Wardfield
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WANL-TME-1422
(Addendum No. 4)

June, 1968

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Westinghouse Astronuclear Laboratory

Operational Manual for Reactor Safety
System Revisions XE-1 (ETS-1)

MASTER

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WANL-TME-1422

Addendum No. 4

TITLE: Operational Manual for Reactor Safety System
Revisions XE-1 (ETS-1)

DATE: June, 1968

AUTHOR:

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APPROVED:

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Electronics and Instrumentation

NOTICE

This report contains information of a preliminary nature and was prepared primarily for internal use at the originating installation. It is subject to revision or correction and therefore does not represent a final report. It is passed to the recipient in confidence and should not be abstracted or further disclosed without the approval of the originating installation or USAEC Technical Information Center, Oak Ridge, TN 37830.

R. W. Kaisner, Manager
Electronics and Instrumentation

INFORMATION CATEGORY

Unclassified
7-9-68

Authorized Classifier Date

OPERATIONAL MANUAL FOR REACTOR SAFETY SYSTEM
REVISIONS XE-1 (ETS-1)

1. GENERAL

1.1 INTRODUCTION

This addendum covers the revisions to the Loss of A.C. Power Scram circuitry and the Drum Roll-In Detector Circuitry of the Reactor Safety System Chassis that is located in Rack 63 at the Test Cell Building.

1.2 DESCRIPTION

Changes to the chassis consist of the replacement of two existing printed boards with the two new printed circuit boards listed below, along with associated wiring changes.

Card A4 - AC Voltage Sensor 978D900G01 is replaced by 929F303G01

Card A27 - Drum Roll-In Detector 910E317G01 is replaced by 910E317G01

Rev. B.

Location of the new boards can be seen on Drawing 937J909 Rev. H.

2. INSTALLATION

2.1 INCOMING INSPECTION

The added equipment was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks, dents, or scratches and should be in perfect electrical order upon receipt. To confirm this, the equipment should be inspected for physical damage from transit and tested for electrical performance using the procedures referred to in Section 6. If there is damage or deficiency, repairs should be made before final use.

2.2 MOUNTING

CAUTION: Before installation of the rewired chassis make sure that all power and signals to the rack are turned off to prevent possible damage to the equipment or injury to personnel.

3. PRINCIPLES OF OPERATION

The purpose of the Reactor Safety System (RSS) is to provide digital signals (0, +10 volts) to the pulse OR circuit in the Engine Safety System (ESS) being provided by AGC.

The design of the AGC OR is such that the input impedance of all inputs is greater than 20K ohms and the logic "1" state is +8 to +16 VDC. The logic 0 state is defined as -1 to +4 VDC.

The Reactor Safety System is designed to respond to the reactor-oriented signals as explained in the original manual and previous addendums. Refer to Schematic Drawing 937J841 Rev. K to understand the explanations of the revisions to the AC Power Scram circuitry and the Drum Roll-In Scram circuitry which have been added to the Safety System.

3.1 AC POWER SCRAM

The AC Power Scram circuit consists of Voltage Sensor Modules A4 and A7, Trigger A1E, and part of Relay Module A11.

The purpose of this circuit is to provide reactor scram and readout if any 2 of the 3 phase AC feedlines to the nuclear instrumentation racks are lost. There is the additional constraint that this condition must persist for longer than 6 cycles on a 60 cycle base. For example, if any 2 of the 3 phase AC feedlines is putting out 117 volts $\pm 5\%$ both the AGC OR and the trigger will be in their "0" state. Should any 2 of the 3 AC feedlines be lost for more than 6 cycles, +16 volts is switched to the input of the AGC OR and the trigger resulting in reactor scram and light indication at the Control Point Building.

3.2 DRUM ROLL-IN SCRAM

Refer to Addendum No. 3 of the operational manual for an explanation of the principles of operation of the Drum Roll-In Scram circuitry.

The revision to this circuitry consists of a noise filter with a time constant of 100 milliseconds added to the scram amplifier A27A3. This filter is implemented by resistors A27R15 and A27R16 and capacitor A27A3.

4. OPERATION

After the chassis has been installed and tested in accordance with the applicable sections of the Test Specification and Modification Checkout Procedures no further procedures are required.

