TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
1630 Chestnut Street Tower II

March 27, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

Please refer to your letter to H. G. Parris dated September 14, 1984 which transmitted question 420.01 regarding isolation devices for the Safety Parameter Display System (SPDS) and questions 620.01 through 620.05 regarding human factors engineering information for the SPDS for our Watts Bar Nuclear Plant. Enclosed is our response questions 420.01. TVA will provide a response to questions 620.01 through 620.05 by June 15, 1985.

If you have any questions concerning this matter, please get in touch with K. Mali of my staff at FTS 858-2682 in Chattanooga.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

D. E. McCloud

D. E. McCloud
Nuclear Engineer

Sworn to and subscribed before me
this 27th day of March 1985

Bryant M. Lowery

Notary Public
My Commission Expires 4/8/86

Enclosure

cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Aperture Card Dist
Drawings
To: T. Kenyon

B001
1/1

ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION
SAFETY PARAMETERS DISPLAY SYSTEM

NCR Request

Each operating reactor shall be provided with a safety parameter display system (SPDS). The Commission approved requirements for an SPDS are defined in NUREG-0737, Supplement 1. In the Regional Workshops on Generic Letter 82-33 held during March 1983, the NRC discussed these requirements and the Staff's review of the SPDS.

The Staff reviewed the SPDS safety analysis provided by the Tennessee Valley Authority (reference 1). The Staff was unable to complete the review because of insufficient information. The following additional information is required to continue and complete the review:

INSTRUMENTATION AND CONTROL SYSTEMS INFORMATION

420.01 Isolation Devices

Provide the following:

a. For each type of device used to accomplish electrical isolation, describe the specific testing performed to demonstrate that the device is acceptable for its application(s). This description should include elementary diagrams when necessary to indicate the test configuration and how the maximum credible faults were applied to the devices.

b. Data to verify that the maximum credible faults applied during the test were the maximum voltage/current to which the device could be exposed, and define how the maximum voltage/current was determined.

c. Data to verify that the maximum credible fault was applied to the output of the device in the transverse mode (between signal and return) and other faults were considered (i.e., open and short circuits).

d. Define the pass/fail acceptance criteria for each type of device.

e. A commitment that the isolation devices comply with the environmental qualifications (10CFR50.49) and with the seismic qualifications which were the basis for plant licensing.

f. A description of the measures taken to protect the safety systems from electrical interference (i.e., electrostatic coupling, EMI, common mode, and crosstalk) that may be generated by the SPDS.

TVA Response

The following attachments A through I provide TVA's response to each paragraph of the above question including those isolation devices under the Westinghouse NSSS scope of supply.

ATTACHMENT A

E-MAX OPTICAL ISOLATOR MODEL 175D304

Paragraph a - Verification that this device is acceptable and qualified for the installed applications is demonstrated by tests in the area of seismic, electrical, environmental, and EMI parameters.

Internal schematic diagram for the model 175C304 isolator, E-Max drawing 175C304, attached for reference. This drawing shows the electrical input is completely isolated electrically from the output, and that coupling to maintain continuity of the information signal is accomplished by means of optical isolation. The optical isolation provides 1/4-inch physical clearance between the input and output electrical circuitry.

E-Max test procedure, attachment 1-A, covering electrical factory test of the 175D304 device is attached to show integration of factory test fixture and module being tested. Results of the test of one module, serial No.0160, is included with the procedure to show results typical for all devices.

TVA test report No. I86-85-4790, Analog Optical Isolator Fault Tests, is included to show isolating capability of the device during electrical fault conditions on the output circuit terminals.

Paragraphs b and c - The concerns addressed by these two paragraphs involve possible electrical faults on the output terminals of the device. The maximum credible fault that the device could see would be from the 120V ac supply power in the SPDS and isolator module cabinets.

Electrical isolation between input and output circuits was demonstrated by means of a 2500 VRMS, 60-Hz voltage applied for 1 minute. Assurance that the 1E input side of the device is immune to faults on the non-1E output side of the device is demonstrated by fault tests. Open and short circuits applied to the output terminals had no effect on the 1E side of the device. Shorts between the non-1E side power supply and the output terminals also had no effect on the input circut. A bolted fault of 280V dc applied directly to the output terminals destroyed the output circuit but did not cause any degradation of the 1E input circuit. This test demonstrates that isolation is maintained for any fault current that may result from the maximum credible voltage, 120V ac being applied to the output circuitry.

Paragraph d - Acceptance criteria dictated that the devices provided electrical isolation for an electrical signal having a range of 0-100 mV dc. The accuracy of the signal must be maintained within $\pm$ 0.5-percent full scale from input to output during normal operating conditions. Electrical isolation between input and output circuitry was to be demonstrated by applying 2500V RMS 60-Hz for 1 minute. The criteria required that the device not degrade or affect any 1E device associated with input signal source during normal operation or during any design basis event referenced in paragraphs e and f. There is no safety requirement for the device to maintain signal continuity and accuracy during or after a design basis event. If the device did not maintain input signal accuracy requirements and electrical isolation capability during the test for normal operating conditions, it would be determined that the device had failed. Had the input side of the isolator been affected by any normal or abnormal event in such a way as to degrade the input source devices, the test would have been determined a failure.

<u>Paragraph e</u> - Verification that the devices comply with seismic qualification which was the basis for plant licensing has been demonstrated by test. The equipment is located in a mild environment and certification by the supplier documents' qualification of the devices for the following environmental conditions.

The abnormal conditions could exist for up to 8 hours per excursion and will occur less than 1-percent of the plant life.

Environmental Conditions

Normal	- Temperature	Maximum 75, minimum 75, average 75°(F)
	- Pressure	ATM (+)
	- Relative Humidity	Maximum 60, minimum 40, average 50 (%)
	- Radiation	$5x10^2$ (rads), TID 40 year
	- Vibration	Seismic category I (active)
Abnormal	- Temperature	Maximum 104°F, minimum 60°F
	- Pressure	ATM (+)
	- Relative Humidity	Maximum 60, minimum 10 (%)
	- Radiation	Negligible
	- Vibration	Seismic category I (active)
Accident	- Temperature	
	- Pressure	
	- Relative Humidity	NA
	- Radiation	
	- Caustic Spray	

<u>Paragraph f</u> - Industry-accepted practices of routing cables and grounding of circuits have been utilized in the design to minimize effects of radiated or coupled signals on the input leads to the device. EMI tests have verified the immunity of the isolators to EMI sources. There is no known source within the SPDS for generating any EMI emissions.

-max
ments, Incorporated
erness Drive East (1-H)
wood, Colo. 80112
'73-6640 TLX 45657

ATTACHMENT 1-A
(TO APPENDIX A)

831326

APPROVED
This approval does not relieve the Contractor from any part of his responsibility for the correctness of design, details and dimensions.
TENNESSEE VALLEY AUTHORITY
Date SEP 9 1982
F. W. CHANDLER

TEST PROCEDURE

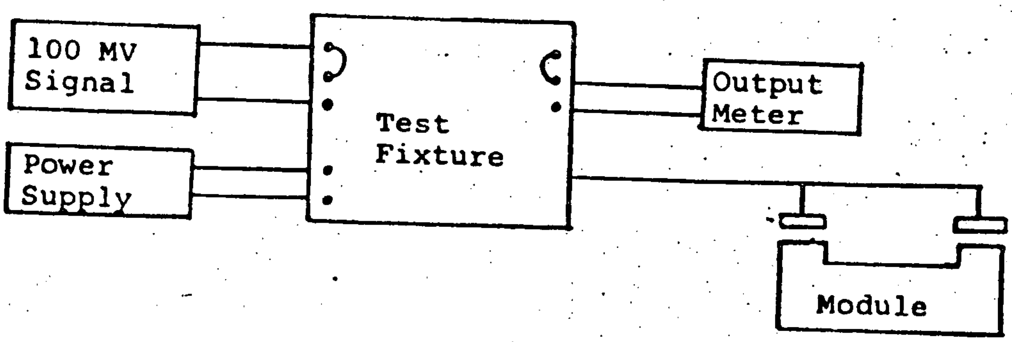
ANALOG OPTICAL ISOLATOR, VOLTAGE
P/N 175D304

A. Test Equipment Required:

1 ea. E-MAX Test Fixture
1 ea. Scope - Tektronix T932A or equivalent
1 ea. Counter - HP5232A or equivalent
1 ea. Signal Generator - Wavetek 180 or evuivalent
1 ea. DVM - Keithly 177 or evuivalent
1 ea. Hypot Tester 0-3 kV AC
1 ea. 100 mV DC Source

B. Procedure

1. Set up the test fixture as shown:



a. Set signal generator to output a 10 Hz square wave, 10 Volts peak-to-peak from 0V to 10V.

b. Set Voltage/Current switch to voltage.

c. Source select to external

d. Range select to maximum.

e. Common mode switch to common mode position.

