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SCHWENCER,A, Licensing Branch 2

SUBJECT: Forwards addl info re safety parameter display sys,in response to NRC 840810 request re Suppl 1 to NUREG-0737.

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Washington Public Power Supply System

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October 9, 1984
G02-84-534

Docket No. 50-397

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PLANT NO. 2
NRC REQUEST FOR ADDITIONAL INFORMATION -
SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

References:
1) Letter, G02-83-596, G. D. Bouchey (SS) to A. Schwencer (NRC), same subject, dated July 1, 1983
2) Letter, A. Schwencer (NRC) to G. C. Sorensen (SS), same subject, dated August 10, 1984

In response to NRC's request for additional information (Ref. 2) concerning the Supply System's submittal on the Safety Parameter Display System (Ref. 1), the following is herewith submitted.

<u>NRC QUESTION(S) RE ISOLATION DEVICES</u>

Question 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.

<u>WNP-2 Response</u>

The SPDS displays in the WNP-2 Main Control Room receive their signal inputs from the Transient Data Acquisition System (TDAS). TDAS consists of computer-based data collection and reduction equipment receiving input signals from both Class 1 and Non-Class 1 equipment. All inputs to TDAS interface through Class 1 isolation devices (one per signal input) hardwired to a multiplex unit. The multiplexer transmits signals to the computer, and ultimately to SPDS, through a fiber optic link. Therefore, the only Non-Class 1 equipment interfacing with the Class 1 isolation devices are the multiplexers. Refer to Attachment 1.

A001
1

The isolation devices are provided to prevent failures in the Non-Class 1 TDAS multiplexers from affecting Class 1 equipment or other signal-sensitive equipment signal input sources.

The isolation devices utilized in the WNP-2 design are manufactured by Analog Devices, Inc. These devices (Model #289) are isolation transformer-type driven by operational amplifiers. They provide electrical and electronic interference protection with a 2500 vdc Common Mode Voltage (input to output) rating, as well as 120 db Common Mode Rejection between input and output common.

The TDAS multiplexers require a power source of ± 15 vdc. Therefore, the maximum credible fault potential which can be applied to the output of the device is ± 15 vdc. This is the same potential which powers the isolation device electronics. Thus, the maximum credible voltage which may be applied to these devices can have no effect on the inputs. Even though the maximum credible applied voltage is low, the isolation devices were tested with an applied voltage of 2500 v to the output terminals (signal to common), resulting in no effect (measured in millivolts of disturbance) on the input terminals. Additionally, the isolation devices were tested with a typical signal input (1-5 vdc) configuration to show that the input was unaffected by shorting the output terminals together or shorting either or both output terminals to ground.

Question b)

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

<u>WNP-2 Response</u>

Attached is a block diagram of the isolation device (Attachment 3) and an electrical schematic of the TDAS multiplexer power supply (Attachment 2) they feed, showing ± 15 vdc as the maximum credible voltage which may be applied to the output terminals through the multiplexer. Refer also to Question a) Response above.

Question 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).

<u>WNP-2 Response</u>

Refer to Questions a) and b) Responses above.

Question d)

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

WNP-2 Response

No pass/fail criteria was established. Initial tests indicated that with a 2500 v source applied to the output terminals no effects were seen at the input.

Question e)

Provide a commitment that the isolation devices comply with the environmental qualification (10 CFR 50.49) and with the seismic qualifications which were the basis for plant licensing.

WNP-2 Response

The TDAS isolators are located in the main control room panels, which are in a mild environment, and therefore not covered under 10 CFR 50.49. Although not required, the TDAS isolators were environmentally qualified by the vendor on a generic basis to IEEE-323, 1974.

The TDAS isolators are seismically qualified by test to meet IEEE-344, 1975, and Reg. Guide 1.100, which are the more recent qualification standard and exceed the plant licensing basis.

Question f)

Provide 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.

WNP-2 Response

Refer to Question a) Response above.

NRC QUESTION - HUMAN FACTORS PROGRAM

Provide a description of the display system, its human factored design, and the methods used and results from a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

WNP-2 Response

A description of the SPDS is provided in FSAR Section 7.5.1.23; Safety Parameter Display System. Because of its dynamic nature, a detailed written description of the system can in no way provide a full understanding of such a system.

If a full appreciation and understanding of the system is desired, we would welcome the chance to provide you an on-site demonstration of the power and flexibility of our design. This has been done in the past with several NRC personnel to include E.L. Jordan, Director, Division of Emergency Preparedness and Engineering Response.

The basic data set, display format, and human factors analysis and validation was performed by active participation of the BWR Owners Group Sub-Committee on SPDS. This program lasted nearly two years and was sponsored in part by DOE. It involved two simulator validation programs to ensure, among other things, that the displays were well human-engineered. Results of this effort were included in the WNP-2 SPDS design. The results of these evaluations are documented in two reports provided to the NRC by the BWR Owners Group. They are as follows: BWR Graphic Display System Dynamic Screening Program; Report No. SAI01381-364LJ and Simulator Evaluation of the BWROG Graphic Display System; Report No. ALO-1019 (DOE) (Sandia Contract No. 50-1132).

It should also be noted, that human engineering of our displays is an ongoing effort. Through training programs, emergency exercises and actual day to day Control Room use, areas of display improvement are discovered and subsequently incorporated into the displays. It is an ongoing process that includes improvement in existing displays and creation of new displays intended to aid the Reactor Operators in day to day operation of the plant.

NRC QUESTION - PARAMETER SELECTION

> NUREG-0737, Supplement 1 includes Radioactivity Control as a Safety function for which information should be available to assess the safety status of the plant. Expand your safety analysis report to include a discussion of the provisions made for WNP-2 to monitor radioactivity control.

WNP-2 Response

In establishing the primary safety parameters to be monitored for this group, the basis must first be established. The primary means of release during an accident situation would be gases exiting the plant through the elevated release duct. The source of these gases is from the fuel, which is inside the reactor, which is inside the containment. Since release of these gases indicates first failed fuel and then a leak in the primary containment or an unisolatable break in the reactor coolant pressure boundary (RCPB), an alarm condition in this group will also alert the operator to evaluate the safety status of both the RCPB and primary containment safety groups.

WNP-2 Response (Continued)

Thus, a status of other plant safety parameters must be integrated into any response associated with this safety group.

The specific primary safety parameters for the radioactivity control group are as follows:

1. Post LOCA Containment Activity Monitors, which provide primary information regarding any release of radioactivity from the fuel and subsequently from the RCPB into the primary containment.

2. Elevated Release Activity, which will provide primary information for any accidents involving a loss of primary containment following any fuel failure scenarios.