If desired, the setpoints of the adjustment potentiometers may be changed by referring to the original manual and the previous addendums.

5. MAINTENANCE

5.1 PREVENTIVE MAINTENANCE

The equipment is designed so that no special maintenance procedures are required other than the normal good housekeeping rules used for similar type electronic equipment.

5.2 CORRECTIVE MAINTENANCE

Major corrective maintenance is performed at the factory or by a Westinghouse field representative. Alignment and replacement of obviously faulty components may be performed locally by a skilled technician. There are no specially selected or matched components used, therefore, components may be replaced by locally available parts of identical value and tolerance.

If there is any apparent or suspected failure or improper functioning of the equipment, the equipment should be checked out in accordance with the Test Specification and Procedure.

6. TEST SPECIFICATION AND PROCEDURE

The proper Test Specification and Procedure is as follows:

6.1 CHASSIS TESTS

T-711854 Rev. A XE-1 Reactor Safety System (937J909G01)

AC Power Scram, Section 5.4.5

6.2 PRINTED CIRCUIT CARD TESTS

T-711854-4 AC Voltage Sensor (929F303G01)

T-711890-1 Rev. A Drum Roll-In Detector (910E317G01)

7. DRAWING LIST

- 937J909 - Reactor Safety System Chassis
- 937J841 - Schematic Diagram-Reactor Safety System
- 937J842 - Wiring Diagram-Reactor Safety System
- 910E317 - Drum Roll-In Detector
- 929F303 - AC Voltage Sensor

8. PHOTOGRAPH LIST

- Figure 1 - Drum Roll-In Detector
- Figure 2 - AC Voltage Sensor

937J841 Rev. K
 (Sheet 1)
 Reactor Safety System Schematic Diagram

937J841 Rev. K
 (Sheet 2)
 Reactor Safety System Schematic Diagram

REVISIONS		DATE	APPROVED
A	REVISED PER ECO 12895	11/15/83	[Signature]
B	REVISED PER ECO 15099	11/15/83	[Signature]
C	REVISED PER ECO 15099	11/15/83	[Signature]
D	REVISED PER ECO 15099	11/15/83	[Signature]
E	REVISED PER ECO 16240	11/15/83	[Signature]
F	REVISED PER ECO 16240	11/15/83	[Signature]

COMPONENT PLATE (BOTTOM VIEW)

← FRONT OF CHASSIS →

14683 937J842

937J842 Rev. G

(Sheet 2)

Reactor Safety System - Wiring Diagram

Figure 1
Drum Roll-In Detector

Figure 2
AC Voltage Sensor

APPENDIX A

TEST SPECIFICATION NUMBER T-711854 REV. A

ACCEPTANCE TEST SPECIFICATION

XE-1 REACTOR SAFETY SYSTEM

937J909G01

DATE: March 15, 1966

PREPARED BY:

R. A. Schatz
Control Systems Engineering
Instrumentation and Control

APPROVED BY:

R. A. Elmiger
Control Systems Engineering
Instrumentation and Control

Quality Engineering

REVISION	A
Changed Section 5.4.5 for Loss of 2 of 3 Scram N.K. 6-12-68	

INFORMATION CATEGORY

Unclassified
3/15/66
Authorized Classifier Date

T-711854 Rev. A

NOTE: Only Section 5.4.5, Neutronics AC Scram Checks, of the test specification is included. The remainder of the specification is contained in the original operational manual for the Reactor Safety System, WANL-TME-1422.

5.4.5 Neutronics AC Scram Checks (See Figure 7 Rev. A)

5.4.5.1 Connect: J1-L to +16V; J1-M to -16V; and

J1-F to the Power Supply return. Allow equipment to warm up for 30 minutes unless this requirement has been previously met.

Connect: X_1 and X_o of power stat PS1 to 117V, 60 Hz AC line; Y_o of PS1 to TP4; Y_1 of PS1 to TP1; Y_2 of PS1 to TP2; Y_3 of PS1 to TP3; Z_1 to +16V; Z_2 to trigger input of oscilloscope; and TP29 to vertical input of scope and TP33 to return of scope. Set E_{ac} to 117V_____. Close S1 and S2 and open S3. Connect DVM to

T-711854 Rev. A

TP31 and TP33. DVM reads $+16V \pm 0.010V$

_____. Connect DVM to TP29 and TP33.

DVM reads zero _____.

