer

	<p>Place nut, washer and gasket over cable and cut jacket to dimension shown.</p>
	<p>Comb out braid and fold out. Cut cable dielectric to dimension shown. Tin center conductor.</p>
	<p>Pull braid wires forward and taper toward center conductor. Place clamp over braid and push back against cable jacket.</p>
	<p>Fold back braid wires as shown, trim to proper length ($\frac{1}{8}$") and form over clamp as shown. For RG-62 and 71/U cable, trim to $\frac{3}{32}$" dimension and add bushing. Solder contact to center conductor.</p>
	<p>Insert cable and parts into connector body. Make sure sharp edge of clamp seats properly in gasket. Tighten nut.</p> <p>note: For Amphenol 421-668 copper jacketed cable replace connector's standard clamping components with contents of accessory adapter kit 31-885. Cut metal jacket back $\frac{3}{32} \pm \frac{1}{64}$. Cut dielectric so that $.120 \pm .005$ is exposed. Place the kit's components over the cable jacket in the following order: clamp nut, gasket, compression clamp (with fingers toward cut end of cable), and compression bushing (with smaller diameter toward cut end of cable in line with jacket). Follow conventional assembly instructions disregarding references to cable braid. Tighten nut applying a torque of up to 100 inch-pounds max. while holding body stationary.</p>

BNC-19



RFORM 1508B



RG/U CABLE	CONNECTOR TYPE	CONTACT AND BODY FINISHES			
		SILVER CONTACT NICKEL BODY PART NO.	SILVER CONTACT SILVER BODY PART NO.	GOLD CONTACT NICKEL BODY PART NO.	GOLD CONTACT SILVER BODY PART NO.
55, 58, 141, 142, 223, 400	Plug	221552-1	221552-2	221552-3	221552-4
	Rt-Angle Plug	221553-1	221553-2	221553-3	221553-4
	Jack	221554-1	221554-2	221554-3	221554-4

Fig. 1

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1. INTRODUCTION

This instruction sheet (IS) covers the selection and assembly of the AMP Coaxial 50-ohm RF Series BNC Connectors listed in Figure 1. The connectors are designed for field service applications. Read these instructions thoroughly before assembling the connectors.

NOTE All dimensions on this instruction sheet are in inches.

2. DESCRIPTION (Figure 1)

Each connector features a plug or jack body, center contact, clamp, gasket, and nut. The connectors are

available for the cable sizes indicated in Figure 1.

3. ASSEMBLY PROCEDURE

Determine the cable size and the connector type and finish needed for your application; then refer to the chart in Figure 1 and select the appropriate connector.

Proceed as follows:

- Slide nut and gasket onto cable, and then strip cable according to dimensions shown in Figure 2.

NOTE Make sure that the groove in the gasket is facing towards the connector body.

* Trademark of AMP Incorporated

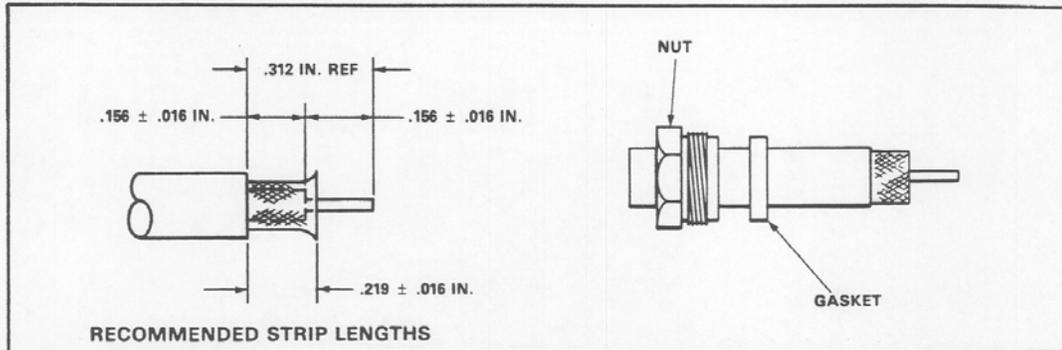


Fig. 2

2. Solder contact to conductor.
3. Slide clamp over braid, and butt clamp against cable jacket.
4. Fold braid over clamp and against clamp collar. See Figure 3, View A.
5. Insert contact into body until dielectric bottoms.
6. Seat gasket in body, then thread nut into body until nut is secured. See Figure 3, View B.