Although not primary safety parameters, two other important safety parameters which can be very helpful in diagnosing the accident scenarios involving radioactivity release, are provided. They are Standby Gas Treatment System flow rate, and Key Area Radiation Monitors in an alarm state. These parameters have proven very helpful to support personnel in the Technical Support Center during our simulated Emergency Exercises we have run in the past two years.

NRC QUESTION - PARAMETER SELECTION

Expand your safety analysis to include discussion of such parameters as hydrogen and oxygen monitors in containment to accommodate expected revisions of the Emergency Procedure Guidelines which address Combustible Gas Control.

WNP-2 Response

At the current time, we do not have hydrogen and oxygen monitors incorporated into the Graphic Display System since they are not primary safety parameters. However, when expected revisions to the Emergency Operating Procedures (EOP's) are incorporated, the need for Graphic Display aids will be reviewed and, if required, appropriate displays will be added to the Level 3 Emergency Procedure Displays to aid the operators in implementing the EOP's.

NRC QUESTION - PARAMETER SELECTION

Expand your safety analysis to include discussion of Source Range Monitors (SRMs) as an indicator of the Reactivity Critical Safety Function during periods of shutdown and startup.

WNP-2 Response

Source Range Monitors (SRMs) are not directly displayed as a primary safety parameter. However, their output is used to determine the reactor period and this parameter is used as a primary safety parameter along with All Rods In (ARI) indication and APRM power. SRM count rate alone is not a good indication of criticality, whereas a positive period is, and hence the basis for period indication not just SRMs.

NRC QUESTION - UNREVIEWED SAFETY QUESTIONS

Provide conclusions regarding unreviewed safety questions.

WNP-2 Response

This has been addressed in FSAR Section 7.7.2 with a conclusion that there are no unreviewed safety questions associated with the SPDS.

This fulfills your request for additional information. Should you have further questions concerning this matter, please contact Mr. P. L. Powell, Manager, WNP-2 Licensing.

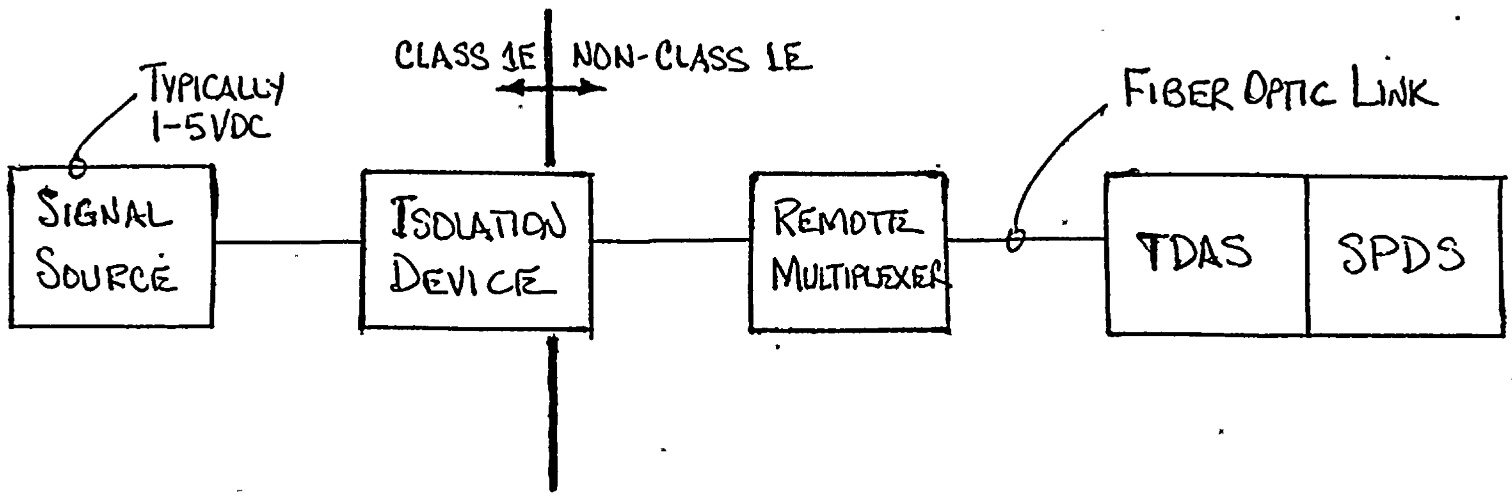
Very truly yours,

G. C. Sorensen, Manager
Regulatory Programs

HLA/tmh
Attachments

cc: R Auluck - NRC
WS Chin - BPA
JB Martin - NRC RV
AD Toth - NRC Site

DIAGRAMATIC ISOLATOR CONNECTIONS
TYPICAL ARRANGEMENT



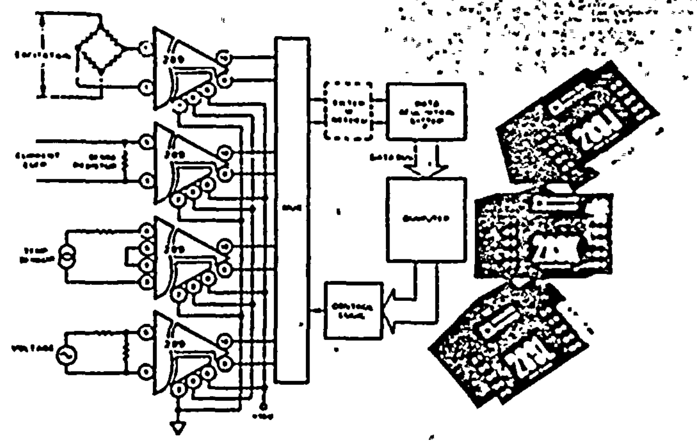
ATTACHMENT 2

ANALOG DEVICES

Precision, Wide Bandwidth, Synchronized Isolation Amplifier

FEATURES
Low Nonlinearity: ±0.012% max (289L)
Frequency Response: (−3dB) dc to 20kHz
(Full Power) dc to 5kHz
Gain Adjustable 1 to 100V/V, Single Resistor
3-Port Isolation: ±2500V CMV Isolation Input/Output
Low Gain Drift: ±0.005%/°C max
Floating Power Output: ±15V @ ±5mA
120dB CMR at 60Hz: Fully Shielded Input Stage
Meets UL Std. 544 Leakage: 2μA rms max, @ 115V ac, 60Hz

APPLICATIONS
Multi-Channel Data Acquisition Systems
Current Shunt Measurements
Process Signal Isolator
High Voltage Instrumentation Amplifier
SCR Motor Control



4 CHANNEL ISOLATED DATA ACQUISITION SYSTEM

GENERAL DESCRIPTION
Model 289 is a wide-band, accurate, low cost isolation amplifier designed for instrumentation and industrial applications. Three accuracy selections are available offering guaranteed gain nonlinearity error at 10V p-p output: ±0.012% max (289L), ±0.025% max (289K), ±0.05% max (289J). All versions of the 289 provide a small signal frequency response from dc to 20kHz (−3dB) and a large signal response from dc to 5kHz (full power) at a gain of 1V/V. This new design offers true 3-port isolation, ±2500V dc between inputs and outputs (or power inputs), as well as 240V rms between power supply inputs and signal outputs. Using carrier modulation techniques with transformer isolation, model 289 interrupts ground loops and leakage paths and minimizes the effect of high voltage transients. It provides 120dB Common Mode Rejection between input and output common. The high CMV and CMR ratings of the model 289 facilitate accurate measurements in the presence of noisy electrical equipment such as motors and relays.