5.4.5.2 Open S1 and measure on scope time interval

Δt_1 between opening of S1 and dropout of

A4K1. All Δt 's $110 \pm 20\text{msec}$. _____.

This test to be run 3 times. Complete

Table V below:

TABLE V

<u>Run No.</u>	<u>Δt_1 (msec)</u>	<u>Δt_1 (Ave)</u>
1		
2		
3		

5.4.5.3 Open S1 and close S2 and S3. Open S2 and

measure on scope time interval Δt_2 between

opening of S2 and dropout of A4K2. All Δt_2 's

$110 \pm 20\text{msec}$. _____. This test to be run

3 times. Complete Table VI below:

TABLE VI

<u>Run No.</u>	<u>Δt_2 (msec)</u>	<u>Δt_2 (Ave)</u>
1		
2		
3

- 5.4.5.4 Open S2 and close S1 and S3. Open S3 and measure on scope time interval Δt_3 , between opening of S3 and dropout of A7K1. All Δt_3 's 110 ± 20 msec. _____. This test to be run 3 times. Complete Table VII below:

TABLE VII

<u>Run No.</u>	<u>Δt_3 (msec)</u>	<u>Δt_3 (Ave)</u>
1		
2		
3		

- 5.4.5.5 Averages of Δt_1 , Δt_2 , and Δt_3 are all within the limits 110 ± 20 msec. _____.
Close S1 and S2 and open S3. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volt AC. E_o remains at zero _____.
5.4.5.6 Close S2 and S3 and open S1. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volts AC. E_o remains at zero _____.
5.4.5.7 Close S1 and S3, open S2. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volts AC. E_o remains at zero _____.

T-711854 Rev. A

- 5.4.5.8 Connect MM to J2-Y and J2-B. Remove P/C cards A4 and A7 from sockets. Connect :
 α_{11} of P_3 to +16V; α_{12} of P_3 to TP33;
 and α_{13} of P_3 to TP29.
- 5.4.5.9 Connect DVM to TP29 and TP33. Set E_o
 = +10.00V. Adjust pot A1ER5 so A1E trips.
 MM reads < 1 ohm _____. Reduce E_o
 to 9.0V and reset. Increase E_o slowly.
 When relay A1EK1 energizes, $E_o =$ _____.
 If E_o (meas.) = +10.00V+50mv, set point of
 A1E is established _____. If not, reduce
 E_o and repeat. With A1EK1 energized,
 reduce E_o to zero. MM continues to read
 < 1 ohm _____. Relay A1EK1 is sealed
 in. Press "reset" switch on TP Panel. MM
 reads $\approx \infty$ _____.
- 5.4.5.10 Connect DVM to A1ETP1 and TP33. Set E_o
 = +9.90V. DVM reads $\geq 14.0V$ _____. Set
 $E_o = +10.10V$. DVM reads $\leq 0.10V$ _____.
- 5.4.5.11 Connect DVM to TP29 and TP33. Set E_o
 = +6.00V. Adjust pot A1ER5 so A1E trips.
 MM reads < 1 ohm _____. Reduce E_o to 5.0V
 and reset. Increase E_o slowly. When A1EK1