2. Apply power to the module to be tested.

3. Measure the ± 12 Volt supplies for the input and output sections. They should be 12V ± .5V.

4. Adjust R2 to minimize the signal seen on the scope at TP2 using TP1 as scope ground.

5. Set the test fixture switches as below:

   a. Turn common mode switch to normal.

   b. Turn source select to +V.

   c. Turn range select to ØV.

6. Observe TP7 with DVM. Set TP7 to zero Volts ± .1V MVDC using R25. Use TP8 as ground.

7. Observe the output on the oscilloscope. The noise should be less than .5MV P-P.

8. Set the range select switch to 100MV and measure the input at test points A and C. Set the input level to +100MV using input level adjust pot.

9. Measure the output at TP7 and adjust the voltage to be the same as the input ± .10 MV using R21.

10. Switch source select to external, set signal generator to sine wave and measure input at points A and C. Adjust level to 100MV peak.

11. Observe the output on the oscillograph. Observable distortion or excessive noise are reasons to fail the unit.

12. Recheck zero and gain adjustments and redo steps 6 through 11 if necessary.

C. Hypot Test

   1. Connect together A1 through A 6 and B1 through B6.

   2. Hypot between A1-6 and B1-6 at 2500V AC for one minute.

D. Aging

   1. Install the module in a cabinet and run under load a minimum of 168 hours at 140°F. The unit should have a 100MV input and the output loaded with a 1 meg. resistor.

   2. Retest for zero and full scale gain as in steps 6 through 11 of the procedure. Zero should be within ± .2MV, gain within ± .2MV. If adjustments are necessary for the unit to be within specifications, the unit has failed and must begin all tests over again.

E. Acceptance

1. The module shall pass all the above tests prior to acceptance. Should it fail at any time, it must begin all tests at the beginning.

2. All failures shall be logged by serial number in the log. An MIR form shall be used to reject all non-conforming materials.

e-max INSTRUMENTS.

MODULE TEST DATA

SUBJECT	NO.
P/N 175C304, Full Scale Rating 100mV,	+30 175C304 +29
% Full Scale Error Allowed 0.5% S/N 0160	PAGE 1 of 1
Contract No. 82KJ3-831326 Item 9B-Watts Bar	DATE
SUPERSEDES	

1. Pre-Aging Calibration Data

Data Recorded By Harold A. Romero Date 10-19-82

a. Power Supply Voltages

Input Side Nominal	Input Side Actual	Output Side Nominal	Output Side Actual
+12V	12.00	+12V	12.00
-12V	12.00	-12V	12.00

b. Isolated Voltage

Input Voltage (~~V~~ mV)	Output Voltage (~~V~~ mV)	Error (~~V~~ mV)	% of Full Scale Error
0.00	0.00	0.00	0.00
50.00	49.95	-0.05	-0.05
100.00	100.00	0.00	0.00

2. Aging Date

a. Aging Temperature 57.63°C

b. Start Aging Date 10-19-82 Time 2000 Recorded By HAR

c. Stop Aging Date 10-27-82 Time 0800 Recorded By HAR

Total Aging Time Date ______ Time 180hrs Recorded By HAR

3. Post-Aging Final Test Data

Data Recorded By Harold A. Romero Date 10-27-82

a. Hypot-2500VRMS, 60 Hz 1 minute Pass ✓ Fail ______

b. Isolated Voltage

Input Voltage (~~V~~ mV)	Output Voltage (~~V~~ mV)	Error (~~V~~ mV)	% of Full Scale Error
0.00	0.00	0.00	0.00
50.00	49.95	-0.05	-0.05
100.00	100.00	0.00	0.00

4. This Unit Passes All Tests. (Yes) No

APPROVED [signature] DATE 9-29-82

APPROVED

E13 85 214 002

TECHNICAL REPORT

REPORT NO.:	186-85-4790
SHEET NO.:	1 of 4 Sheets
DATE OF WORK:	2/4/85
DATE OF REPORT:	2/8/85

LOCATION Central Laboratories Services, Chattanooga PSC

SUBJECT ANALOG OPTICAL ISOLATOR FAULT TEST

COPIES SENT TO: H. Styles, C. Bell, ARMS, WWR

PREPARED BY: V. E. Kmet CHECKED BY: G. A. Erickson APPROVED BY: H. A. Taft

INTRODUCTION

The Central Laboratories were requested to perform fault tests for analog optical isolator voltage channel plug-ins, P/N 175C304, to determine if any credible electrical events occur at the input while inserting various faults to the output. These tests were requested by H. Styles, Office of Engineering, Electrical Engineering Branch, W8A32C-K.

RESULTS

No effect was observed on the input when introducing an open, short, 12 V dc, or 280V dc, to the output. It is evident that the device provides complete isolation between input and output. Oscillograph readings for the various tests are being furnished to the Electrical Engineering Branch.

PROCEDURE

All measurements were performed by instruments that are certified in accordance with the laboratory quality assurance program and have documented traceability to officially recognized standards. Specific tests performed are contained in the following test report.

The circuit shown in Figure 1 was used to obtain reference data representing normal operating conditions. This configuration was used prior to beginning the test sequence and after each fault application. Operating power (+V and -V) was supplied by four 12-volt (nominal) 1.2 amp hour nickel-cadmium battery packs.

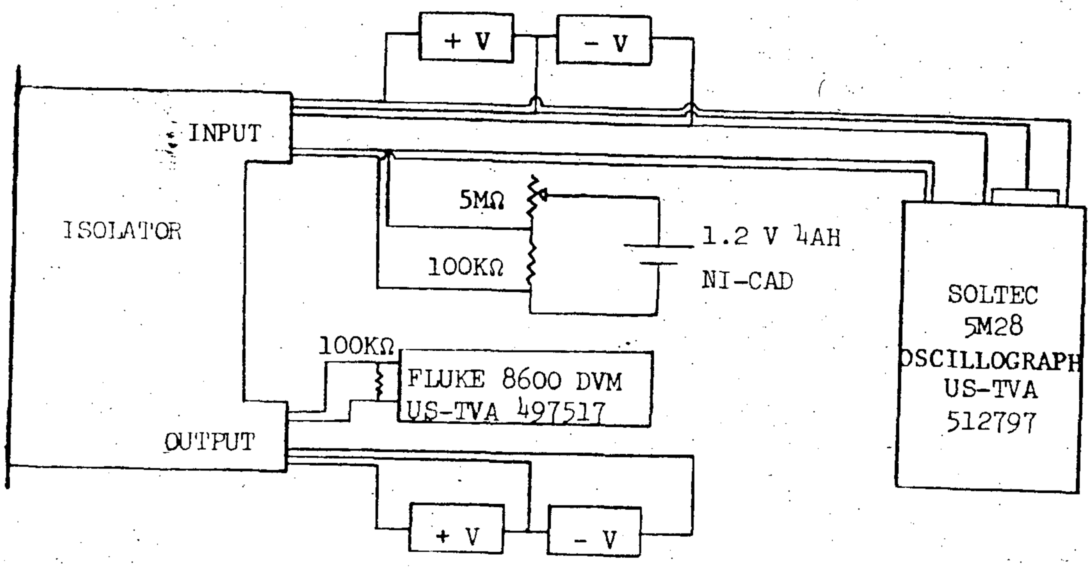


FIGURE 1

Batteries were used to provide operating power to insure total isolation. A battery and resistor network was used to supply the 0 to 100 mv input signal, and to provide an approximate 100 KΩ input impedance. Using this configuration, and with input voltages of 0, 50, and 100 mv, nominal readings were taken on each isolator at the output and each signal test point provided on the circuit board. Although only one unit (S/N 0114) was tested to the point of destruction, each unit was operationally checked. All outputs were found to be within specified tolerance and test point measurements were similar from unit to unit. Test point 7 was not used as it is the same electrical point as the output terminal.