WHERE TO USE THE MODEL 289
The model 289 is designed to interface single and multichannel data acquisition systems with dc sensors such as thermocouples, strain gauges and other low level signals in harsh industrial environments. Providing high accuracy with complete galvanic isolation, and protection from line transients of fault voltages, model 289's performance is suitable for applications such as process controllers, current loop receivers, weighing systems, high CMV instrumentation and computer interface systems.

Use the model 289 when data must be acquired from floating transducers in computerized process control systems. The photograph above shows a typical multichannel application allowing potential differences or interrupting ground loops, among transducers, or between transducers and local ground.

DESIGN FEATURES AND USER BENEFITS
Isolated Power: The floating power supply section provides isolated ±15V outputs @ ±5mA. Isolated power is regulated to within ±5%. This feature permits model 289 to excite floating signal conditioners, front-end buffer amplifiers and remote transducers such as thermistors or bridges, eliminating the need for a separate isolated dc/dc converter.

Adjustable Gain: A single external resistor adjusts the model 289's gain from 1V/V to 100V/V for applications in high and low level transducer interfacing.

Synchronized: The model 289 provides a synchronization terminal for use in multichannel applications. Connecting the synchronization terminals of model 289s synchronizes their internal oscillators, thereby eliminating the problem of oscillator "beat frequency" interference that sometimes occurs when isolation amplifiers are closely mounted.

Internal Voltage Regulator: Improves power supply rejection and helps prevent carrier oscillator spikes from being broadcast via the isolator power terminal to the rest of the system.

Buffered Output: Prevents gain errors when an isolation amplifier is followed by a resistive load of low impedance. Model 289 can drive a 2kΩ load.

Three-Port Isolation: Provides true galvanic isolation between input, output and power supply ports. Eliminates need for power supply and output ports being returned through a common terminal.

Reliability: Model 289 is conservatively designed to be capable of reliable operation in harsh environments. Model 289 has a calculated MTBF of 271,835 hours. In addition, the model 289 meets UL Std. 544 leakage, 2μA rms @ 115V ac, 60Hz.

P.O. Box 280; Norwood, Massachusetts 02062 U.S.A.
Tel:617/329-4700 Twx: 710/394-6577
Telex: 924491 Cables: ANALOG NORWOODMASS

SPECIFICATIONS (typical @ +25°C and V_S = +14.4V to +25V dc unless otherwise noted)

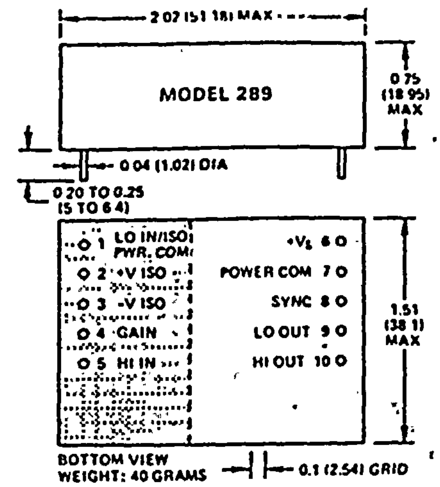
Model	289J	289K	289L
GAIN SPECIFICATIONS			
Range		1 to 100V/V	
Equation		$G = 1 + \frac{100k\Omega}{R_G(k\Omega)}$	
Deviation from Formula		±1.5% max	
vs. Temperature (0 to +70°C)[1]		15ppm/°C typ (50ppm/°C max)	
Nonlinearity (10V Swing)[2,3]	±0.05% max	±0.025% max	±0.012% max
INPUT VOLTAGE RATINGS			
Linear Differential Range (G = 1V/V)		±10V min	
Max Safe Differential Input			
Continuous		120V rms	
1 Minute		240V rms	
Max CMV (Inputs to Outputs)			
Continuous ac or dc		±2500V peak max	
ac, 60Hz, 1 Minute Duration		2500V rms	
CMR, Inputs to Outputs 60Hz			
R_S < 1kΩ, Balanced Source Impedance		120dB	
R_S < 1kΩ, HI IN Lead Only		104dB min	
Max Leakage Current, Input to Output @ 115V rms, 60Hz ac		2μA rms max	
INPUT IMPEDANCE			
Differential		3pF‖10^8Ω — 100M Diff	
Overload		100kΩ	
Common Mode		20pF‖5 × 10^{10}Ω — 5 x 10^{10}	
INPUT DIFFERENCE CURRENT			
Initial @ +25°C		10nA (75nA max)	
vs. Temperature (0 to 70°C)		0.15nA/°C	
INPUT NOISE (GAIN = 100V/V)			
Voltage			
0.05Hz to 100Hz		8μV p-p	
10Hz to 1kHz		3μV rms	
Current			
0.05Hz to 100Hz		3pA rms	
FREQUENCY RESPONSE			
Small Signal -3dB			
G = 1V/V		20kHz	
G = 100V/V		5kHz	
Full Power, 10V p-p Output			
G = 1V/V		5kHz	
G = 100V/V		3.5kHz	
Full Power, 20V p-p Output			
G = 1V/V		2.3kHz	
G = 100V/V		2.3kHz	
Slew Rate		0.14V/μs	
Settling Time[4] ±0.05%, ±10V Step		400μs	
OFFSET VOLTAGE, REFERRED TO INPUT			
Initial, @ +25°C		$\pm5 \pm \frac{10}{G}$ mV max	
vs. Temperature (0 to +70°C)	$\pm20 \pm \frac{200}{G}$ max	$\pm15 \pm \frac{100}{G}$ max	$\pm10 \pm \frac{50}{G}$ μV/°C max
vs. Supply Voltage (+15V to +20V change)		$\pm2 \pm \frac{10}{G}$ μV/V	
RATED OUTPUT			
Voltage, 2kΩ Load		±10V min	
Output Impedance		<1Ω (dc to 100Hz)	
Output Ripple, 0.1MHz Bandwidth			
No Signal IN		5mV p-p	
+10V_{IN}		50mV p-p	
ISOLATED POWER SUPPLY			
Voltage		±15V dc	
Accuracy		±10%	
Current		±5mA, min	
Regulation No Load to Full Load		±5%	
Ripple, 0.1MHz Bandwidth, No Load		25mV p-p	
Full Load		75mV p-p	
POWER SUPPLY, SINGLE POLARITY[5]			
Voltage, Rated Performance		+14.4V to +25V	
Voltage, Operating		+8.5V to +25V	
Current, Quiescent (@ V_S = +15V)		+25mA	
TEMPERATURE RANGE			
Rated Performance		0 to +70°C	
Operating		-15°C to +75°C	
Storage		-55°C to +85°C	
CASE DIMENSIONS		1.5" X 2.0" X 0.75"	

NOTES:
[1] Gain temperature drift is specified as a percentage of output signal level.
[2] Gain nonlinearity is specified as a percentage of 10V pk-pk output span.
[3] When isolated power output is used, nonlinearity increases by ±0.002%/mA of current drawn.
[4] G = 1V/V, with 2-pole, 5kHz output filter (see Figure 13).
[5] Recommended power supply, ADI model 904, ±15V @ 50mA output.