- energizes, $E_o = \underline{\hspace{1cm}}$. If E_o (meas.) = $+6.00V \pm 50mv$, set point of A1E is established $\underline{\hspace{1cm}}$. If not, reduce E_o and repeat.
- With A1EK1 energized, reduce E_o to zero.
- MM continues to read $< 1 \text{ ohm}$ $\underline{\hspace{1cm}}$.
- Relay A1EK1 is sealed in. Press "reset" switch. MM reads $\approx \infty$ $\underline{\hspace{1cm}}$.
- 5.4.5.12 Connect DVM to A1ETP1 and TP33. Set $E_o = +5.90V$. DVM reads $\geq 14.0V$ $\underline{\hspace{1cm}}$. Set $E_o = +6.10V$. DVM reads $\leq 0.10V$ $\underline{\hspace{1cm}}$.
- 5.4.5.13 Set $E_o = +6.10V$. Connect DVM to J2-BB and TP33. DVM reads $+6.10V$ $\underline{\hspace{1cm}}$.
- 5.4.5.14 Set $E_o = 0.0V$. Connect J2-BB to E_{inA} of Figure 9. Connect β_1 to $+16V$; β_o to TP33; MM to β_2 and β_3 , B_4 to $-16V$ and open and close switch S1. MM reads $\approx \infty$ $\underline{\hspace{1cm}}$. Connect oscilloscope to TP29 and TP33. Increase E_o until MM reads $< 1 \text{ ohm}$ $\underline{\hspace{1cm}}$. During interval of increasing E_o and trip of test circuit (Figure 9), no appreciable transient in E_o , exempting signal step is observed $\underline{\hspace{1cm}}$.
- 5.4.5.15 Insert P/C cards A4 and A7.

FIG. 6.

FIG. 7 REV. A

FIG. 8

APPENDIX B

T-711854-4

ACCEPTANCE TEST SPECIFICATION AND PROCEDURE

Reactor Safety System

AC Voltage Sensor

929F303G01

DATE: April, 1968

PREPARED BY:

H. Kowalechek 4-24-68
Circuits Design Date
Electronics and Instrumentation

APPROVED BY:

R.A. Elmer 4/24/68
Supervisor, Circuits Design Date
Electronics and Instrumentation

E.J. DeCarlo 5-2-68
Quality Engineering Date

T.G. Elmer 5-7-68
Control Systems Engineering Date

INFORMATION CATEGORY

Unclassified
R.A. Elmer 4/24/68

Authorized Classifier Date

**Astronuclear
Laboratory**

WANL-TME-1422

Addendum No. 4

T-711854-4
ACCEPTANCE TEST SPECIFICATION AND PROCEDURE
Reactor Safety System
AC Voltage Sensor
929F303G01

1. SCOPE

This document contains the requirements for the acceptance testing of the AC Voltage Sensor Circuit Board prior to incorporating the board into the Reactor Safety System Chassis 937J909G01.

2. REQUIREMENTS

2.1 The acceptance test shall consist of a Visual Examination (to be performed by Quality Control) and a Functional Test (to be performed by Electronics and Instrumentation and witnessed by Quality Control).

2.2 The acceptance test shall be performed in the order of and as specified in the procedure. Discrepancies found during the visual examination shall be corrected and reinspected before performing the functional test. Failure or inability to obtain a required measurement during formal functional testing shall result in establishing a "hold" on the test. The failure or inadequacy shall be recorded by Quality Control and shall be reviewed by the WANL Engineering Review Board (ERB). The equipment shall be repaired and sections of the test repeated as determined by the ERB. Visual examination shall be performed on the reworked or repaired areas before resuming testing.

T-711854-4

3. APPLICABLE DOCUMENTS

- 3.1 Drawing 929F303 - AC Voltage Sensor
- 3.2 Drawing 929F304 - Printed Circuit Board

4. EQUIPMENT REQUIRED

- 4.1 Model 269 Simpson Ohmmeter or equal
- 4.2 115VAC $\pm$ 5% source
- 4.3 Tektronix 502A oscilloscope or equal

5. VISUAL EXAMINATION

The equipment under test shall be presented in its final form together with the applicable schematic and assembly drawing. The visual examination shall consist of the following parts:

5.1 WORKMANSHIP, ASSEMBLY, AND FIT

The inspector shall inspect the equipment for workmanship to WANL requirements, and to assure that the overall board is of the proper dimensions per the assembly drawing.

Dwg. No. _____ Group No. _____ Rev. _____

Serial No. _____ Workmanship OK _____

5.2 MATERIALS, PARTS, AND FINISHES

The equipment shall be inspected to assure that the materials, parts, and finishes are in accordance with the applicable assembly drawings. Incoming inspection records on materials, parts, and finishes shall be utilized to determine conformance to the assembly drawings where possible.