This completes the assembly procedure.

NOTE

If additional information is needed concerning AMP BNC connectors, contact:

AMP Incorporated
Signal Components Engineering
P.O. Box 3608
Harrisburg, PA 17105-3608

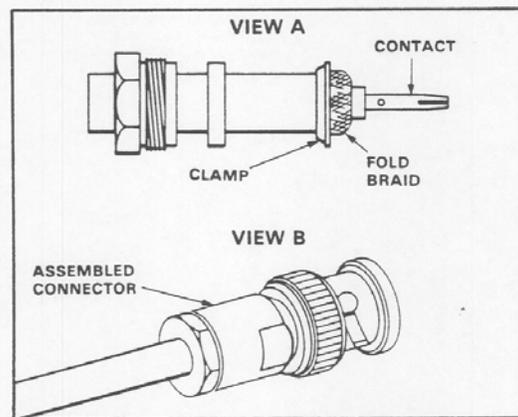


Fig. 3



AMP INCORPORATED
HARRISBURG, PA 17105

AMP*
CIRCULAR PLASTIC CONNECTORS
(CPC)

REDUCED FOR PACKAGING

IS. 7593

CUSTOMER HOTLINE
1 800 722-1111

RELEASED
10-12-89

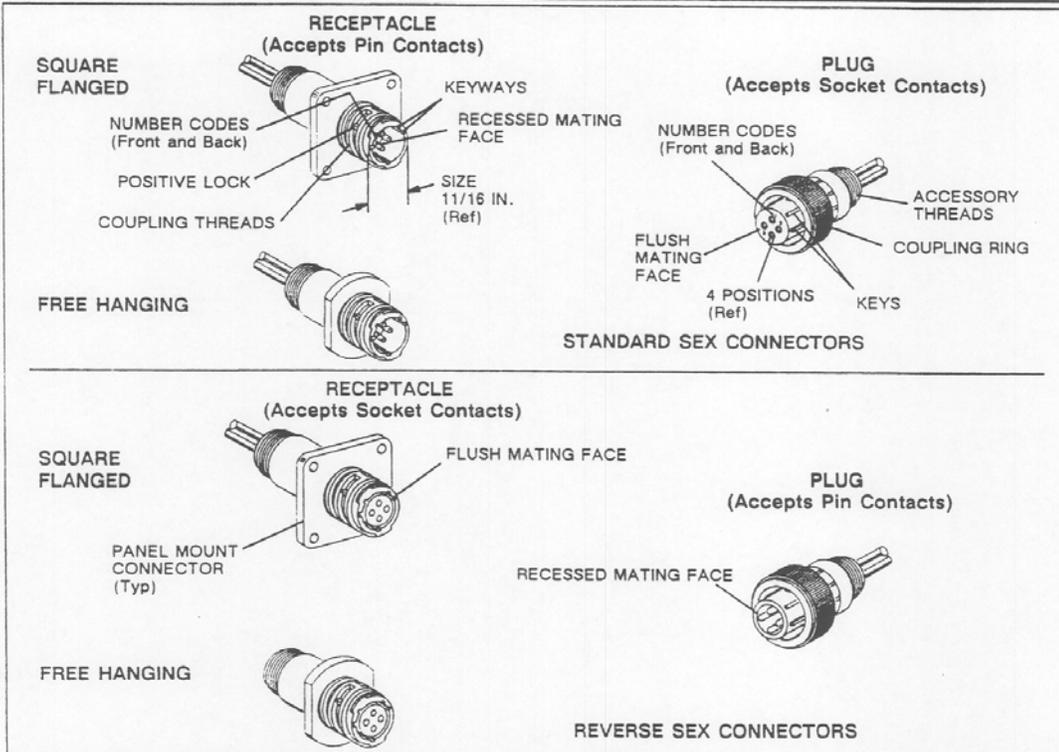


Fig. 1

1. INTRODUCTION

This instruction sheet covers the assembly procedures for the AMP Circular Plastic Connectors (CPC) listed in Selection Charts 1 through 4. Typical connector configurations are shown in Figure 1.