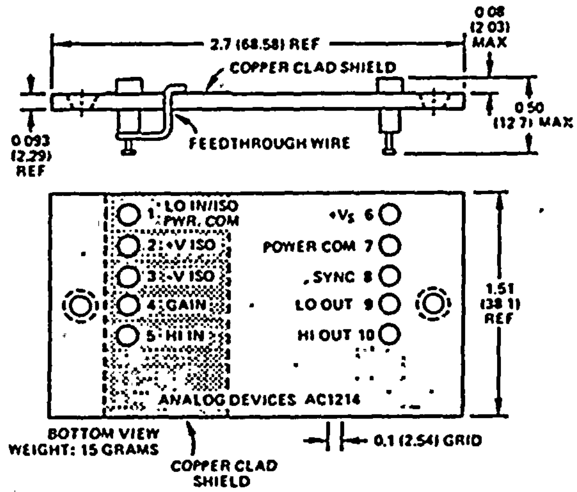
Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



SHIELDED MATING SOCKET AC1214



INTERCONNECTIONS AND SHIELDING TECHNIQUE

To preserve the high CMR performance of model 289, care must be taken to keep the capacitance balanced about the input terminals. A shield should be provided on the printed circuit board under model 289 as illustrated in the outline drawing above (screened area). The LO IN/ISO PWR COM (pin 1) must be connected to this shield. This shield is provided with the mounting socket, model AC1214 (solder feedthrough wire to the socket pin 1 and copper foil surface). A recommended shielding technique using model AC1214 is illustrated in Figure 1.

Best CMR performance will be achieved by using twisted, shielded cable for the input signal to reduce inductive and capacitive pickup. To further reduce effective cable capacitance, the cable shield should be connected to the common mode signal source as close to signal low as possible (see Figure 1).

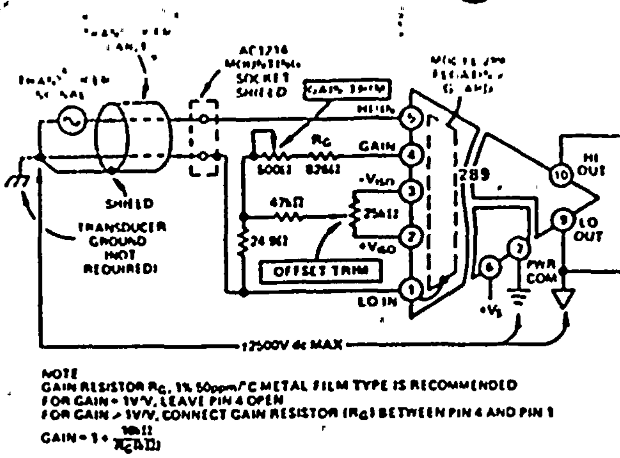


Figure 1. Basic Isolator Interconnection

THEORY OF OPERATION

The remarkable performance of the model 289 is derived from the carrier isolation technique used to transfer both signal and power between the amplifier's input stage and the rest of the circuitry. A block diagram is shown in Figure 2.

EMR Isolator

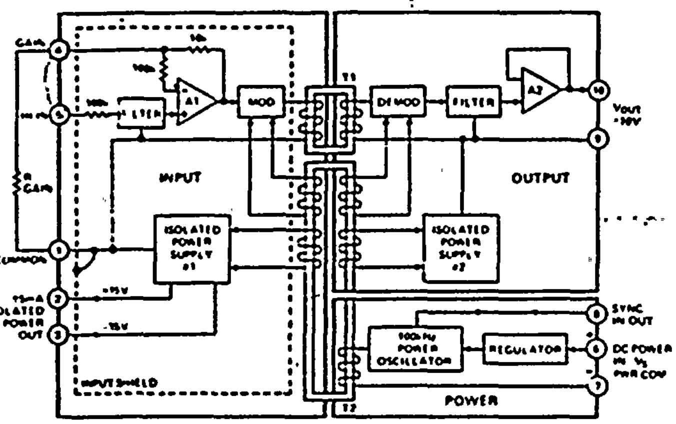


Figure 2. Model 289 Block Diagram

The input signal is filtered and appears at the input of the non-inverting amplifier, A1. This signal is amplified by A1, with its gain determined by the value of resistance connected externally between the gain terminal and the input common terminal. The output of A1 is modulated, carried across the isolation barrier by signal transformer T1, and demodulated. The demodulated voltage is filtered, amplified and buffered by amplifier A2, and applied to the output terminal. The voltage applied to the V_S terminal is set by the regulator to +12V which powers the 100kHz symmetrical square wave power oscillator. The oscillator drives the primary winding of transformer T2. The secondary windings of T2 energize both input and output power supplies, and drives both the modulator and demodulator.

INTERELECTRODE CAPACITANCE AND TERMINAL RATINGS

Capacitance: Interelectrode terminal capacitance, arising from stray coupling capacitance effects between the input terminals and the signal output terminals, are each shunted by leakage resistance values exceeding 50GΩ. Figure 3 illustrates model 289's capacitance, between terminals.

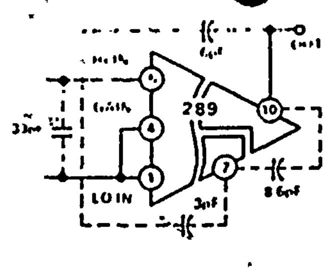


Figure 3. Model 289 Terminal Capacitance

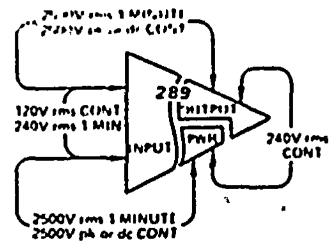


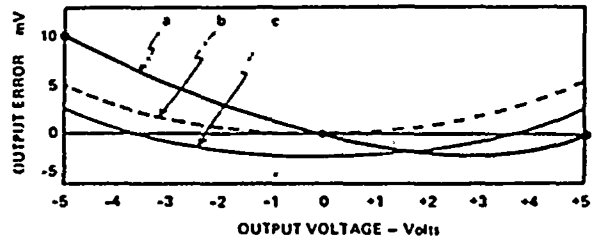
Figure 4. Model 289 Terminal Ratings

Terminal Ratings: CMV performance is given in both peak pulse and continuous ac, or dc peak ratings. Continuous peak ratings apply from dc up to the normal full power response frequencies. Figure 4 illustrates model 289 ratings between terminals.