Materials OK _____

5.3 MARKING

The markings on the equipment shall be inspected to ensure conformance to the applicable drawings and to assure that they are acceptable as to performance and readability.

Marking OK _____

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6. FUNCTIONAL TESTS

6.1 RESISTANCE CHECK - RELAYS DE-ENERGIZED

6.1.1 Make the following resistance checks:

<u>From (+)</u>	<u>To (-)</u>	<u>Ohms Required</u>	<u>Ohms Measured</u>
Pin 1	Pin 2	> 100 Meg	_____
Pin 1	Pin 15	> 100 Meg	_____
Pin 2	Pin 18	< 1	_____
Pin 2	Pin 34	< 1	_____
Pin 15	Pin 34	> 100 Meg	_____
Pin 16	Pin 34	< 1	_____
* Pin 11	Pin 12	22K $\pm$ 20%	_____
* Pin 12	Pin 11	22K $\pm$ 20%	_____
* Pin 30	Pin 32	22K $\pm$ 20%	_____
* Pin 32	Pin 30	22K $\pm$ 20%	_____

6.2 RESISTANCE CHECK - RELAYS ENERGIZED

6.2.1 Energize Relay K1 by applying 115VAC between Pin 11 and Pin 12.

* Use X10K scale on ohmmeter.

6.2.1.1 Make the following resistance checks:

<u>From (+)</u>	<u>To (-)</u>	<u>Ohms Required</u>	<u>Ohms Measured</u>
Pin 1	Pin 2	< 1	_____
Pin 1	Pin 34	> 100 Meg	_____
Pin 2	Pin 15	> 100 Meg	_____
Pin 2	Pin 16	> 100 Meg	_____
Pin 15	Pin 16	> 100 Meg	_____
Pin 15	Pin 34	> 100 Meg	_____
Pin 16	Pin 34	> 100 Meg	_____
Pin 18	Pin 34	< 1	_____

6.2.2 Energize Relay K2 by applying 115VAC between Pin 30 and Pin 32.

(Leave Relay K1 energized).

6.2.2.1 Make the following resistance checks:

<u>From (+)</u>	<u>To (-)</u>	<u>Ohms Required</u>	<u>Ohms Measured</u>
Pin 1	Pin 34	< 1	_____
Pin 2	Pin 34	< 1	_____
Pin 15	Pin 34	< 1	_____
Pin 16	Pin 34	> 100 Meg	_____
Pin 16	Pin 18	> 100 Meg	_____
Pin 18	Pin 34	> 100 Meg	_____

6.2.3 De-energize Relay K1 by removing 115VAC from Pin 11 and Pin 12.

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6.2.3.1 Make the following resistance checks:

<u>From (+)</u>	<u>To (-)</u>	<u>Ohms Required</u>	<u>Ohms Measured</u>
Pin 1	Pin 34	< 1	_____
Pin 2	Pin 18	< 1	_____
Pin 2	Pin 34	> 100 Meg	_____
Pin 2	Pin 15	> 100 Meg	_____
Pin 15	Pin 16	> 100 Meg	_____
Pin 15	Pin 34	> 100 Meg	_____
Pin 16	Pin 34	> 100 Meg	_____
Pin 16	Pin 18	> 100 Meg	_____

6.2.4 De-energize Relay K2 by removing 115VAC from Pin 30 and Pin 32.

6.3 TIME DELAY CHECK

6.3.1 Energize Relay K1 as in step 6.2.1.

6.3.2 Observe output with the oscilloscope across Pin 1 and Pin 2.

6.3.3 De-energize Relay K1 as in step 6.2.3 and measure the time interval between the 115VAC power removal and the opening of the relay contacts across Pin 1 and Pin 2.

The time delay should be 115 $\pm$ 20% milliseconds. Record results.

K1 Time Delay _____ milliseconds

6.3.4 Energize Relay K2 as in step 6.2.2.

6.3.5 Observe output with the oscilloscope across Pin 1 and Pin 34.

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6.3.6 De-energize Relay K2 as in step 6.2.4 and measure the time interval between the 115VAC power removal and the opening of the relay contacts across Pin 1 and Pin 34. The time delay should be $115 \pm 20\%$ milliseconds. Record results.