Assembly procedures for CPC accessories—such as shield and strain relief, environmental sealing, keying plugs, and coupling rings—are covered on AMP instruction sheet IS 7582.

Read this sheet carefully, and applicable referenced material, before assembling connectors, installing accessories, or panel mounting a connector.

2. DESCRIPTION

There are four connector series. Series 1 connectors (Selection Chart 1) are available in four shell sizes

(11, 13, 17, and 23) and accept Type III+, and Subminiature COAXICON* contacts. Series 2 connectors (Selection Chart 2) are available in three shell sizes (11, 17, and 23) and accept size 20 DM (screw machined) and 20 DF (precision formed) contacts. Series 3 connectors (Selection Chart 3) are available in two shell sizes (17 and 23) and accept Type XII power contacts. Series 4 connectors (Selection Chart 4) are available in one shell size (23) and accept a mixture of Type XII Contacts from series 3 and size 16 contacts previously mentioned for Series 1 connectors.

The connector designator indicates the size and contact positions of the connector. For example, 11/4 - size 11, meaning the outside diameter in 16ths of an inch as measured across the coupling threads, and contact positions 4, meaning the number of contact cavities in the connector.

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SERIES 1 CONNECTORS				RECOMMENDED CONTACTS
DES	SEX	HOUSING		
		DESCR	PART NO.	
11/4	Std	Plug	206060-1	Type III+ and Subminiature COAXICON Contacts (See Fig. 2) (See IS 1379 and Catalog CPC/CMC 73-204)
		Rcpt (PM)	206061-1	
		Rcpt (FH)	206153-1	
	Rvs	Plug	206429-1	
		Rcpt (PM)	206430-1	
		Rcpt (FH)	206430-2	
13/9	Std	Plug	206708-1	
		Rcpt (PM)	206705-1	
		Rcpt (FH)	206705-2	
17/14	Rvs	Plug	206044-1	
		Rcpt (PM)	206043-1	
		Rcpt (FH)	206043-3	
17/16	Std	Plug	206037-1	
		Rcpt (PM)	206036-1	
		Rcpt (FH)	206036-3	
23/24		Plug	206837-1	
23/24		Rcpt (PM)	206838-1	
23/37	Std	Plug	206150-1	
		Rcpt (PM)	206151-1	
		Rcpt (FH)	206151-2	
	Rvs	Plug	206305-1	
		Rcpt (PM)	206306-1	
		Rcpt (FH)	206306-2	

Selection Chart 1

SERIES 3 CONNECTORS				RECOMMENDED CONTACTS
DES	SEX	HOUSING		
		DESCR	PART NO.	
17/3	Std	Plug	206037-2	Type XII (See Fig. 4) (See IS 1379 and Catalog CPC/CMC 73-204)
		Rcpt (PM)	206036-2	
		Rcpt (FH)	206207-1	
	Rvs	Plug	206426-1	
		Rcpt (PM)	206425-1	
		Rcpt (FH)	206425-2	
23/7	Std	Plug	206136-1	
		Rcpt (PM)	206137-1	
		Rcpt (FH)	206137-2	
	Rvs	Plug	206226-1	
		Rcpt (PM)	206227-1	
		Rcpt (FH)	206227-2	

Selection Chart 3

There are two connector styles, standard and reverse sex. Standard plugs have a flush mating face and standard receptacles have a recessed mating face. Reverse sex connectors are just the opposite — plugs have a recessed mating face and receptacles have a flush mating face. Note that socket contacts should be installed in a connector that has a flush mating face.

Receptacle connectors are available with mounting flanges for FRONT or REAR panel mount (PM) applications, and without mounting flanges for free hanging (FH) applications.