Typical measurements at each point on the isolators are as follows:

Input	TP 2	TP 3	TP 4	TP 5	TP 6	Output
0 mv	0 V	-1.49 V	+12 V pulse 32 μs 3850 Hz	Differentiated TP 4 Signal	+28 mv	0 mv
50 mv	+2.38 V	-5.38 V	+12 V pulse 32 μs 13.75 KHz	Differentiated TP 4 Signal	-4.18 V	50-51 mv
100 mv	+4.75 V	-9.30 V	+12 V pulse 32 μs 24.00 KHz	Differentiated TP 4 Signal	-8.35 V	100-101 mv

During fault testing, the inputs (signal and supply) were monitored with a Soltec 5M28 light beam oscillograph. This instrument is capable of capturing transients and long-term changes while maintaining complete isolation between inputs. Measurements were also taken at each circuit test point while the fault was applied (except for the 280 V dc fault) as well as after fault removal, and no deviation to nominal readings were observed. Faults were applied with isolator operating with 100 mv input.

TEST NO. 1, S/N 0114

Instrument output load was removed and reconnected several times and then left open approximately five minutes.

RESULT

No effect on the isolator inputs was found on the oscillograph recording. Normal readings were obtained at each signal test point and the isolator output while the output was opened. No visual effect was seen. When the load was reconnected at the end of the test, the isolator continued to operate normally.

TEST NO. 2, S/N 0114

Instrument output short circuit was applied and removed several times and then left shorted approximately five minutes.

RESULT

No effect on the isolator inputs was found on the oscillograph recording. Normal readings were obtained at each signal test point while the output was shorted. No visual effect was seen, but a slight amount of heating could be felt on U8, the output buffer amplifier. When the short was removed at the end of the test, the output immediately returned to normal and U8 returned to its normal temperature in a few minutes.

TEST NO. 3, S/N 0114

Instrument output was shorted to positive polarity output power source for approximately five minutes.

RESULT

No effect on the isolator inputs was found on the oscillograph recording. Normal readings were obtained at each signal test point while the fault was applied. No visual effect was seen but a significant amount of heating could be felt on U8. When the fault was removed at the end of the test, the output immediately returned to normal and U8 returned to its normal temperature in a few minutes.

TEST NO. 4, S/N 0114

Instrument output was shorted to negative polarity output power source for approximately five minutes.

RESULT

Isolator response was identical to that reported for Test No. 3 above.

TEST NO. 5, S/N 0114

Instrument output was connected to 280 V dc power source.

RESULT

No effect on the isolator inputs was found on the oscillograph recording. Visual effects noted were varied. Within approximately 2 seconds, U8, the output buffer, was almost totally consumed in a mass of sparks, smoke, and flames. A crackling sound was heard as U8 burst apart and the sparks and flame erupted. The area of the circuit board beneath and around U8 is also severely burnt and in some places the conductive foil is separated from the board surface. Resistor R31, the feedback resistor for U8 is also burnt with very minor damage to the circuit board in that area. After the fault potential was removed, the isolator was checked at each signal test point and found to be operating properly through test point 6.

TEST NO. 6

As requested, Test No. 6, application of 120 V ac to isolator output was not performed as no effect had been noted on the input circuit to this point.

GAE:VEK:KM

ATTACHMENT B
ROBERTSHAW ISOLATION AMPLIFIER MODEL 572-C2

Paragraph a - Analysis and test verify that the device is acceptable for the isolation function intended. The Robertshaw isolation amplifier is a solid-state device that provides isolation of input circuit from output circuit through transformer coupling. Attached product specification sheet for the Robertshaw model 572 shows a block diagram of the device. The device isolates a 10-50 mA dc (input to output) signal.

Paragraphs b and c - The maximum credible fault that the output terminals could experience is from a 120V ac source applied at the remote terminal of the connecting cable between the isolating device and the remote multiplex cabinets. For this event to happen would require a failure within the remote terminal cabinets that would result in an electrical connection between the 120V ac source for the cabinet power supplies and the signal cable terminal block. Due to arrangement of equipment this connection would essentially have to be inadvertently made during testing or maintenance being done inside the cabinets.

Attached sketch RS527A shows the isolating device with respect to cabling leaving the isolator cabinet.

Also shown on this sketch is a resistor network in the isolating device output circuit which increases the circuit impedance as seen from the remote terminal of the interconnecting signal cable. During normal operation an open or short circuit in the output circuit side of the resistor network would have no effect on the input circuit current loop. The high impedance of the two series 5k-ohm resistors essentially presents an open circuit in the output cable; whereas, the 10-ohm shunt resistors offer a low impedance path for the isolator output current regardless of the type of fault the output signal cable may experience. Should the maximum credible voltage (120V ac) be applied directly across the two signal conductors, the maximum current to flow would be 0.012 amperes. This is due to the 10k ohms of series resistance in the signal circuit. This current would be too low to be detected by the protective devices in the fault source voltage. Should the fault not be detected by erratic indications at the remote terminal and persist long enough, the low wattage series resistors would open up the signal output circuit. Any disturbances due to arcing or fault current feed into the internal output circuit of the isolator would have no effect on the input circuit current loop due to the transformer isolating design of the device. Attached Robertshaw product specification sheet and internal schematic diagram illustrate the isolating construction of the device.

Paragraph d - Acceptance criteria requires that the device not degrade or affect any 1E device associated with the input signal source during normal operation or during any design basis event.

Paragraph e - Verification that the devices comply with seismic qualification which was the basis for plant licensing has been demonstrated by seismic testing (per Wyle test report No. 43522-1). The equipment is located in a mild environment and certification by the supplier documents qualification of the devices for the following environmental conditions.

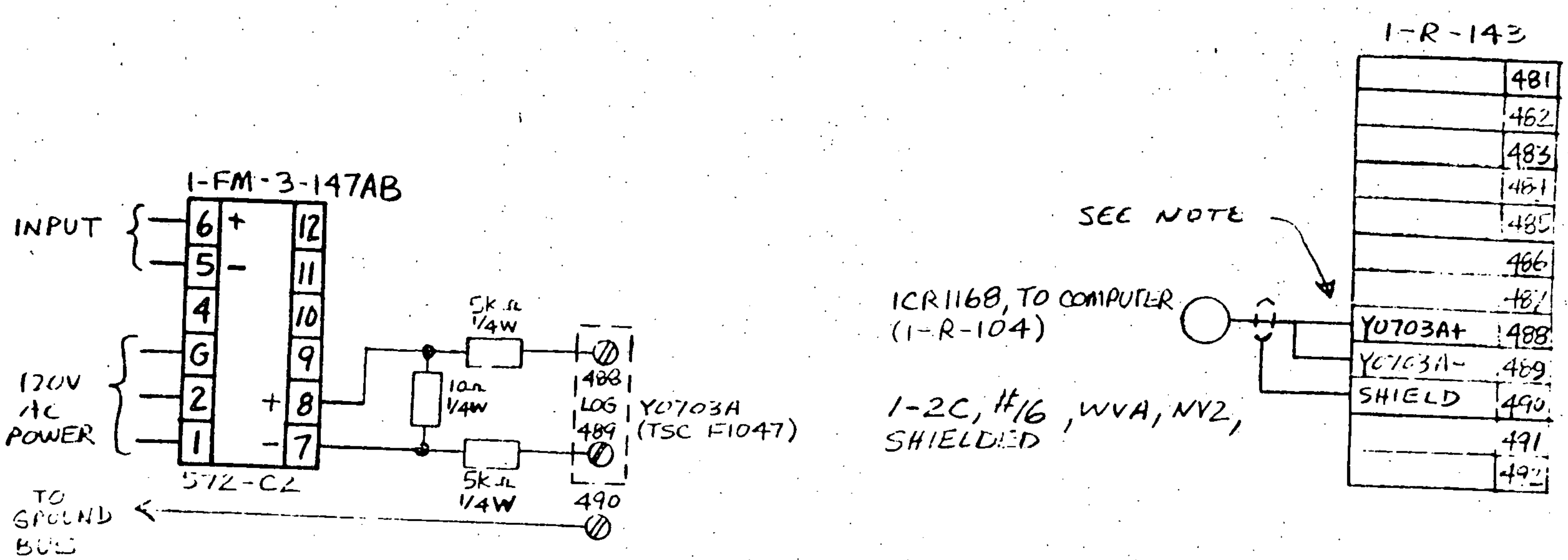
Unit Control Room and Auxiliary Instrument Rooms

a. Ambient temperature: 75°F normal (40°F to 120°F maximum range)
b. Pressure humidity : 50-percent normal (10- to 90-percent maximum range)
c. Radiation : Negligible

Auxiliary Building and Turbine Building

a. Ambient temperature: 40 to 120°F normal.
b. Pressure : Atmospheric.
c. Humidity : 10- to 90-percent normal (95 percent maximum).
d. Radiation : 1 to 5 mR/hr (auxiliary building); negligible (turbine building).