K2 Time Delay _____ milliseconds

APPENDIX C

T-711890-1 Rev. A

ACCEPTANCE TEST SPECIFICATION AND PROCEDURE

Reactor Safety System

Drum Roll-In Detector

910E317G01

DATE: September, 1967

PREPARED BY:

H. Kowalcheck 9-21-67
Circuits Design Date
Equipment Design

APPROVED BY:

R. A. Elvinger 9-21-67
Supervisor, Circuits Design Date
Equipment Design

E. J. McQuade 9-26-67
Quality Engineering Date

C. C. Muchant 9-26-67
Control Systems Engineering Date

REVISION	A
Changed 6.2.4 because of filter addition.	H.K. 6-10-68

INFORMATION CATEGORY

Unclassified
R. A. Elvinger 9/21/67
Authorized Classifier Date

Astronuclear
Laboratory

WANL-TME-1422

Addendum No. 4

T-711890-1
ACCEPTANCE TEST SPECIFICATION AND PROCEDURE
Reactor Safety System
Drum Roll-In Detector
910E317G01

1. SCOPE

This document contains the requirements for the acceptance testing of the Drum Roll-In Detector Circuit Board prior to incorporating the board into the Reactor Safety System Chassis 937J909G01.

2. REQUIREMENTS

2.1 The acceptance test shall consist of a Visual Examination (to be performed by Quality Control) and a Functional Test (to be performed by Electronics and Instrumentation and witnessed by Quality Control).

2.2 The acceptance test shall be performed in the order of and as specified in the procedure. Discrepancies found during the visual examination shall be corrected and reinspected before performing the functional test. Failure or inability to obtain a required measurement during formal functional testing shall result in establishing a "hold" on the test. The failure or inadequacy shall be recorded by Quality Control and shall be reviewed by the WANL Engineering Review Board (ERB). The equipment shall be repaired and sections of the test repeated as determined by the ERB. Visual examination shall be performed on the reworked or repaired areas before resuming testing.

3. APPLICABLE DOCUMENTS

- 3.1 Drawing 910E317 - Drum Roll-In Detector
- 3.2 Drawing 928F982 - Printed Circuit Board

4. EQUIPMENT REQUIRED

- 4.1 $+16 \pm .05$ VDC source with $\pm 0.05\%$ regulation and 1 mv. max. ripple
- 4.2 $-16 \pm .05$ VDC source with $\pm 0.05\%$ regulation and 1 mv. max. ripple
- 4.3 0 to +10 VDC signal source with .01% resolution and 1 mv. max. ripple
- 4.4 0 to -10 VDC signal source with .01% resolution and 1 mv. max. ripple
- 4.5 Model 269 Simpson Ohmmeter or equal
- 4.6 Digital Voltmeter H-P 3440A or equal
- 4.7 Tektronix 502A oscilloscope or equal

5. VISUAL EXAMINATION

The equipment under test shall be presented in its final form together with the applicable schematic and assembly drawing. The visual examination shall consist of the following parts:

5.1 WORKMANSHIP, ASSEMBLY, AND FIT

The inspector shall inspect the equipment for workmanship to WANL requirements, and to assure that the overall board is of the proper dimensions per the assembly drawing.

Dwg. No. _____ Group No. _____ Rev. _____

Serial No. _____ Workmanship OK _____

5.2 MATERIALS, PARTS, AND FINISHES

The equipment shall be inspected to assure that the materials, parts, and finishes are in accordance with the applicable assembly drawings. Incoming inspection records on materials, parts, and finishes shall be utilized to determine conformance to the assembly drawings where possible.

Materials OK _____

5.3 MARKING

The markings on the equipment shall be inspected to ensure conformance to the applicable drawings and to assure that they are acceptable as to performance and readability.