SERIES 2 CONNECTORS				RECOMMENDED CONTACTS
DES	SEX	HOUSING		
		DESCR	PART NO.	
11/8	Std	Plug	205838-1	Size 20 DF and 20 DM (See Fig. 3) (See IS 1379 and Catalog CPC/CMC 73-204)
		Rcpt (PM)	205841-1	
		Rcpt (FH)	205841-2	
	Rvs	Plug	206434-1	
		Rcpt (PM)	206433-1	
		Rcpt (FH)	206433-2	
11/9	Std	Plug	206485-1	
		Rcpt (PM)	206486-1	
		Rcpt (FH)	206486-2	
17/28	Std	Plug	205839-3	
		Rcpt (PM)	205840-3	
		Rcpt (FH)	206152-1	
		Rvs	Plug	206039-1
		Rcpt (PM)	206038-1	
		Rcpt (FH)	206038-2	
		23/57		Plug
		Rcpt (PM)	206438-1	
		Rcpt (FH)	206438-2	
23/63	Std	Plug	205842-1	
		Rcpt (PM)	205843-1	
		Rcpt (FH)	205843-2	

Selection Chart 2

SERIES 4 CONNECTORS				RECOMMENDED CONTACTS
DES	SEX	HOUSING		
		DESCR	PART NO.	
23/13M	Std	Plug	211824-1	Type XII and Size 16 Multimate® (See Fig's 2 and 4) (See IS 1379 and Catalog CPC/CMC 73-204)
		Rcpt (PM)	211825-1	
		Rcpt (FH)	211825-2	
23/16M	Std	Plug	207485-1	
		Rcpt (PM)	207486-1	
		Rcpt (FH)	207486-2	
23/22M	Std	Plug	206612-1	
		Rcpt (PM)	206613-1	
		Rcpt (FH)	206613-3	

• III+ AND SUBMINIATURE COAXICON CONTACTS

Selection Chart 4

Each receptacle has polarizing keys to assure proper mating. To provide circuit identification, contact cavities are numbered on the FRONT and BACK of each connector.

3. CONNECTOR SELECTION

Using the Selection Charts and Paragraph 2, DESCRIPTION, determine the appropriate connectors to be used by the following method:

1. Determine application requirements (Series 1, 2, 3 or 4).
2. Determine number of contacts positions required.

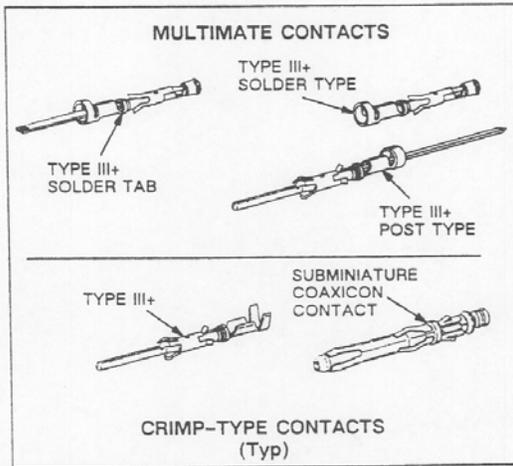


Fig. 2

3. Determine which connector style (standard or reverse) is desired.
4. Select plug housing. Determine whether or not panel mount application is to be used and select applicable receptacle housing.

4. CONTACTS

Selection — When selecting contacts according to the connector Selection Charts on this sheet, refer to Catalog CPC/CMC 73-204. For visual identification of the proper contacts to be used in the various connector series, see Figures 2, 3, and 4.