GAIN AND OFFSET TRIM PROCEDURE

The following procedure illustrates a calibration technique which can be used to minimize output error. In this example, the output span is +5V to -5V and Gain = 10V/V.

1. Apply E_{IN} = 0 volts and adjust R_O for E_O = 0 volts.
2. Apply E_{IN} = +0.500V dc and adjust R_G for E_O = +5.000V dc.
3. Apply E_{IN} = -0.500V dc and measure the output error (see curve a).
4. Adjust R_G until the output error is one-half that measured in step 3 (see curve b).
5. Apply +0.500V dc and adjust R_O until the output error is one-half that measured in step 4 (see curve c).



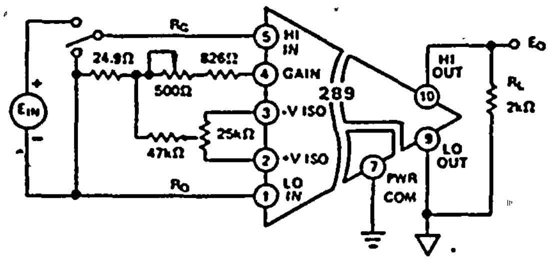


Figure 5a. Recommended Offset and Gain Adjustment for Gains > 1

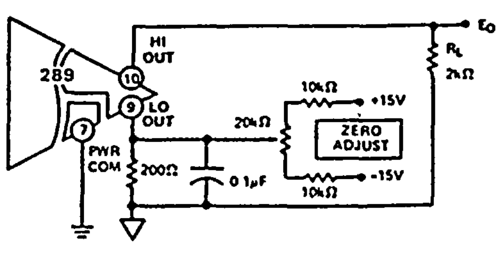


Figure 5b. Recommended Offset Adjustment for G = 1V/V

PERFORMANCE CHARACTERISTICS

Figure 6 shows the phase shift vs. frequency. The low phase shift and wide bandwidth of the model 289 make it suitable for use in SCR Motor Controller and other high frequency applications.

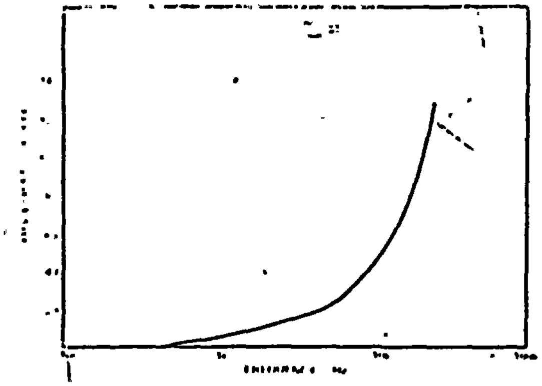


Figure 6. Typical 289 Phase vs. Frequency

Figure 7 illustrates the effect of source impedance imbalance on CMR performance at 60Hz for gains of 1V/V, 10V/V, and 100V/V. CMR is typically 120dB at 60Hz and a balanced source impedance. CMR is >60dB for source impedance imbalances up to 100kΩ.

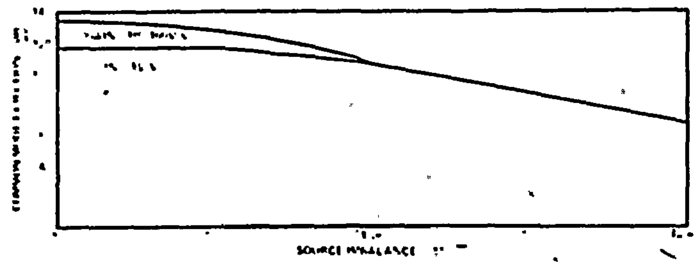


Figure 7. Typical 289 Common Mode Rejection vs. Source Impedance

Input Voltage Noise: Voltage noise, referred to input, is dependent on gain and bandwidth. Figure 8 shows rms voltage noise in a bandwidth from 0.05Hz to the frequency shown on the horizontal axis. The noise in a bandwidth from 0.05Hz to 100Hz is 8μV pk-pk at a gain of 100V/V. The peak-to-peak value is derived by multiplying the rms value at F = 100Hz (1.2μV rms) by 6.6.

For best noise performance in particular applications, a low pass filter at the output should be used to selectively roll-off noise and undesired signal frequencies beyond the bandwidth of interest. Increasing gain will also reduce the noise, referred to input.

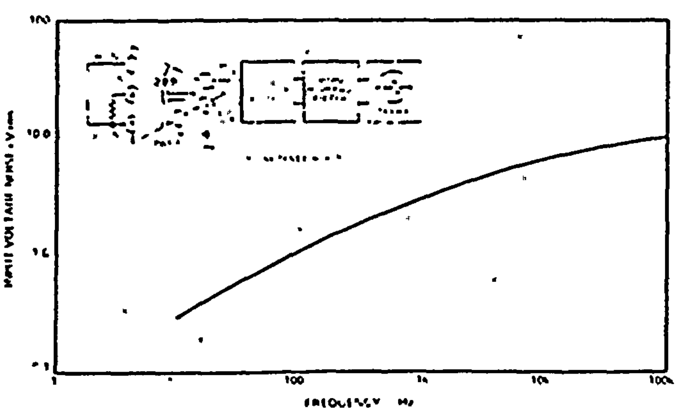


Figure 8. Typical Input Voltage Noise vs. Bandwidth

Gain Nonlinearity: Linearity error is defined as the deviation of the output voltage from the best straight line and is specified as % pk to peak of output voltage span, e.g., nonlinearity of model 289J operating at an output span of 10V pk-pk (±5V) is ±0.05% or ±5mV. Figure 9 illustrates gain nonlinearity for any output span to 20V pk-pk (±10V). Figure 10 shows the effect of gain vs. gain nonlinearity.

