FLUKE®
Biomedical

Victoreen®

960SF-220, 960SF-221
960SF-230, & 960SF-231

Scaler Module

Users Manual

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Table of Contents

Section 1: **Introduction 1-1**
1.1 General Description 1-1
1.2 Application 1-1
1.3 Components 1-1
1.4 Specifications 1-2
1.5 Receiving Inspection and Storage 1-3
1.6 Installation 1-3
1.7 Procedures, Warnings, and Cautions 1-3

Section 2: **Theory of Operation 2-1**
2.1 Theory of Operation 2-1
2.2 Detector Input Circuitry 2-1
2.3 Discriminator 2-1
2.4 Counters 2-1
2.5 Address Decoding Circuits 2-2
2.6 Bus Transceivers 2-2
2.7 Lamp Drivers 2-2
2.8 Relay Drivers 2-2
2.9 CHECK SOURCE and ACK/FAIL Switches 2-4
2.10 Analog Inputs 2-4
2.11 Analog Output 2-4
2.12 High Voltage Power Supply 2-4
2.13 High Voltage Shut Down 2-5
2.14 Anti-Jam Printed Circuit Board 2-5

Section 3: **Maintenance, Calibration and Troubleshooting 3-1**
3.1 Maintenance 3-1
3.2 Calibration 3-1
3.3 Troubleshooting 3-1

Appendix A: **Connector Designations A-1**
A.1 Connector Designations A-1

Appendix B: **Applicable Drawings and Bill of Materials B-1**
B.1 Applicable Drawings B-1
B.2 Bill of Materials B-1

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Section 1
Introduction

1.1 General Description

The 960SF Scaler Module accumulates pulses from a remote radiation detector. The pulses are available upon request from the associated controller. The discriminator permits adjustment of the scaler output to eliminate the effects of extraneous input pulses or to select an input signal representing a single isotope.

The high voltage supply for energizing the remote detector is controlled by signals from the controller. The controller can also select a digital signal representative of anyone of up to four separate analog input signals.

An analog output signal representing the radiation level is provided. The scaler also provides up to six digital output signals in response to the appropriate commands from the controller module. Figure 2-1 is a block diagram of the scaler.

The module also provides an upper and lower discriminator adjustment for the input pulses. There are four indicator lamps. They are controlled by the associated controller and are labeled ALARM, WARN, ACK/FAIL, and CHECK SOURCE. The last two ACK/FAIL and CHECK SOURCE are lamp/pushbuttons that communicate back to the controller.

A HIGH VOLTAGE adjustment provides the operator control over the remote detector high voltage supply. A TEST INPUT jack and a TEST/NORM switch allows selection of a simulated detector input signal for module testing.

1.2 Application

The scaler module is used in VICTOREEN 960 series digital radiation monitoring systems. The scaler is compatible with both the 960MB and the 961MB motherboard bus structure.

1.3 Components

The scaler module contains the following basic components:

- Counter (18 bits)
- Relay drivers (6)
- Lamp drivers (6)
- Analog input (4)
- Switch inputs (C/S, ACK)
- Analog output (4-20 mA)
  Options: 0-10 mV, 0-50 mV,
  0-1 V, 0-5 V, and 0-10 V
- Signal select switch (TEST/NORM)
- Anti-jam board (960AJ)
- Automatic HV shutdown circuit
- Adjustable High Voltage

- Test Input

1.4 Specifications

General specifications for the scaler are listed below. The Scaler Module is rated for nuclear safety-related applications and any repairs made to the nuclear rated module will void the safety-related rating. The module (Series 960SF-200) must be returned to the factory for authorized, qualified (ANSI 45.2.6, 1978,Skill Level II) service.