Paragraph f - Immunity to EMI sources has been considered in the system design. Industry-accepted practices of routing, shielding, grounding, and termination of signal circuits have been utilized in the design to minimize effects of radiated or coupled signals on the input leads to the device. There is no known source within the SPDS for generating any EMI emissions.



CABLE ICR1168 IS ROUTED IN CONDUIT 1PM6239 TO A LEVEL 2 CABLE TRAY TO CONDUIT Z105 TO CMPT 1-R-104. FROM THE PROCESS COMPUTER THE POINT IS PARALLELED TO THE TSC COMPUTER.

TYPICAL LOOP FOR ROBERTSHAW MODEL 572-C2
FM-3-147AB
FM-3-155BB
FM-3-163AB
FM-3-170BB

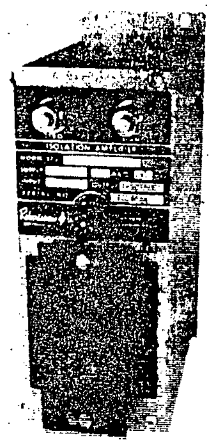
CHECKED ____ DATE ____
COMPUTED ____ DATE ____
SHEET ____ OF ____

ATTACHMENT TO APPENDIX

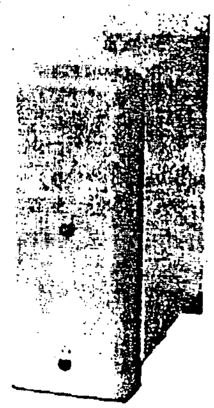
Robertshaw
CONTROLS COMPANY

PRODUCT SPECIFICATION MODEL 572

Isolation Amplifier Model 572 -C2



MODEL 572
ISOLATION AMPLIFIER



MODEL 572
(With Cover and Mounting Bracket)

GENERAL DESCRIPTION

The Robertshaw Model 572 Isolation Amplifier is an interface instrument for use with standard process signals. The floating circuit design permits the application of input signals having a potential above or below ground. The instrument is designed for use with either grounded or ungrounded inputs, and the output signal can be used with either configuration.

High common mode noise rejection permits use on noisy signals with high noise attenuation at the output. A solid state chopper/transformer combination insures maximum isolation with long-term reliability. This instrument, in addition to offering complete isolation between input/output, can also be used as a current to current (I to I) transmitter having a wide selection of standard input and output signals.

The universal back of panel surface mounting enclosure requires only three inches in width by eight inches in height to provide a high density installation. Adjustments and wiring terminals are readily accessible. Multiturn Zero and Span adjustment pots are equipped with locking provisions.

PRINCIPLE OF OPERATION

Reference to the block diagram shown in Figure 1 will aid in understanding the operation of this instrument. The Isolation Amplifier utilizes an inverter multivibrator to provide a 5K Hz square wave to the Chopper Modulator circuit and also provides the isolated dc power supply for the input stage. The chopper is operated full wave to prevent assymmetry from affecting the output level.

The isolated input signal is chopped and then transmitted through the transformer to the output Amplifier. The output Amplifier rectifies the signal and converts it to a current signal using an integrated circuit operational Amplifier.

Zero and Span adjustments are provided in the output amplifier. The output signal is from a true current generator which is unaffected by changes in load resistance.

FEATURES AND BENEFITS

- **Solid State Reliability** -
  Silicon integrated circuits and transistors.
- **Application Flexibility** -
  Wide choice of input/output signals for use as current to current amplifier.
- **Complete Isolation** -
  Input and output isolated by transformer isolation.
- **High Accuracy** -
  ±0.25% of full scale, temperature coefficient only 0.01%.
- **High Resolution Adjustments** -
  Zero and Span are multi-turn pots.

BLOCK DIAGRAM MODEL 572

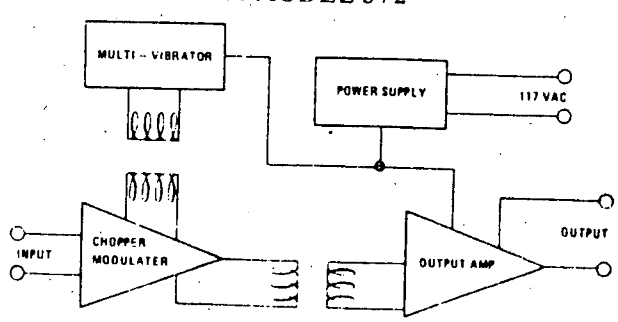


Figure 1

ROBERTSHAW CONTROLS COMPANY
INDUSTRIAL INSTRUMENTATION DIVISION

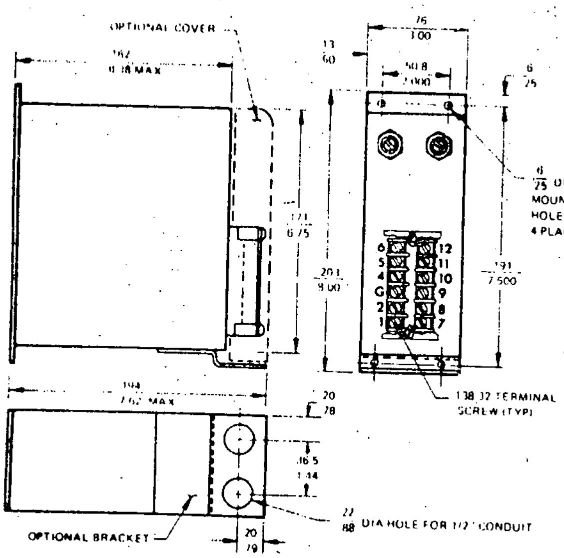
SPECIFICATIONS

Supply Voltage	26.5 vdc ±10% @ 40 ma max.
	117 vac ±10%, 50/60 Hz, 3W, 7VA
	230 vac ±10%, 50/60 Hz, 3W, 7VA
Input Signal	1-5 ma dc @ 1000 ohms
	4-20 ma dc @ 250 ohms
	10-50 ma dc @ 100 ohms
	1-5 vdc @ 400K ohms nominal
Output Signal	1-5 ma dc into 2.5K ohm load
	4-20 ma dc into 650 ohm load
	10-50 ma dc into 250 ohm load
	1-5 vdc @ 250 ohm output impedance
Accuracy	± 0.25%
Power Supply Effect	±0.25%/10% Supply Variation
Repeatability	±0.1%
Sensitivity	0.01%
Operating Temperature	+20°F to +120°F
	-7°C to +48°C
Humidity Effect	0.25% @ 95% R.H.
Temperature Coefficient	0.01%/°F
Common Mode Rejection	> 40db

CUSTOMER CONNECTIONS

ELECTRICAL CONNECTIONS			
Terminal	Connections	Terminal	Connections
1 −	Supply Voltage	7 −	Output
2 +	(See Rating Plate)	8 +	
G	Chassis Ground	9	Spare
4	Spare	10	Spare
5 −	Input	11	Spare
6 +		12	Spare

DIMENSION DATA



ORDERING INFORMATION

STANDARD MODEL* 572 − B 2

OPTIONAL MODELS

Select from tables below.
(Allow additional 2 weeks delivery.)

572 − _ _

Key Model Number
Table 1 - Input/output Signal
Table 2 - Supply Voltage

KEY MODEL NUMBER

Model	Description
572	Isolation Amplifier provides a wide choice of input/output currents with complete isolation between input and output. Universal back of panel enclosure.