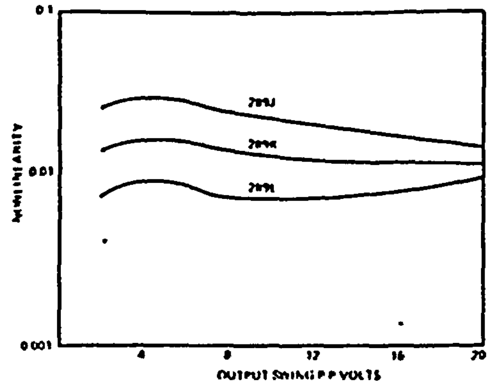


Figure 9. Typical Gain Nonlinearity vs. Output Swing

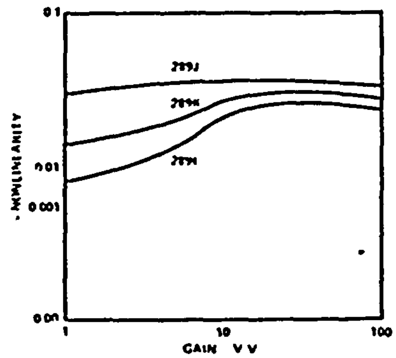


Figure 10. Typical Gain Nonlinearity vs. Gain

Common Mode Rejection: Input-to-output CMR is dependent on source impedance imbalance, signal frequency and amplifier gain. CMR is rated at 115V ac, 60Hz and 1kΩ balanced source at a gain of 100V/V. Figure 11 illustrates CMR performance as a function of signal frequency. CMR approaches 156dB at dc with source imbalance as high as 1kΩ. As gain is decreased, CMR is reduced. At a gain of 1V/V, CMR is typically 6dB lower than at a gain of 100V/V.

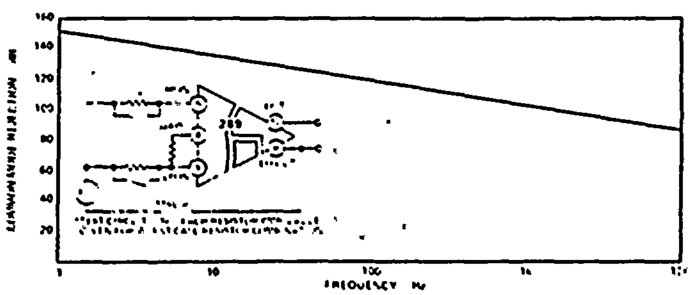


Figure 11. Typical Common Mode Rejection vs. Frequency

MULTICHANNEL APPLICATIONS

Isolation amplifiers containing internal oscillators may exhibit a slowly varying offset voltage at the output when used in multichannel applications. This offset voltage is the result of adjacent internal oscillators beating together. For example, if two adjacent isolation amplifiers have oscillator frequencies of 100.0kHz and 100.1kHz respectively, a portion of the difference frequency may appear as a slowly varying output offset voltage error. Model 289 eliminates this problem by offering a synchronization terminal (pin 8). When this terminal is interconnected with other model 289 synchronization terminals, the units are synchronized. Alternately, one or more units may be synchronized to an external 100kHz ±2% squarewave generator by the connection of synchronization terminal(s) to that generator. The generator output should be 2.5V–5.0V p-p with 1kΩ source impedance to each unit. Use an external oscillator when you need to sync to an external 100kHz source, such as a sub-multiple of a microprocessor clock. A differential line driver, such as SN75158, can be used to drive large clusters of model 289. When using the synchronization pin, keep leads as short as possible and do not use shielded wire. These precautions are necessary to avoid capacitance from the synchronization terminal to other points. It should be noted that units synchronized must share the same power common to ensure a return path.

APPLICATIONS IN INDUSTRIAL MEASUREMENT AND CONTROL SYSTEMS

Isolated DAS: In data acquisition systems where multiple transducers are powered by a single supply and the magnitude of that supply is low enough for a multiplexer to handle the voltages on all the transducers, it is economical to multiplex ahead of an isolator. The fast settling time of the model 289 makes this configuration practical where slower isolators would not be usable.

Figure 12 shows an application where the difference in voltage between any two terminals of any of the transducers does not exceed 30 volts. Though the input of the model 289 is protected against line voltage, its power terminals are not; neither is the multiplexer so protected. This circuit will not, therefore, withstand the differential application of line voltage.

Multiplexer addressing is binary, an enable providing selection of the circuit shown as a signal source. Optical isolation is provided for digital signals. When several of these circuits are used for several groups of transducers, the model 289's should be synchronized.

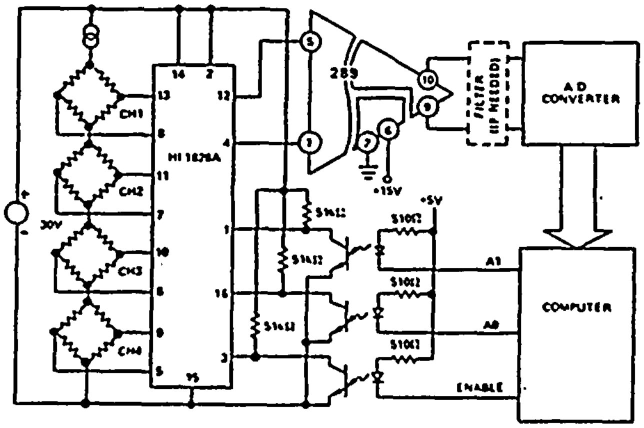


Figure 12. DAS with MUX Ahead of Isolator

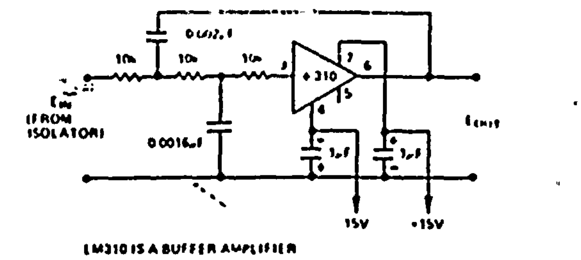


Figure 13. 2-Pole, 5kHz Active Filter

Noise Reduction in Data Acquisition Systems: Transformer coupled isolators must have a carrier to pass dc signals throu[gh] their signal transformers. Inevitably some carrier frequency ripple passes through to the isolator output. As the bandwid[th] of an isolator becomes a larger fraction of its carrier frequen[cy] this ripple becomes more difficult to control. Despite this dif[-]ficulty, the model 289 produces very low ripple; therefore, additional filtration will usually be unnecessary. However, in some applications, particularly where a fast analog-to-digital converter is used following the isolator, it may be desirable to add filtration; otherwise, ripple may cause inaccurate conversions. The 2-pole low-pass shown in Figure 13 limits isolator bandwidth to 5kHz, which is the full power bandwidth of th[e] model 289. Carrier ripple is much reduced. Another benefici[al] effect of an output filter is smoothing of discontinuous high frequency waveforms.

Motor Control and AC Load Control: Phase shift and bandwidth are important considerations for motor control and ac load control applications. The model 289 possesses sufficient bandwidth and acceptable phase shift for such tasks.