Dimensions (W x H)	7.5 x 11.5 in (29.2 x 19.1 cm)
Weight	1 lb 7 oz (0.64 kg)
Operating Temperature	32°F to 122°F (0°C to 50°C)
Relative Humidity	0 to 95% non-condensing
Power	+5 V @ 600 mA, +15 V @ 350 mA, -15 V @ 100 mA
Address Lines	A0, A1, & A2
Control and Timing	R/W, SHORT 02, & DS
Data Bus	8-bit bi-directional D0 through D7
Analog Inputs	Four analog inputs 0 to +10 V
Analog Outputs	Standard 4 to 20 mA (500 Ω maximum load)
Relay Drivers	Six 24 VDC relay drivers used to drive 961RE-200-10 or 961RE-210-10 Relay Modules
Lamp Drivers	Four lamp drivers for ALARM, WARN FAIL, CHECK SOURCE (C/S)
Switch Inputs (ACK)	Two switch inputs for CHECK SOURCE (C/S) and ACKNOWLEDGE
High Voltage Power Supply	Adjustable 400 to 1800 VDC @ 1 mA maximum for detector HV Model 960SF-231, adjustable -400 VDC to -1800 VDC @ 1 mA
Discriminator	Two selectable thresholds (upper and lower discriminator)
Test/Normal Switch	Switch selectable between test signal and detector input
Pulse Out (J7)	Buffered signal output to be used by the analyzer
Anti-jam register	On board circuit to detect jam condition causing a bit to be set at a
HV Shutdown	High voltage shutdown circuit enables automatic shutdown of high voltage by the controller. LED in front panel also lights up
HV Test Point Accuracy 2%	Front panel test point available to measure HV value at ratio of 300:1 +/-

Table 1-1. Model Descriptions

Model No.	High Voltage	Analog Inputs (4)	Analog Output (1)	24 V Solid State Relay Outputs (6)
960SF-220	Positive	Yes	Yes	Yes
960SF-221	Positive	No	Yes	Yes

960SF-230	Negative	Yes	Yes	Yes
960SF-231	Negative	No	Yes	Yes

1.5 Receiving Inspection and Storage

Receiving Inspection

Upon receipt of the unit:

1. Inspect the carton(s) and contents for damage. If damage is evident, file a claim with the carrier and notify Fluke Biomedical, Radiation Management Services at 440.248.9300.
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 Fluke Biomedical.

Storage

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

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

Storage of Victoreen instruments must comply with the following:

1. Inspection and examination of items in storage must be in accordance with ANSI N45.2.2 (1972) Section 6.4.1.
2. Requirements for proper storage must be documented and written procedures or instructions must be established.
3. In the event of fire, post-fire evaluation must be in accordance with ANSI N45.2.2 (1972), Section 6.4.3.
4. Removal of items from storage must be in accordance with ANSI N45.2.2 (1972), Sections 6.5 and 6.6.

1.6 Installation

The 960SF Scaler Module is supplied as part of a Radiation Monitoring System (RMS) or as a replacement part for an existing RMS. When the module is shipped as part of a system, it is installed as part of the RMS at the factory.

When a module is shipped as a replacement part, verify that jumper addresses and PROMs are in the same configuration as the module that is being replaced.

1.7 Procedures, Warnings, and Cautions

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

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

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

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

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

Section 2
Theory of Operation

2.1 Theory of Operation

During the following discussion, refer to block diagram, Figure 2-1, and the schematic diagrams in Appendix B.

2.2 Detector Input Circuitry

Connector J5 is the detector signal input. Input impedance is 50 ohms to match the signal cable and the detector's output impedance. The input signal is a pulse train that could be positive or negative depending upon the detector used. Z5 is a unity gain differential amplifier with single ended output whose output is fed into signal multiplexer Z6. Z6 selects detector input or test input, depending on the setting of the test switch. The signal is then fed into the discriminator.

2.3 Discriminator

The function of the discriminator is to provide clock pulses to the counter, for those pulses which peak between the LOW DISC and HIGH DISC threshold levels. The LOW DISC threshold is adjusted with potentiometer R3 and measured at TP2. The HIGH DISC threshold is adjusted with potentiometer R2 and is measured at TP1. When the signal level goes above LOW DISC threshold, Z7 pin 6 will go low. The first half of flip-flop Z19 clocks and then latch. When the signal goes below LOW DISC threshold, Z7 pin 6 return to a high state. This will provide a clock pulse into the second half flip-flop of Z19. Z19 pin 8 will goes low and CLOCK is active (high). The clock is fed to the counter circuit.

If the signal level goes above the HIGH DISC threshold, Z7 pin 1 will go low. This will reset the first flip-flop. When the signal goes below the LOW DISC threshold, the second flip-flop is clocked keeping Z19 pin 8 high. Therefore Z22 pin 8 is low inactive and this pulse is not counted.

2.4 Counters

The CLOCK pulse from Z22 is inverted by inverting Schmidt trigger Z21. Z21 provides a negative going clock pulse for Z24. Z24, Z25, and Z26 are 16-bit dual module counters. Bits 1 through 8 are from Z24. Z25 contains bits 9 through 16 and Z26 pins 3 and 4 are bits 17 and 18 respectively. Bit 18 is a stop bit that causes the CLOCK to stay low and is also provided to register 3 to indicate overrange. The output of the counters are input to registers 0, 1, and 3 and are available to the bus upon READ 0, READ 1, or READ 3 control signals. Register 0, 1, and 3 are read only registers.