TABLE 1 - INPUT/OUTPUT SIGNAL

Designation	Description
A	1-5 ma dc input, 1-5 ma dc output
*B	4-20 ma dc input, 4-20 ma dc output
C	10-50 ma dc input, 10-50 ma dc output
D	1-5 ma dc input, 4-20 ma dc output
E	4-20 ma dc input, 1-5 ma dc output
F	1-5 vdc input, 4-20 ma dc output
G	4-20 ma dc input, 1-5 vdc output

TABLE 2 - SUPPLY VOLTAGE

Designation	Description
1	26.5 vdc ±10%
*2	117 vac ±10% 50/60 Hz
3	230 vac ±10% 50/60 Hz

ENCLOSURE ACCESSORIES

Part Number	Description
020-950-668	Conduit Mounting Bracket (Specify On Order)
040-950-418	Full Terminal Board Cover (Specify On Order)

Robertshaw
CONTROLS COMPANY

U.S.: Industrial Instrumentation Division
333 North Euclid Way
Anaheim, California 92803
TWX 910-591-1164 Telephone: (714) 535-8151

FOREIGN: International Marketing Division
1910 Byrd Avenue
P. O. Box 26544
Richmond, Virginia 23261
TWX 710-956-0232 Telephone: (804) 285-4161

CANADA: Robertshaw Controls (Canada) LTD.
1222 Fewster Drive
Mississauga, Canada L4W 1A1
Telex 06-961169 Telephone: (416) 625-0805

MFG. AT ANAHEIM CA

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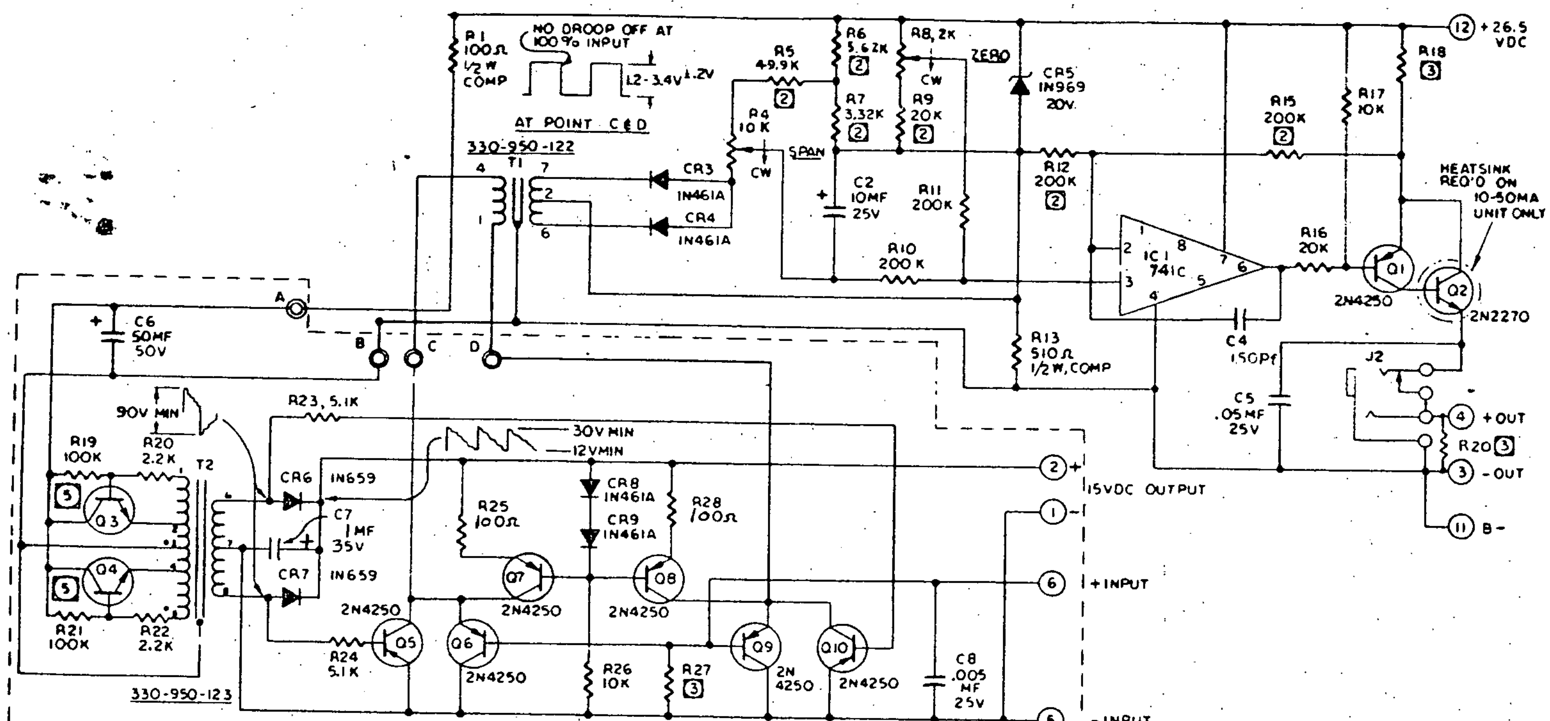


[3] SEE TABLE I
[2] INDICATES RESISTORS: 1/8W, ±1%, FILM.
1. ALL RESISTORS: 1/4W, ±5% COMP.

[5] Q3 & Q4 ARE (270-950-037-02)
4. WAVE FORMS ARE MEASURED WITH RESPECT TO THE (-) INPUT CONNECTION.

6. FOR PCA REV. H AND BELOW, R25 AND R28 WAS 200 OHMS AND C7 WAS .02 MF, 35V.

TABLE II

VALUE OF R27 WHEN 1-5VDC INPUT SPAN IS USED		VALUE OF R18 WHEN 1-5VDC INPUT SPAN IS USED		[3] VALUE OF R20 WHEN 1-5VDC INPUT SPAN IS USED
INPUT	R27(OHMS)	OUTPUT	R18(OHMS)	
1-5 MADC	1 K [2]	1-5 MA	909 [2]	—
4-20MADC	249 [2]	4-20MA	226 [2]	—
1-5 VDC	OMIT	1-5 VDC	226 [2]	249Ω ±1% 1/4W FILM
10-50MADC	100Ω [2]	10-50 MA	90.9 [3]	—

Figure 5-2. Schematic Diagram for Model 572 Isolation Amplifier Printed Circuit Board.

Paragraph a - Analysis and test verify that the device is acceptable for the isolation function intended. The General Electric 550 transmitter is a solid-state device that provides isolation of input circuit to output circuit through transformer coupling. Attached copy of General Electric schematic diagram 4532K10-001, page 31/32, shows internals of the device. The device isolates a 10-50 mA dc (input to output) signal. The input has been equipped with a resistor network to develop a millivolt signal to be compatible with the device input impedance requirements.

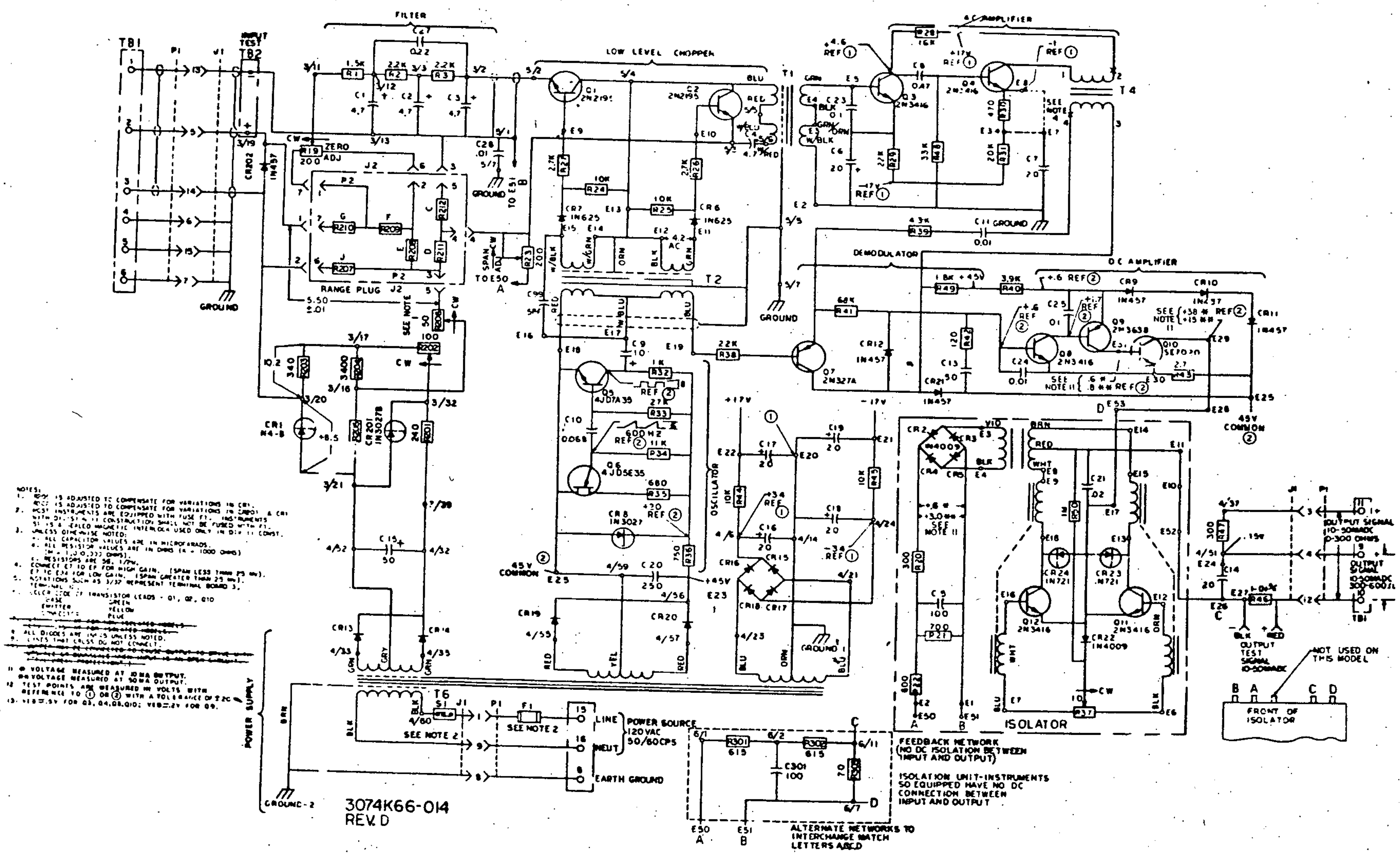
Paragraphs b and c - The maximum credible fault that the output terminals could experience is from a 120V ac source applied at the remote terminal of the connecting cable between the isolating device and the remote multiplex cabinets. In order for this event to happen would require a failure within the remote terminal cabinets that would result in an electrical connection between the 120V ac source for the cabinet power supplies and the signal cable terminal block. Due to arrangement of equipment this connection would essentially have to be inadvertently made during testing or maintenance being done inside the cabinets.