Figure 14 shows two model 289's sensing the armature volta[ge] and current of a motor. Faithful replicas of the waveforms of these variables are applied to the motor control. A1 operates at unity gain from divided R1–R3 to deliver an output that is 1/100 of the armature voltage of the motor. A2 operates at a gain of 100V/V to deliver a voltage 100 times that developed across the current sensing shunt.

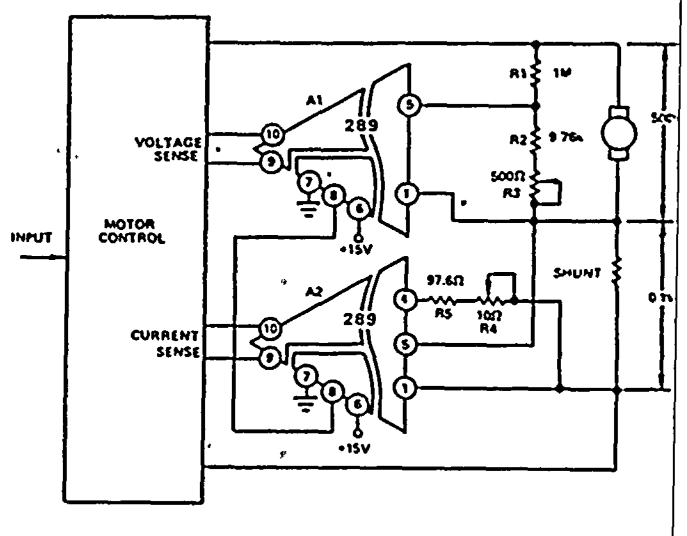


Figure 14. Isolating a Motor Controller

Figure 15 shows three model 289's sensing the voltages on the three phases of an ac load. The Y network shown divides the voltages of the three phases and creates a neutral for the input commons of the isolators. The output of each isolator is a faithful replica of the phase of the waveform it senses. The isolator outputs provide the feedback necessary for the trigger control to correctly fire the triacs. In other applications, the outputs of the isolators might have been fed to rms-to-dc converters.

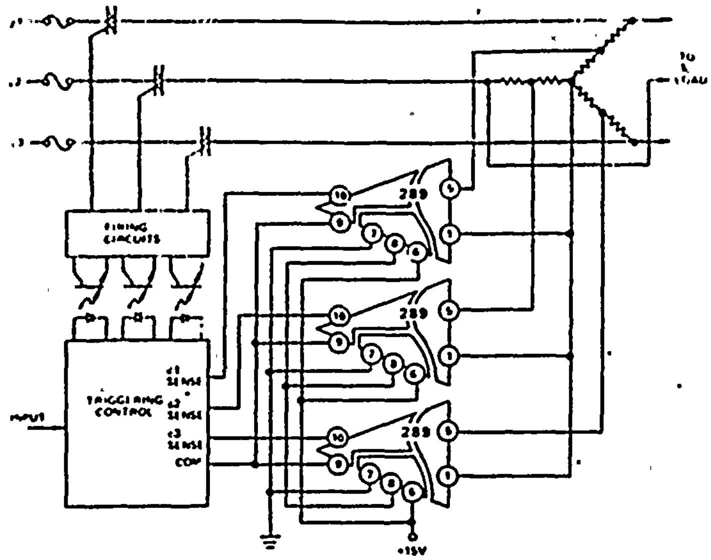


Figure 15. Isolating a 3 Phase Load Controller

Isolated DACs: Figure 16 shows a 12-bit DAC with ±5V isolated output. A buffered −5V reference voltage is provided to the DAC by A1a, A1b and associated circuitry. The digital input causes a proportion of DAC current to flow into OUT1 of the DAC. The remaining DAC current flows into OUT2. Current flowing into OUT1 causes positive voltage at the output of A1c. Current flowing into OUT2 causes a positive voltage at the output of A1d, which in turn causes a negative voltage at the output of A1c. Voltage appearing at the output of A1c is reproduced at the output of the model 289. R5 and R8 must be adjusted to produce less than 0.5mV at OUT1 and OUT2 of the DAC respectively. R15 may be used to adjust gain and R11 to adjust offset with the binary code 1000 0000 0000 to zero.

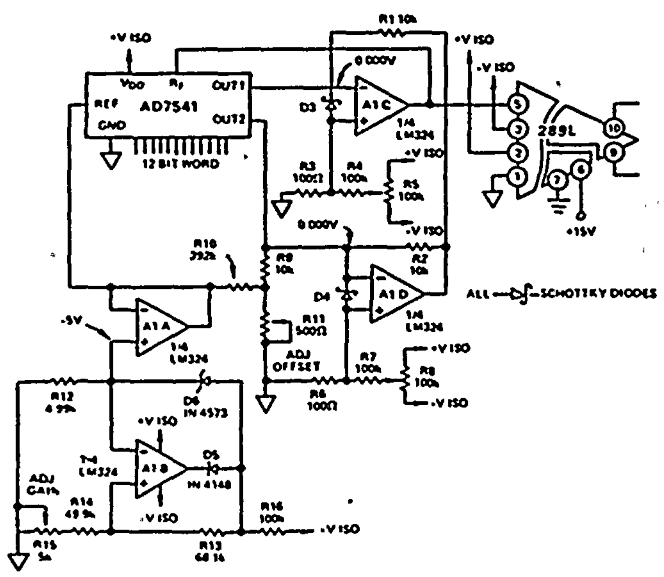


Figure 16. 12-Bit Isolated Voltage DAC

Figure 17 shows the model 289 providing an isolated 4-to-20mA output from a 12 bit DAC. A1a provides a -4V reference to the DAC. The digital input causes a portion of DAC current to flow into OUT1, causing a positive voltage at the output of A1d. A1b produces a voltage across R4 proportional to DAC current. A1c and associated circuitry sink a current which is one-fourth of the full scale current of the DAC, causing a positive voltage of 1 volt at the output of A1d. With the code 1111 1111 1111, +5 volts appears at the output of A1d. Operation is unipolar with a positive offset. The output voltage of A1d is reproduced at the output of the isolator, where the circuitry shown converts it into a 4-to-20mA current which may be applied to the load R_L.