2.5 Address Decoding Circuits

Device selection is set by a jumping option on SW1 or SW2. Input signals for decoding are DS, 02, R/W, A0, A 1, and A2. These input signals are inverted through Z36 and Z37 and fed into Z27 and Z28 that are decoders. Z27 decodes for READ ONLY registers and Z28 decodes for WRITE ONLY registers. The decoding scheme is shown in Table 2-1.

Table 2-1. Address Decoding

A2	A1	A0	R/W	DS	Function	Enable Signal
0	0	0	1	1	COUNTER HIGH BYTE	READ 0
0	0	1	1	1	COUNTER LOW BYTE	READ 1
0	1	0	1	1	A/D UPPER BITS	READ 2
0	1	1	1	1	SCALER STATUS	READ 3
1	0	0	1	1	A/D LOWER 4 BITS	READ 4
0	0	0	0	1	RELAYS	WRITE 0
0	0	1	0	1	SCALER CONTORL	WRITE 1
0	1	0	0	1	LAMPS	WRITE 2
0	1	1	0	1	D/A CONVERTER	WRITE 3
1	0	0	0	1	MPU RESET	WRITE 4
x	x	x	0	1	-	WRITE
x	x	x	1	1	-	READ

2.6 Bus Transceivers

Z31 and Z30 are data bus transceivers transferring data from the scaler to the external data bus when READ is active (high) and from the external data bus to the scale when WRITE is active (low).

2.7 Lamp Drivers

Z32 is a WRITE only register used for lamps. It clocks the data in when WRITE 2 is active (low). Z23 is a Darlington array driving the front panel ALARM, WARN, and FAIL lamps. The FAIL lamp is handled through watchdog timer Z38 that is set for 5 seconds. If the fail light is not written to every 5 seconds or sooner, it will go off to indicate failure and also provide a pulse to watchdog pin 72 on J1.

2.8 Relay Drivers

Z29 is a WRITE only register used for relays. It clocks data in when WRITE 0 is active (low). Z18 is a Darlington array capable of switching +24 VDC at up to 150 mA with all outputs energized simultaneously.