Marking OK _____

T-711890-1

6. FUNCTIONAL TESTS

6.1 RESISTANCE CHECK

6.1.1 Set Pots R6, R7, R11, and R14 fully CCW. Make the following resistance checks:

<u>From</u>	<u>To</u>	<u>Ohms</u>	<u>Check</u>
Pin 3	TP1	< 1	_____
Pin 6	TP2	< 1	_____
Pin 24	TP6	< 1	_____
Pin 32	TP8	< 1	_____
Pin 35	TP10	< 1	_____
TP2	TP3	1K _± 5%	_____
TP4	TP5	10K _± 5%	_____
TP8	TP9	.9K _± 5%	_____
TP8	TP11	.9K _± 5%	_____

6.2 GAIN AND LIMITS CHECK

6.2.1 Ground Pins 3 and 35. Set Pots R6, R7, R11, and R14 fully CCW. Connect +16 VDC to Pin 1 and -16 VDC to Pin 2. Connect +10 VDC to Pin 6 and -10 VDC to Pin 32.

6.2.2 Amplifier A1

6.2.2.1 Connect jumper wire across Capacitor C1. Ground TP7 and adjust the voltage offset for minimum output (< 10 mv.) at TP4. Record offset voltage: _____.
 Verify that offset pot > 1/2 turn from ends: _____.

6.2.2.2 Remove ground from Pin 35. Measure gain and limits by using input at Pin 35 and output at TP5. Record results.

<u>Input VDC</u>	<u>Output VDC</u>
0	0 $\pm$.1 _____
+0.5	+0.6 $\pm$.2 _____
+1.0	+0.6 $\pm$.2 _____
-0.5	-0.6 $\pm$.2 _____
-1.0	-0.6 $\pm$.2 _____

6.2.2.3 Set Pots R6 and R14 fully CW and repeat Step 6.2.2.2.

<u>Input VDC</u>	<u>Output VDC</u>
0	0 $\pm$.1 _____
+0.5	+8.2 $\pm$.3 _____
+1.0	+10.6 $\pm$.5 _____
-0.5	-8.2 $\pm$.3 _____
-1.0	-10.6 $\pm$.5 _____

6.2.3 Amplifier A2

6.2.3.1 Set Pots R6 and R14 fully CCW. Remove jumper wire from Capacitor C1 and remove ground from TP7. Ground Input Pin 35 and adjust the voltage offset for minimum output ($<10\text{mv.}$) at TP5. Record offset voltage: _____. Verify that offset pot $> 1/2$ turn from ends: _____.

6.2.3.2 Remove ground from Pin 35. Measure time constant by using input at Pin 35 and output at TP7. Set Pots R6 and R14 fully CW.

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- 6.2.3.3 Apply a positive step voltage of 0.5 VDC to Pin 35.
- 6.2.3.4 Exponential rise of output voltage at TP7 should have a time constant (63.2% point) of $2.5 \pm .2$ seconds.

Record time constant: _____ sec.

- 6.2.3.5 Set Pot R7 fully CW. Repeat Step 6.2.3.3.
- 6.2.3.6 Exponential rise of output voltage at TP7 should have a time constant (63.2% point) of $1.8 \pm .2$ seconds.

Record time constant: _____ sec.

6.2.4 Amplifier A3

6.2.4.1 Connect jumper wire across Capacitor C1. Ground Input Pin 35 and TP7 and adjust the voltage offset for minimum output (< 1 volt) at Pin 24. Record offset voltage: _____. Verify that offset pot $> 1/2$ turn from ends: _____.

6.2.4.2 Remove ground from Pin 35. Measure gain and limits by using input at Pin 35 and output at Pin 24. Record results.

<u>Input VDC</u>	<u>Output VDC</u>
0	0+1 _____
+ .05	+9+1 _____
+ .10	+13+2 _____
- .05	- .6+ .2 _____
- .10	- .6+ .2 _____

- 6.2.4.3 Set Pot R11 fully CW and repeat Step 6.2.4.2.

<u>Input VDC</u>	<u>Output VDC</u>
0	-.6+.2 _____
+1.00	-.6+.2 _____
+1.16	-.6+.2 _____
+1.26	+9+1 _____
+2.00	+13+2 _____

6.2.4.4 Set Pot R11 fully CCW. Measure time constant by using input at Pin 35 and output at Pin 24.

6.2.4.5 Apply a positive step voltage of 0.05VDC to Pin 35.

6.2.4.6 Exponential rise of output voltage at Pin 24 should have a time constant (63.2% point) of 100+10 milliseconds.

Record time constant: _____ sec.