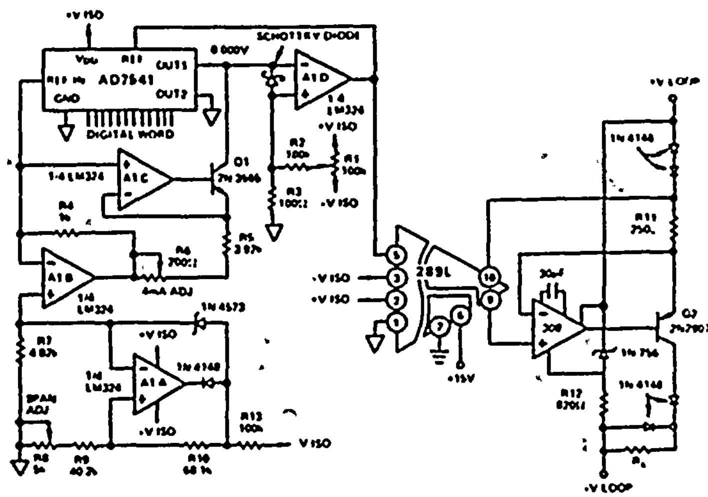


Figure 17. 12-Bit Isolated Process Current DAC

Temperature Measurement: Figure 18 shows the model 289 providing a ground-referred output in an application measuring the temperature of an object floating at a high common mode voltage. The AD590 temperature sensor sinks a current of $-1\mu A/K$. This current flows into the gain terminal of the model 289, developing +10mV/K across the internal feedback resistor. This voltage also appears at the output of the model 289.

The circuitry shown connected by a dotted line may be useful if an output of 10mV/°C is desired. A current of +273μA is sourced through the 8.66k resistor and the potentiometer cancelling the AD590 current at 0°C (273K), resulting in 0mV at the output at 0°C.

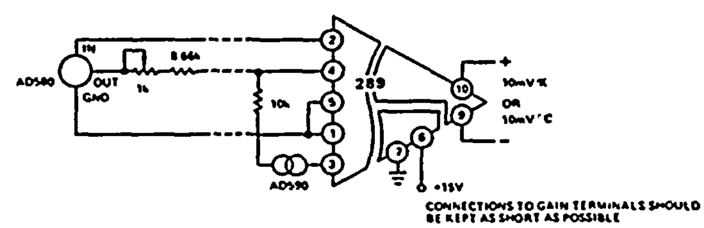
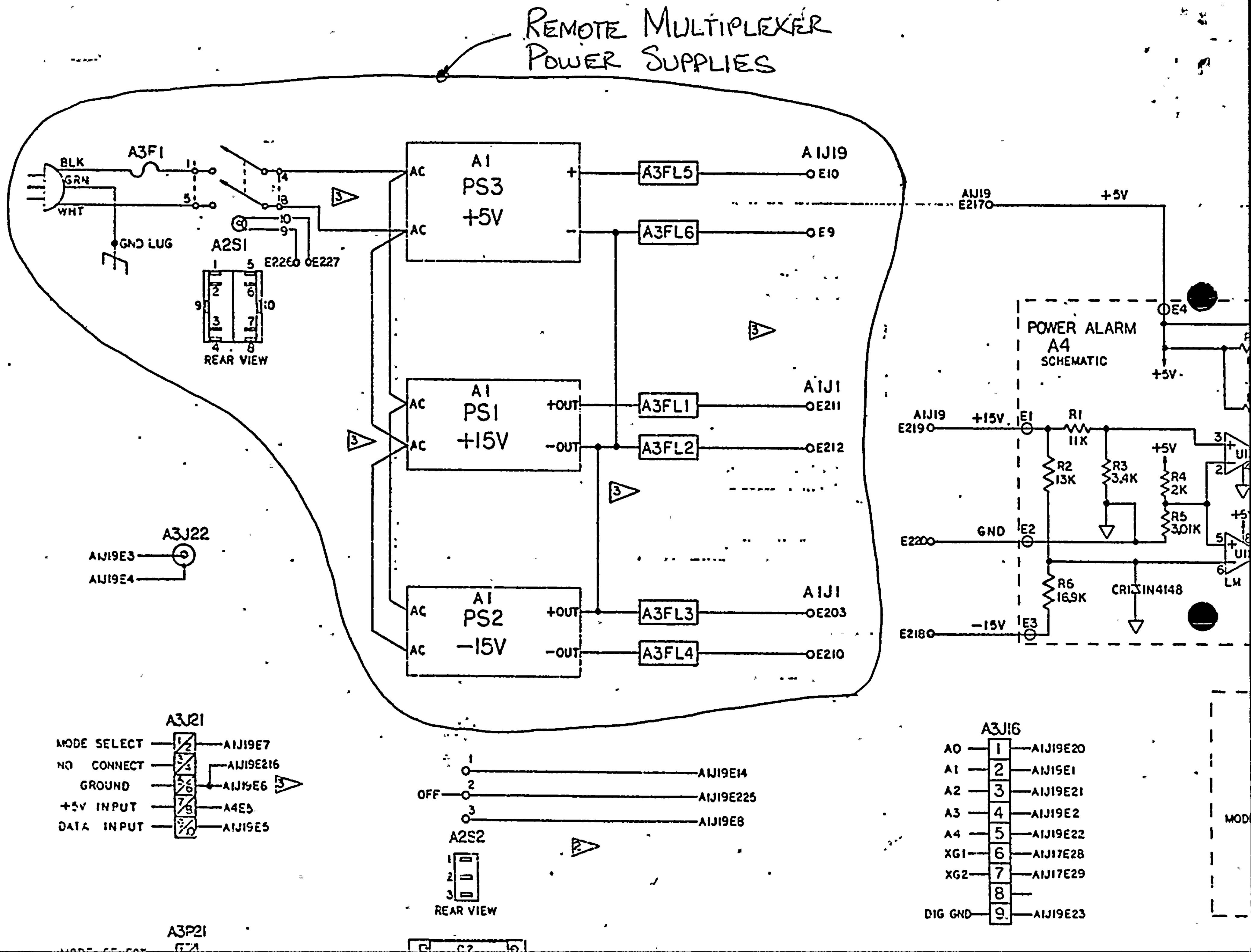


Figure 18. Isolated Temperature Measurement

ATTACHMENT 3



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SUBJECT: WPPSS Nuclear Project No. 2

The following documents concerning our review of the subject facility are transmitted for your information.

- ☐ Notice of Receipt of Application, dated ____________.
- ☐ Draft/Final Environmental Statment, dated ____________.
- ☐ Notice of Availability of Draft/Final Environmental Statement, dated ____________.
- ☐ Safety Evaluation Report, or Supplement No. ______, dated ____________.
- ☐ Notice of Hearing on Application for Construction Permit, dated ____________.
- ☐ Notice of Consideration of Issuance of Facility Operating License, dated ____________.
- ☐ Monthly Notice; Applications and Amendments to Operating Licenses Involving no Significant Hazards Considerations, dated July, August & September 1984
- ☐ Application and Safety Analysis Report, Volume ____________.
- ☐ Amendment No. ______ to Application/SAR dated ____________.
- ☐ Construction Permit No. CPPR- ______, Amendment No. ______ dated ____________.
- ☐ Facility Operating License No. ______, Amendment No. ______, dated ____________.
- ☐ Order Extending Construction Completion Date, dated ____________.
- ☐ Other *(Specify)* ____________

Office of Nuclear Reactor Regulation

Enclosures:
As stated

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DATE	10/4/84						

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WNP-2

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