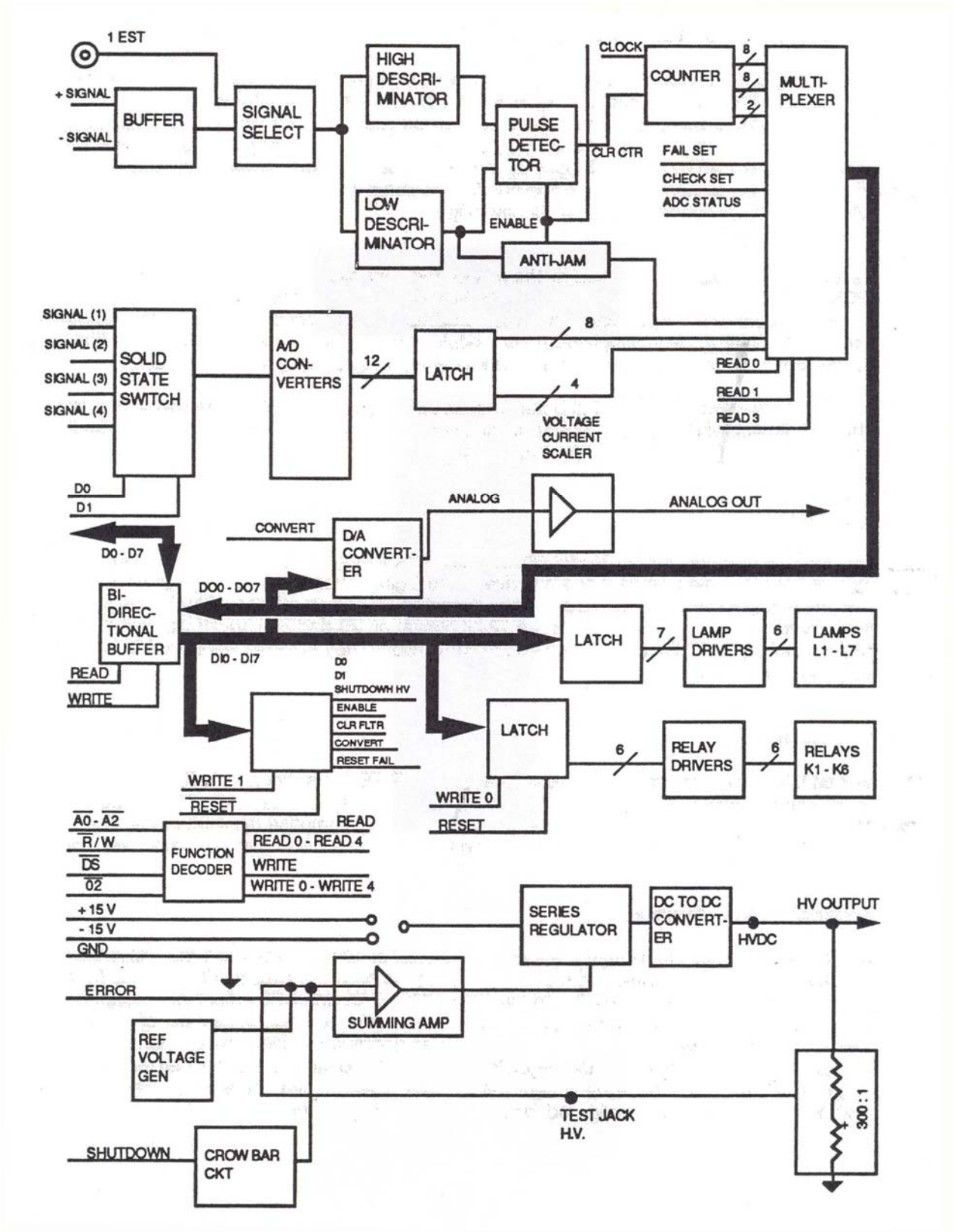

Figure 2-1. Scaler Module Functional Block Diagram

2.9 CHECK SOURCE and ACK/FAIL Switches

CHECK SOURCE is a front panel momentary switch which, when pressed, causes the check source in the detector to move in front of the detector. The ACK/FAIL switch is a momentary switch used to acknowledge an alarm or warn condition. When the microprocessor flags an out-of-limits operating condition, the operator can press the ACK/FAIL pushbutton to acknowledge the alarm. Since the out-of--limits conditions which can be acknowledged by the microprocessor are firmware dependent, refer to the operation section of the system manual to find out the additional alarms, other than WARN and ALARM, that the ACK/FAIL pushbutton is used to acknowledge.

There are four indicator lights, controlled by the associated controller labeled ALARM, WARN, ACK/FAIL, and CHECK SOURCE. The ACK/FAIL and CHECK SOURCE indicators are also pushbuttons and provide a way to communicate with the controller. A HIGH VOLTAGE adjustment provides operator control over the remote detector high voltage supply from the module. A TEST INPUT jack and an associated TEST/NORM switch permits selection of a simulated detector signal for testing the module.

Normally the C/S Flip-Flop-flop is reset and the CHECK SET signal is low. When an operator pushes SW4, he sets the C/S flip-flop and the CHECK SET signal becomes high (active) to cause the C/S reading. FAIL SET will become active (high) if SW3 is pushed because the FAIL Flip-Flop is set.

2.10 Analog Inputs

This description applies only for the 960SF-220-10 Scaler and the 960SF-230-10 Scaler. There are four 0-10 V analog inputs that are converted to digital. These four analog signals are multiplexed by Z17 and the signal to be converted is picked by decoding D0 and D1. CH2 (SIGNAL 2) is an optional high voltage monitor-using jumper W15. Z8 is a 12-bit converter. Z9 and Z10 are READ ONLY registers. Digital data is clocked into Z9 and Z10 upon end of conversion. They are read when READ 2 and READ 4 are active (low) respectively.

2.11 Analog Output

Z11 is an 8-bit D/A converter and latches input data when WRITE 3 is active (high). R126 is ZERO ADJUST and R127 is GAIN ADJUST. R126 sets the low limit and R127 sets the upper limit of the output. DAC output goes into the input of Z2. Z2, Z3, and associated circuitry comprise the 4-20 mA analog output. Feedback divider R23 and R24 insure load independent output to a maximum load impedance of 500 Ω.