Attached sketch, GEM 550C, shows the isolating cabling device with respect to cabling leaving the isolator cabinet. Also shown on this sketch is a resistor network in the isolating device output circuit which increases the circuit impedance as seen from the remote terminal of the interconnection signal cable. During normal operation, an open or short circuit in the output circuit side of the resistor network would have no effect on the input circuit current loop. The high impedance of the two series 5k-ohm resistors essentially presents an open circuit in the output cable; whereas, the 10-ohm shunt resistors offers a low impedance path for the isolator output current regardless of the type of fault the output signal cable may experience. Should the maximum credible voltage (120V ac) be applied directly across the two signal conductors, the maximum current to flow would be 0.012 A. This is due to the 10k ohms of series resistance in the signal circuit. This current would be too low to be detected by the protective devices in the fault source voltage. Should the fault not be detected by erratic indications at the remote terminal and persist long enough, the low wattage series resistors would open up the signal output circuit. Any disturbances due to arcing or fault current feed into the internal output circuit of the isolator would have no affect on the input circuit current loop due to the transformer isolating design of the device. Attached General Electric schematic diagram 4532K10-001, page 31/32, shows the isolating construction of the device.

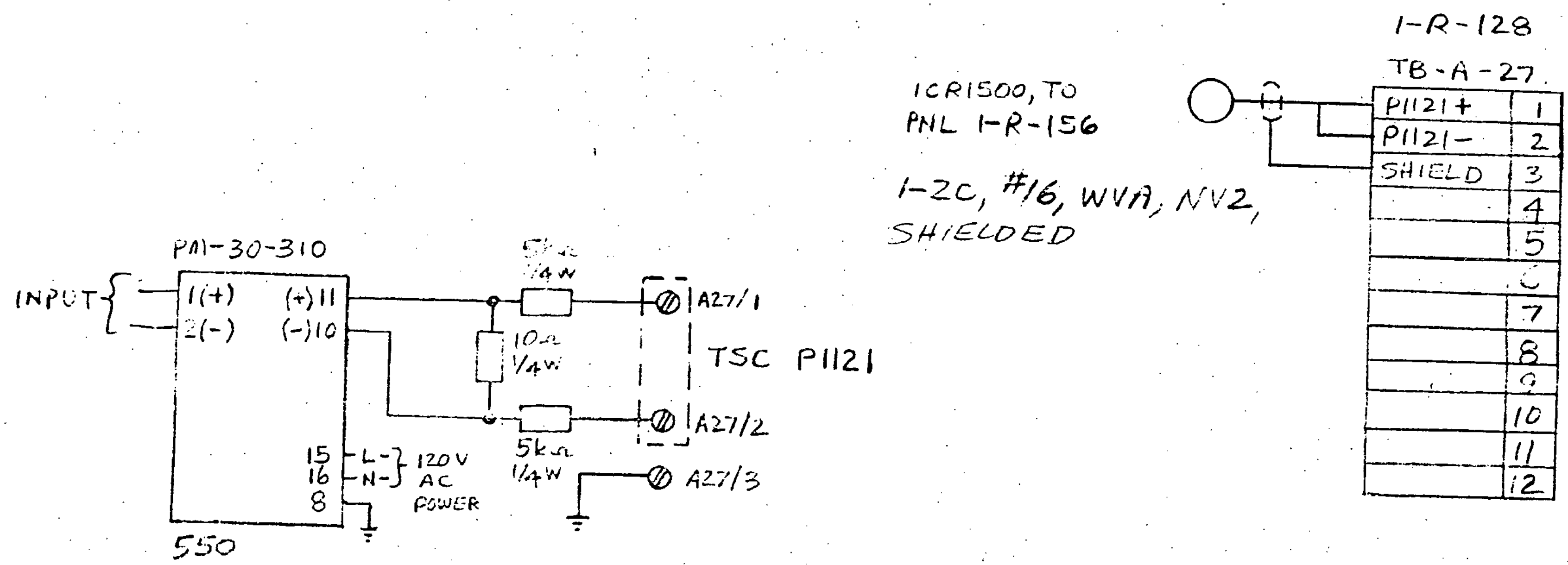
Paragraph d - Acceptance criteria requires that the device not degrade or affect any 1E device associated with the input signal source during normal operation or during any design basis event.

Paragraph e - Verification that the device complies with seismic qualification which was the basis for plant licensing has been demonstrated by seismic test. Qualification for the cabinets is demonstrated in Bailey Controls Company test report QR-4100-SEIS-CAB and for the isolator device in test report 10348-7. The equipment is located in a mild environment. TVA's evaluation demonstrates that the isolator environmental ratings are greater than the environmental conditions of the installation, and that the device will perform its isolating function under normal and abnormal conditions. The device has an ambient temperature operating range of $40^{\circ}F$ to $120^{\circ}F$ (continuous) and $140^{\circ}F$ (intermittently); whereas, the ambient temperature range of the installation is from an abnormal condition of $40^{\circ}F$ to $120^{\circ}F$ with a normal temperature of $75^{\circ}F$.

<u>Paragraph f</u> - Immunity to EMI sources has been considered in the system design. Industry-accepted practices of routing, shielding, grounding, and termination of signal circuits have been utilized in the design to minimize effects of radiated or coupled signals on the input leads to the device. There is no known source within the SPDS for generating any EMI emissions.



Type 550 MV/I Transmitter



CABLE 1CR1500 IS ROUTED IN CONDUIT 1PM6127 TO A LEVEL 2 CABLE TRAY TO CONDUIT Z222 TO CONDUIT Z220 TO CMPT 1-R-156.

TYPICAL LOOP FOR GE MAC TYPE 550
PM-30-310
PM-30-311

Sketch GEM 550C

CHECKED ___ DATE ___
COMPUTED ___ DATE ___
SHEET ___ OF ___

Paragraph a - Analysis and test verify that the device is acceptable for the isolation function intended. The CRYDOM relay is a solid-state device that provides photoisolation between the input power source and the output circuit.

Paragraphs b and c - The maximum circuit voltage to which the output terminals of the device could be subjected is 120V ac.