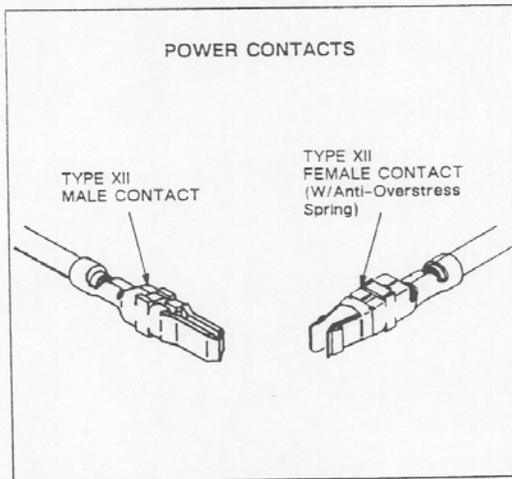


Fig. 4

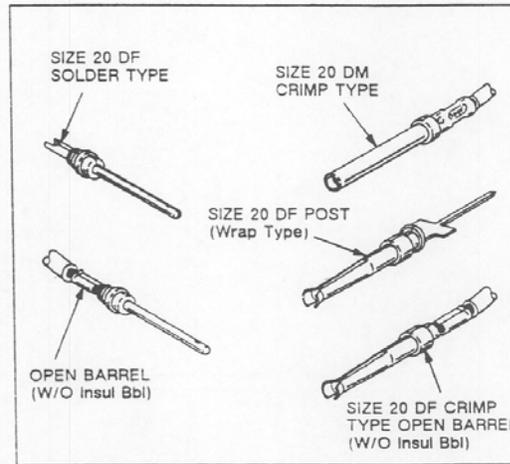


Fig. 3

For contacts used in Series 1 connectors, Multimate contacts, see Figure 2. Due to the large selection available, for crimp type contacts and hand crimping tools, we refer you to the master instruction sheet IS 1379.

For contacts used in Series 2 connectors, size -20 DM and 20 DF contacts, see Figure 3.

For contacts used in Series 3 connectors, Type XII contacts, see Figure 4.

For contacts used in Series 4 connectors, Multimate and Type XII contacts, see Figures 2 and 4.

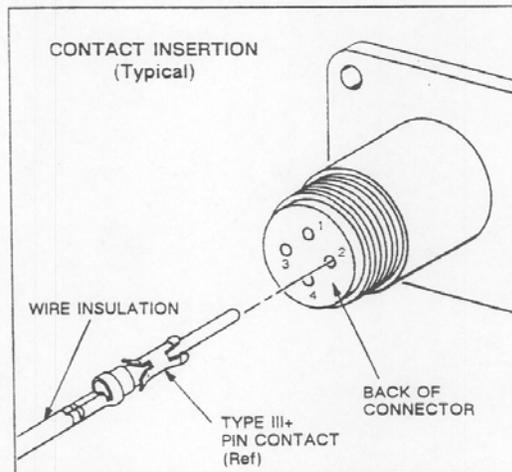


Fig. 5

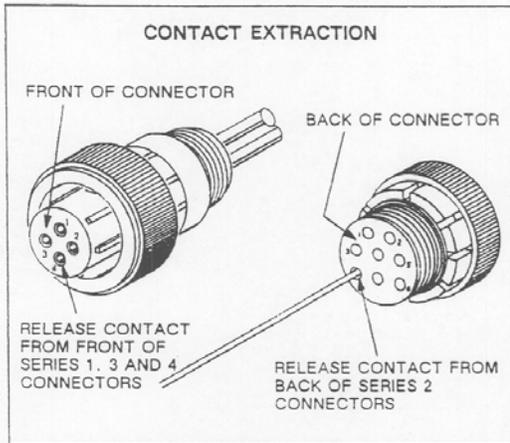


Fig. 6

Recommendation — Socket contacts should be attached to wires leading to power source, and installed in housing that has flush mating surface. This procedure provides maximum protection for both the pin and the socket contact, and minimizes the possibility of electrical shock.

Crimping — Strip form contacts are designed to be crimped with an AMP semi-automatic or automatic machine. Consult your local AMP representative for assistance in selecting the machine that will best suit your needs.

Loose piece contacts are designed to be crimped with AMP crimp tooling (hand tools, die assemblies, or crimping heads). The applicable crimp tooling for the contacts is listed on IS 1379. Read the material packaged with the crimp tooling for the proper crimping procedure.

Insertion — Normally, an insertion tool is not required to insert contacts into the housings. However, if the wire bundle is large, or if the wire is fragile, an insertion tool is recommended. Refer to IS 1379 for the appropriate insertion tool.

To insert a contact, grip insulation of wire (directly behind contact) and align contact with BACK of desired contact cavity. Insert contact straight into cavity until it bottoms. Pull back lightly on wire to be sure contact is locked in place. (See Figure 5).

Extraction — AMP extraction tools, (refer to IS 1379), are designed for removing pin and socket contacts from the connectors. Refer to the instruction material packaged with the tool for the proper extraction procedure.