2.12 High Voltage Power Supply

The scaler provides an adjustable high voltage power supply of 400 to 1800 V at 1 mA. R8 is the HIGH VOLTAGE ADJUST driving Z4 that drives Q7. Q7drives the oscillator circuitry Q6, Q4 and T1 that generates high voltage pulses rectified by bridge CR5, CR6, CR8, and CR9. This high voltage is divided by a ratio of 300:1, then buffered by voltage follower Z39 that is fed back to the input of Z4 as feedback for regulation. TP3 is the test point used to measure the scaled down voltage value. There is also an ERROR input originated by an americium regulator (separate optional external module) that is fed into the high voltage circuit at Z4 pin 3 to regulate high voltage when system gain needs to be changed. 960SF-230 and 960SF-231 are configured for negative high voltage output.

2.13 High Voltage Shut Down

The microprocessor can generate, under overrange or jam conditions, a command to shut the high voltage down. When the SHUT DOWN signal goes high, Q3 turns on, Q5 turns on and Z4 pin 2 will be forced into about 4.5 V potential.

This will cause Z4 pin 6 to become positive, Q7 to turn off and high voltage to turn off. Model 960SF-231 provides negative high voltage and does not utilize transistor Q3, a jumper is provided from the base to the collector of the Q3 position on the circuit board.

2.14 Anti-Jam Printed Circuit Board

The anti-jam condition is detected when a pulse pile up condition exists. Discriminator output is fed into a comparator after integration.

Integration is determined by R7*C2 with a one millisecond time constant. Z2 is the comparator and compares the integrated voltage to the threshold set by R6. When the duty cycle exceeds a preset value, the output of Z2 pin 1 will go high. This will trigger Z1 to go into a latch up condition that will cause Z1 pin 4 to stay high. This condition will turn Q2 and Q3 on which will cause the following to occur:

1. The jam bit will go high to indicate a "jam" condition.
2. Fuse F1 will blow causing the input of F1 permanently to stay low, which keeps the jam bit high (active).

There is a start-up delay of ½ second to allow the high voltage to stabilize upon power up of the monitor. The associated controller module also has access to this to allow the controller to reset the anti-jam circuit. This delay is caused by the time constant of R13*C4. When the scaler is used with a scintillation detector, jumper W1 is connected between pins B and C. If a GM detector is in use, W1 is jumpered between pins A and B on the module.

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Section 3
Maintenance, Calibration and Troubleshooting

3.1 Maintenance

No periodic maintenance is required for the module.

NOTE

If a maintenance question arises and cannot be resolved by using this manual, please contact the Fluke Biomedical at 440.248.9300 for assistance.

3.2 Calibration

The 960SF-220, 960SF-221, 960SF-230 and 960SF-231 modules do not require any calibration.

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

If a problem develops, verify that the voltages at connection point inputs and outputs are present and that all wiring is secure. Refer to Appendix B for drawings.

The 960SF-220, 960SF-221, 960SF-230, and 960SF-231 Scaler Modules must be returned to the factory for service if troubleshooting of the module is necessary.

NOTE

If a problem cannot be resolved by using the drawings In Appendix B while applying the troubleshooting Instructions found in this manual, please contact Cardinal Health for assistance.

Appendix A
Connector Designations

A.1 Connector Designations

Pin	Description	Pin	Description	Pin	Description	Pin	Description
1	GND	21	MICRO RESTART	41	DSI0CO	61	A6
2	GND	22	BIT RATE	42	DS01E0	62	A7
3	GND	23	R/W	43	GND	63	A8
4	GND	24	02	44	GND	64	A9
5	+5V	25	IRQ	45	D0	65	A10
6	+5V	26	SHORT 02	46	D1	66	A11
7	+5V	27	DS 0000	47	D2	67	A12
8	+5V	28	DS 0020	48	D3	68	A13
9	+15V	29	DS 0040	49	D4	69	A14
10	+15V	30	DS 0060	50	D5	70	A15
11	GND	31	DS 0080	51	D6	71	EXMEM
12	GND	32	DS 00A0	52	D7	72	WATCH DOG
13	-15	33	DS 00C0	53	GND	73	PULSE OUT #1
14	-15	34	DS 00E0	54	GND	74	PULSE OUT #2
15	5 V BAT	35	DS 0100	55	A0	75	PULSE OUT #3
16	5 V BAT	36	DS 0120	56	A1	76	ERROR OUT
17	MEMORY PROTECT	37	DS 0140	57	A2	77	GND
18	POWER FAIL	38	DS 0160	58	A3	78	GND
19	RESET	39	DS 0180	59	A4	79	GND
20	BNKG	40	DS 01A0	60	A5	80	GND