Attached sketch 1-D shows the circuit in which the CRYDOM relay is applied. The maximum fault current the output side of the relay could experience would be when a short circuit is applied directly across the interposing relay coil when the output circuit of the CRYDOM photoisolator is in a conducting state. Attached TVA engineering calculation, WBN-SPDS-SC-2 (EEB 850215 902), shows the maximum current during this event to be 48.19 amperes. The time to clear this fault by the circuit fuses is 0.01 seconds. During this period, it is postulated that the junction in the output solid-state component in the photoisolator would open due to the fault current; however, there would be no effect on the input circuit. The photoisolation between input and output circuit and the epoxy encapsulated construction of the device would prevent any migration of the fault from the output solid-state component to the input circuit. Should the junction not open, the fast clearing time of the fault by the interposing circuit fuses would prevent any significant heat build-up in the device that would affect the input circuit components. The output circuit of the device has a one cycle surge rating of 15 amperes. A short circuit on the output terminals of the photoisolator would not have any effect on the input side of the relay since there are no electrical connections between input and output circuits. Likewise, an open circuit in the output would have no effect on the input circuit. A short circuit directly on the output terminals of the isolator would appear as if the output of the device was in a conductive state. This would have no effect on the input circuit since there is no electrical connection between the input and output side. Any effect on the external 1E circuit supplying the photoisolator due to an internal failure within the isolating device is further prevented by fuses in the input circuit to the isolating device.

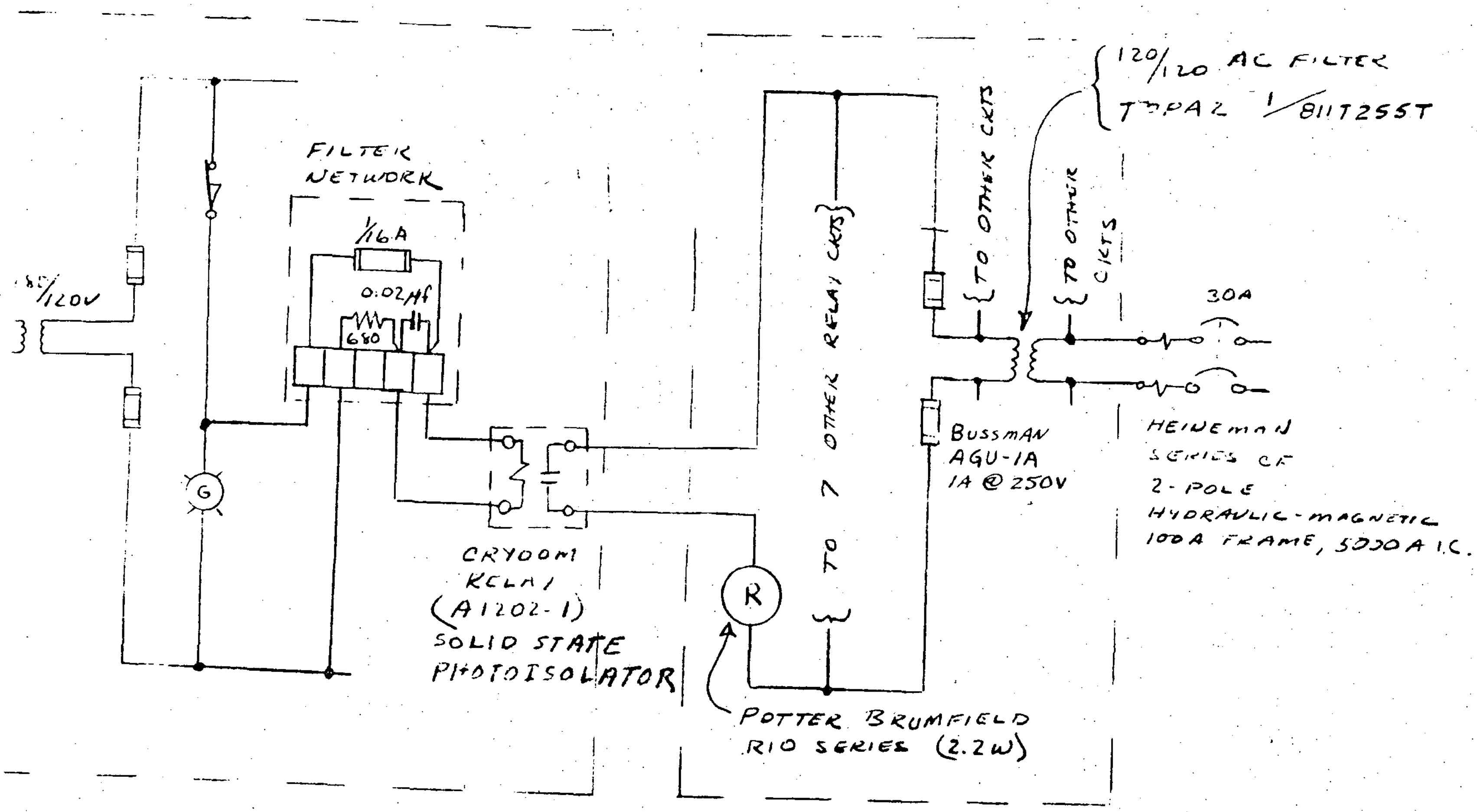
Paragraph d - The acceptance criteria required that the device not degrade or affect any 1E device associated with the input signal source during normal operation or during any design basis event. There is no safety requirement for the device to maintain signal output continuity and accuracy during or after a design basis event.

Paragraph e - An evaluation was made to determine the potential effects a seismic event may have on the isolation function of the isolator. The light weight of the device (4 oz), the photoisolation - solid-state design of the electrical circuit, and the epoxy encapsulated construction of the device were considered in the evaluation. The device is secured to its mounting surface at two places. Due to the light weight, small size, and rigidity of the isolator any seismic forces experienced by its mounting surface would not be amplified throughout the device. The encapsulating material will hold all internal components of the device rigidly in place which will prevent any direct electrical connection between the photoisolated input and output circuits. Therefore, the device will continue to perform its intended function of isolating the safety-related circuit from any credible faults occurring in the nonsafety-related circuit during a seismic event.

The device is located in a mild environment. The device is rated to carry an output load current of 3 amperes in an ambient temperature ranging from -22°F to 176°F. This is greater than the abnormal 40°F to 120°F and 1.0 ampere load current (load circuit fused at 1 amp) the device would experience in the installed environment. This margin assures that the device will perform its intended isolating function during normal and abnormal environmental conditions.

Paragraph f - Industry-accepted practices of routing cable and grounding of circuits have been utilized in the design to minimize effects of radiated or coupled signals on the input leads to the device. The devices are tested to a 2500V ac surge test as shown in attachment 1 to this appendix. All devices have been equipped with a resistor-capacitor suppression network on the input terminals to protect the device against surges. There is no known source within the SPDS for generating any EMI emissions.

TYPICAL CKT UTILIZING THE CRYDOM RELAY FOR THE LISTED MOV



MOTOR CONTROL CENTER
(TRAIN A OR B)
(FILTER NETWORK & RELAY MTD ON REAR PANEL)

TECH SPRT CENTER
SMS CAB (NON-DIVISION)

SKETCH 1-D

to Appendix D

COMPUTED T.C. Kidd DATE 2-6-85

CHECKED DATE

SHEET OF

TVA's original response to FSAR question 40.15 incorrectly characterized some "dedicated contact" inputs as providing an isolation function. These devices (limit switches and reed switches) actually provide the separation between 1E and non-1E circuits.

This portion of TVA's response to NRC question 420.01 addresses only those inputs to the SPDS for which the existing limit switches or reed switches are used to ensure separation between the 1E and non-1E circuits.

An evaluation of the input devices to the SPDS has revealed this arrangement on 10 valves. These limit switch and reed switch contacts are used to provide valve status to the SPDS by switching the 120V ac interrogation voltage to the input relays of the multiplexer. An adjacent set of contacts could interface with a 1E circuit. As outlined in IEEE 384-1974 and Regulatory Guide 1.75 section C.5, an analysis was performed to justify the safety aspects of this design.

The problem was broken into two parts:

1. The cable separation and integrity up to the switch.

2. The reed or limit switch integrity.

I. Cabling of the Reed and Limit Switches

As outlined in WBN FSAR Section 8.3.1.4.3 the cables for non-safety-related devices are not run in conduit used for essential circuits. Where the terminal equipment has only one conduit entrance available, the non-1E cables are separated from the 1E cables as near the device as possible. The only 1E to non-1E interaction that could exist in the cabling is therefore at the common conduit entrance. TVA calculations evaluated this common entrance. This evaluation calculated the maximum fault current available for a worst case fault on the SPDS cable to the limit switch. Due to the fusing and protection circuitry associated with this cable, it was determined that the maximum fault current will be well below the point where auto-ignition of the cable insulation will take place.