Release the contact from the FRONT of Series 1, 3 and 4 connectors, and from the BACK of Series 2 connectors. (See Figure 6).

5. PANEL MOUNTING

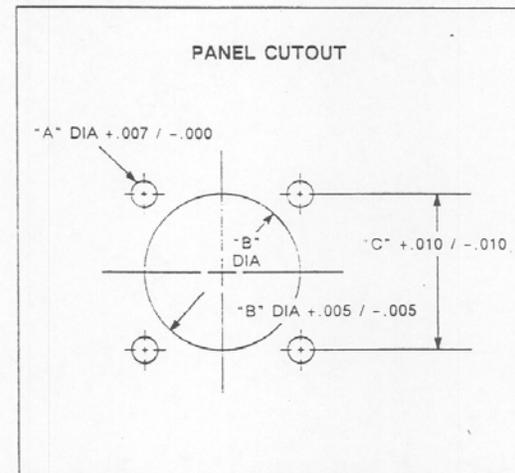
The receptacle may be either FRONT or REAR panel mounted. When REAR mounted, the panel thickness must not exceed 1/8 in., otherwise plug will bottom on panel before it is secure.

Determine size of connector to be mounted. Refer to the applicable dimensions provided in Figure 7 and make the panel cutout. Secure connector to panel using commercially available hardware (No. 4 screws).

6. MATING CONNECTORS

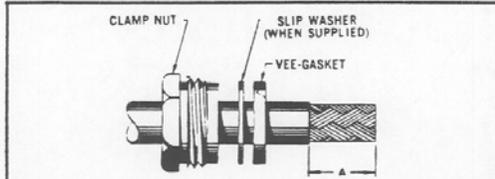
These connectors have a positive lock feature which prevents accidental disengagement. Align polarizing keys and keyways and start plug into receptacle. Rotate coupling ring CLOCKWISE until positive lock snaps into position.

NOTE Do not use for blind mating applications.

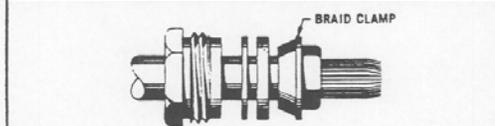


CONNECTOR SIZE	DIMENSIONS		
	A	B	C
11	.125	.850	.844
13	.125	.964	.969
17	.150	1.156	1.125
23	.150	1.610	1.438

Fig. 7



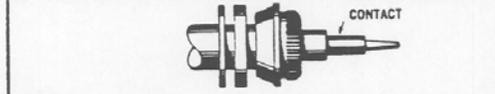
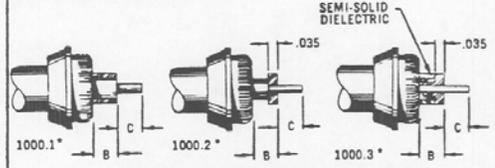
1. Cut cable end square, place clamp-nut, slip washer (when supplied), and gasket over jacket. Remove jacket to dimension "A."



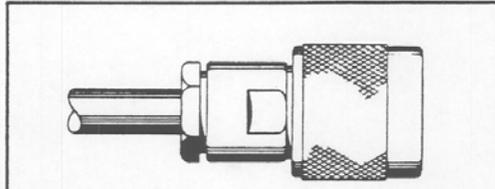
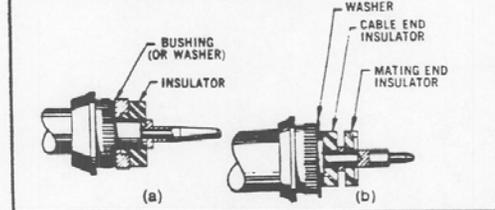
2. Comb out braid and taper forward. Place braid clamp over braid against jacket cut.