J2 Pin Designation

* Pin	Description	* Pin	Description
A	Analog Out +	a	SIG- (2)
B	GND	b	SIG+ (1)
C	Not Used	c	GND
D	Not Used	d	Not Used
E	Not Used	e	SIG+(2)
F	Not Used	f	GND
H	Not Used	h	GND
J	Not Used	i	GND
K	Not Used	k	Not Used
L	GND	m	Not Used
M	Not Used	n	Not Used
N	Not Used	D	Not Used
P	GND	r	K3 (ALARM)
R	SIG- (3)	s	Relay Common
S	Counter Enable (Not Used)	t	K5 (HORN)
T	GND	u	K4 (CHECK SOURCE)
U	SIG+ (4)	Y	K1 (FAIL)
V	SIG+ (3)	w	K6 (BEACON)
W	GND	x	K2 (WARN)
X	SIG- (1)		
Y	SIG- (4)		
Z	GND		

J3 Pin Designation

Pin	Description	Pin	Description
1	GND	14	FAIL/ACK SW
2	GND	15	C/S SW N.O.
3	-	16	C/S SW N.C.
4	-	17	-
5	-	18	TEST/NORMAL SW (TP)
6	-	19	+15 VDC
7	Warn Light	20	+15 VDC
8	C/S Light	21	SIG IN (TEST) (TP)
9	Scare Light	22	SHUT DOWN LED
10	Scare Light	23	+5 VDC
11	Alarm Light	24	+5 VDC
12	Scare Light	25	HV Test Point
13	Fail Light	26	-

N.O. - Normally Open Contacts

N.C. - Normally Closed Contacts

960SF Jumpers (Including 960AJ)

Designation	Position	Purpose	Factory Setting
W2	N	4-20 mA OFFSET	960SF-220/221/230/231
W3	N	4-20 mA OFFSET	960SF-220/221/230/231
W5	A-B	For – HV	960SF -230/231
	B-C	For + HV	960SF-220/221
W6	A-B	For + HV	960SF-220/221
	B-C	For – HV	960SF-230/231
W7	N	4-20 mA	960SF-220/221/230/231
W8	N	To digitize 300:1 HV on Flow input 2	-
	OUT	To digitize Flow 2	960SF-220/221/230/231
W10	A-B	D1 enable sig. on PRAM	960SF-220/221/230/231
	B-C	+5 V to enable RAM	-
W11	A-B	+5 V to enable RAM	-
	B-C	D0 enable signal	960SF-220/221/230/231
W9	A-B	Positive input signal from detector. (GM)	As required
	B-C	Negative input signal from detectors (Scintillation)	As required
J5	Conductor B	Positive input from detectors (GM)	As required
	Conductor A	Negative input from detectors (Scintillators)	As required
W12	A-B	Presence for Flow input or analog output.	960SF-220/230
	B-C	Indicates no Flow input or analog output.	960SF-221/231
W13	-	Not Used	
W14	-	Not Used	

960AJ Jumpers

Designation	Position	Purpose	Factory Setting
W1	A-B	Use with 857/897 GM detectors	As required
W1	B-C	Use with 843 Scintillation detectors	As required
W2	N	Disables Anti-Jam	Factory test
W2	OUT	Enables Anti-Jam	Normal
W3	N	Protects Fuse	Factory test
W3	OUT	Will allow fuse to blow if Anti-Jam occurs	Normal

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Appendix B
Applicable Drawings and Bill of Materials

B.1 Applicable Drawings

Drawing Number	Description
960SF-220-10	Scaler Module Main Assembly
960SF-221-10	Scaler Module Main Assembly
960SF-230-10	Scaler Module Main Assembly
960SF-231-10	Scaler Module Main Assembly
960SF-220-13	Scaler Module Schematic Positive HV
960AJ-200-10	Anti-Jam Module Main Assembly
960AJ-200-13	Anti-Jam Module Schematic
960SF-230-13	Scaler Module Schematic Negative HV
960SF-200-15	Scaler Switch/Indicator Circuit Board Assembly
960SF-200-18	Scaler Switch/Indicator Schematic

B.2 Applicable Bill of Materials

Drawing Number	Description
960SF-220-10	Scaler Module Main Assembly
960SF-221-10	Scaler Module Main Assembly
960SF-230-10	Scaler Module Main Assembly
960SF-231-10	Scaler Module Main Assembly
960AJ-200-10	Anti-Jam Module Main Assembly
960SF-200-15	Scaler Switch/Indicator Circuit Board Assembly

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