No damage to the 1E circuit could therefore be incurred by this fault condition due to non-1E cable damage.

II. Limit Switch Integrity

The acceptance criteria for the limit switches is that for any credible fault, no impairment of the adjacent set of 1E contacts could occur. To ascertain this, the limit switch manufacturer was approached with the maximum fault current that would be available at the switch. The manufacturer replied that this should present no problem to the operation of the switch. No electrical or mechanical failures should occur (such as arcing between the switches or welding together of the contacts). Since the SPDS (non-1E) contacts can withstand this fault condition without damage, there should be no propagation into the 1E circuit. A formally documented analysis is was performed and issued.

Reed Switch Integrity

An engineering evaluation of these switches revealed that they are totally encapsulated, single pole-single throw switches located in physically separate tubes. They are actuated magnetically and as such possess no physical interface with the valve operator or each other. This physical independence extends to each separate tube which is separated by at least 1/4-inch.

With the voltage and current levels present for a worst case fault (120V ac at 40 A, for 0.01 SPC), as discussed in I above, sufficient separation exists between the switches and their associated circuitry to prevent any propagation of the non-1E fault into the 1E circuit. This analysis is documented with the limit switch analysis mentioned above.

In addition to the above, it was verified that conduit seals were installed to prevent moisture intrusion into the switch assembly. This precludes any possibility of terminal to terminal shorting due to moisture.

ATTACHMENT F

STINGHOUSE ISOLATOR MODEL 2837A G03

<u>Paragraph a</u> - This device is used in the reactor vessel level instrumentation system which is installed in Westinghouse 7300 series process control system cabinets. The model 2837A12G03 isolator provides isolated output only and is essentially identical to the model 2837A12G02 which provides both isolated and nonisolated output. Maximum credible fault testing of the model 2837A12G02 is described in WCAP 8892-A, "Westinghouse 7300 Series Process Control System Noise Tests," which was accepted by the NRC in R. L. Tedesco's letter to C. Eicheldinger dated April 20, 1977.

<u>Paragraph b</u> - For conservatism, Westinghouse chose fault voltages of 580V ac and 250V dc which far exceed the maximum potential allowed by Westinghouse's generic electrical circuit and instrument impulse lines separation interface criteria. The WBN installation meets these criteria.

<u>Paragraphs c and d</u> - See WCAP 8892-A.

<u>Paragraph e</u> - Seismic and environmental qualification of this device is reported in Westinghouse WCAP-8687, supplement 2-E13C, "Equipment Qualification Test Report Process Protection System (Supplemental Testing of Printed Circuit Cards)."

<u>Paragraph f</u> - See WCAP 8892-A.

ATTACHMENT G

FOXBORO ISOLATION AMPLIFIER MODEL M/66B-CO

Paragraph a - This isolation amplifier is used extensively in the process instrumentation and control system and is described in FSAR sections 7.2.1.1.8 and 7.2.2.1.3 which reference WCAP 7685, "Topical Report, Test Report on Isolation Amplifiers." The specific testing performed to demonstrate acceptability of this device is described in WCAP 7685 (nonproprietary version) and WCAP 7508-L (proprietary version).

Paragraphs b, c, and d - See WCAP 7685 and WCAP 7508-L.

Paragraph e - These devices are located outside containment in the auxiliary instrument room in the Foxboro process control equipment cabinets. Seismic qualification of this equipment is discussed in FSAR section 3.10. The environmental qualification of this equipment is discussed in FSAR section 3.11.

Paragraph f - The Foxboro isolation amplifier has a high tolerance rating for interfering signals, particularly for ac, the most common form of interference. The impedance of these devices is low, and the dc signal level is high. The Model M/66B-CO isolation amplifier is designed so that the input, output, ac power supply, and ground are isolated from each other. The use of twisted, shielded pair signal wire minimizes the effects of interfering signals, particularly electrostatic pickup. All shields of signal wiring are grounded to a ground bus. All ac power wiring is physically separated from the dc signal wiring in the Foxboro process control equipment cabinets.

ATTACHMENT H

WESTINGHOUSE ISOLATION AMPLIFIER MODEL 6065D75G01
AND HYBRID ISOLATION AMPLIFIER MODEL N200-3

Paragraph a - These isolation amplifiers are described in FSAR sections 7.2.1.1.8 and 7.2.2.1.3 which reference Westinghouse topical report WCAP-7819, revision 1-A, "Nuclear Instrumentation System Isolation Amplifier." The specific testing performed to demonstrate acceptability of these devices is described in WCAP-7819 (nonpropietary version) and WCAP 7506-L (proprietary version).

Paragraph b - The maximum credible faults applied during the test are described in the Introduction of the WCAP reports referenced in response (a) as a short-circuited or grounded output and as the maximum voltage sources which could enter the racks containing the nuclear instrumentation equipment (i.e., +150V dc, -150V dc, and 120V ac).

Paragraph c - The data in WCAP 7819 verify the application of the maximum credible faults in the transverse mode (output to ground) for 120V ac and ± 150V dc. Open circuit is not a fault mode. Short-circuited output was tested.

Paragraph d - Pass/fail acceptance criteria were not defined in quantitative terms prior to the test. Test results were summarized in the WCAP reports as "No significant effect on the input (protection) when the output (nonprotection) circuit is subject to shorts or the application of 120V ac or ± 150V dc." The reports include a discussion of perturbations in the output of the dropped-rod circuit as a result of fault voltage application. The effects are given in millivolts. In retrospect, these values can be characterized as acceptable or tolerable values that would not trigger an undesired reactor trip.

Paragraph e - The hybrid isolation amplifier model number N200-3 was qualified to IEEE 323-1971 requirements and successfully passed all environmental testing. Isolation amplifier model No. 6065D75G01 was qualified to IEEE 323-1974 requirements and successfully passed environmental testing. The nuclear instrumentation system seismic qualification is described in FSAR section 3.10.1 which references WCAP-7817.

Paragraph f - These isolation amplifiers were subjected to noise susceptibility testing in three parts:

1) MIL-N-19900B Noise Susceptibility Test
2) credible voltages applied to nonprotective cables
3) ac current in control cables simulating magnetic interference

The results of the testing demonstrated that electrical interference or noise associated with the nonprotection output cabling did not degrade the performance of the protection functions.

ATTACHMENT I

WESTINGHOUSE AR REL[illegible] (MODELS ARD440SR, ARD440AR, AR[illegible]0SR, AND ARD880AR)

Paragraph a - Westinghouse has recently completed testing of the AR relay for isolation capabilities. The test report No. EQTP(84)-19, revision 1, "Isolation Tests for the Westinghouse Type Auxiliary Relay Rack AR Relays," is currently in the signout process. The tests successfully demonstrated the acceptability of the AR relay for coil-to-contact and contact-to-contact isolation for voltages of 250V dc and 580V ac.

Paragraph b - For conservatism, Westinghouse chose fault voltages of 580V ac and 250V dc which far exceed the maximum potential allowed by Westinghouse's generic electrical circuit and instrument impulse lines separation interface criteria. The WBN installation meets these criteria.

Paragraph c - This question is not applicable to relay testing; however, the isolation testing described in EQTP(84)-19, revision 1, includes induced coil voltage testing and testing for leakage current between contacts.

Paragraph d - Pass/fail criteria are provided in EQTP(84)-19, revision 1.

Paragraph e - These relays are mounted in the solid-state protection system, reactor trip breaker, and auxiliary relay rack cabinets. Seismic qualification of the solid-state protection system and reactor trip breaker cabinets is described in FSAR section 3.10.1. Westinghouse has seismically qualified the auxiliary relay racks by analysis. The solid-state protection system cabinets and auxiliary relay racks are located in the control building in the auxiliary instrument room. The reactor trip breaker cabinets are located in the control rod drive equipment room in the auxiliary building. The environment in these rooms is normally maintained at $75^{\circ}F$, but during abnormal conditions, temperature excursions up to $104^{\circ}F$ could occur. These conditions are within normally anticipated environmental conditions for industrial application and no special environmental qualification testing is required.

Paragraph f - Although no testing of this type has been done, adequate grounding capability is provided, and many years of operating experience with these type of applications have demonstrated no electrical interference problems.