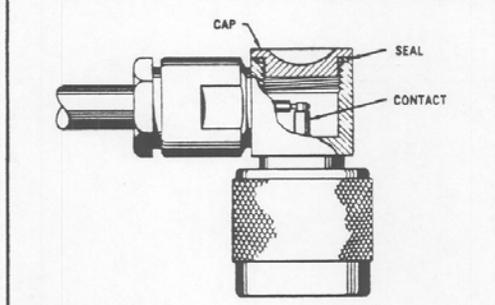
3. Fold braid back over braid clamp and trim as shown above. Remove dielectric to dimension "B." Cut center conductor to dimension "C."
When cable positioning insulators are used adjust trim code dimensions as shown below, and assemble as indicated.



4. Solder contact to center conductor. For access type angle connectors, omit this step and proceed to step 5.
For captive contacts: (a) assemble bushing and insulator, attach contact, or (b) assemble washer and larger (cable end) insulator. Attach contact. Assemble smaller (mating end) insulator.
When center contact is undercut captive type, insert cable assembly until insulator detent locks into contact.



5. Thread assembly into connector, and lock securely. Vee gasket must be split by braid clamp.



6. For access type angle connectors, solder center conductor in contact groove. Close access opening.

TRIM CODE CHART			
CODE	A	B	C
1001	11/16	.440	7/64
1002	23/32	.470	7/64
1003	11/16	.420	1/8
1004	11/32	.106	7/64
1005	11/32	.040	5/32
1008	3/8	.180	1/16
1012	13/32	.128	5/32
1013	7/16	.170	5/32
1014	7/16	.118	7/32
1015	3/8	.118	5/32
1016	3/8	.046	7/32
1017	13/32	.074	3/16
1018	31/64	.065	7/32
1019	5/8	.371	5/32
1021	3/8	.096	5/32
1022	5/16	.046	5/32
1024	3/8	.046	3/16
1025	13/32	.216	3/32
1030	1/4	.045	3/32
1031	5/8	.296	7/32
1033	19/32	.327	5/32
1042	5/16	.070	1/8
1044	5/16	.105	9/64
1050	19/64	.109	7/64

CABLING

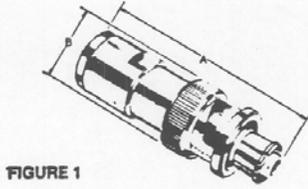


FIGURE 1

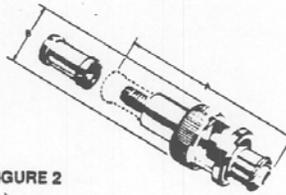


FIGURE 2

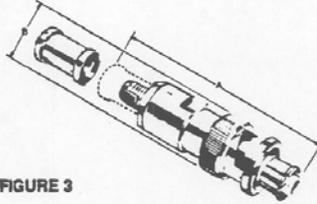


FIGURE 3

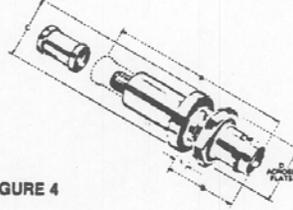


FIGURE 4

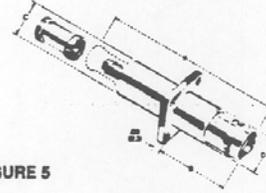
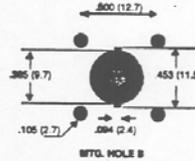
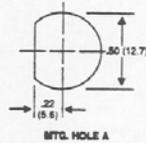


FIGURE 5



PLUGS - CONVENTIONAL CONSTRUCTION

CABLE GROUP	KINGS PART NUMBER		FIG. NO.	NOTES	DIMENSIONS					CABLING									
	SILVER FINISH	TR-5 FINISH			A	B	C	D	t	MTG. HOLE	CBL. TRIM CODE	CRIMP DIE	JACKET TRIM JIG	DIELEC. TRIM JIG					
					in	mm	in	mm	in	mm	in	mm	in	mm					
DE		1705-15-9	1	Contact Gold Plate	1.80	45.7	8.56	14.2							1001				
G		1705-14	1		1.81	46.0	8.56	14.2							1001.3				

SHV

SUPPLEMENTAL DATA (CUSTOMER SPECIFIC)

F.1 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 Cardinal Health at 440.248.9300 or by Fax at 440.542.3682.

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Radiation Management Services

For additional information, please contact
Radiation Management Services business
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