OPERATING AND MAINTENANCE MANUAL
RESOLVER/SYNCHRO BRIDGE
MODEL 540/10

NAI TM 5006

north atlantic

OPERATING AND MAINTENANCE MANUAL
RESOLVER/SYNCHRO BRIDGE
MODEL 540/10

NAI TM 5006

NORTH ATLANTIC *industries, inc.*

60 plant avenue, hauppauge, n.y. 11788 ~~516-582-6500~~

STATUS OF CHANGE PAGES

Following is a list of all pages in this manual, their change status and the date of change. A zero (0) in the Change Status column indicates an original issue. Changed text is indicated by a vertical bar in the margin. Changed illustrations are indicated by a vertical bar next to the title.

Original - December 1981
Change 1 - November 1982

Pages	Change Status
Title	0
A	C1
i thru iv	0
1-1, 1-2	0
2-1	0
3-1 thru 3-4	0
4-1 thru 4-6	0
5-1, 5-2	0
6-1 thru 6-9	0
7-1 thru 7-10	0
8-1	C1
8-2	0

CAUTION

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

North Atlantic Industries, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration, or setting up of the instrument.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1

GENERAL DESCRIPTION

1.1 GENERAL

This manual contains general description, installation, operating instructions, maintenance and troubleshooting procedures, replacement parts lists, and schematic diagrams for the Resolver/Synchro Bridge, Model 540/10 (herein after referred to as the Model 540/10).

1.2 PHYSICAL DESCRIPTION

The Model 540/10 (fig. 1-1) is a 3-1/2-inch rack mounted instrument.

1.3 FUNCTIONAL DESCRIPTION

The Model 540/10 provides the means for measuring directly the angular shaft position of both three-wire synchros and four-wire resolvers to an accuracy of 2 seconds of arc.* In addition to its dual-mode capability, the Model 540/10 will accommodate synchros and resolvers operating at any of the standard voltages up to 115 V ac, maximum. Its high input impedance and ability to measure synchros and resolvers either as components, or as elements of operating systems, permit it to be used with equal accuracy in the laboratory, on the production line, or in ground checkout systems.

Accuracy of two seconds for all angular positions is achieved through use of a unique ratio transformer bridge, developed at North Atlantic Industries for this application. Null voltage gradient is constant over the entire range of angle, permitting use of the instrument for rapid deviation measurements on the production line or in systems evaluation.

The Model 540/10 is designed for optimum accuracy at 400 Hz and is useful over the extended band of 400 Hz to 5 kHz with somewhat reduced accuracy. Both input and output are isolated to provide high common-mode rejection and to permit the use of any North Atlantic Phase Angle Voltmeter as the null indicator.

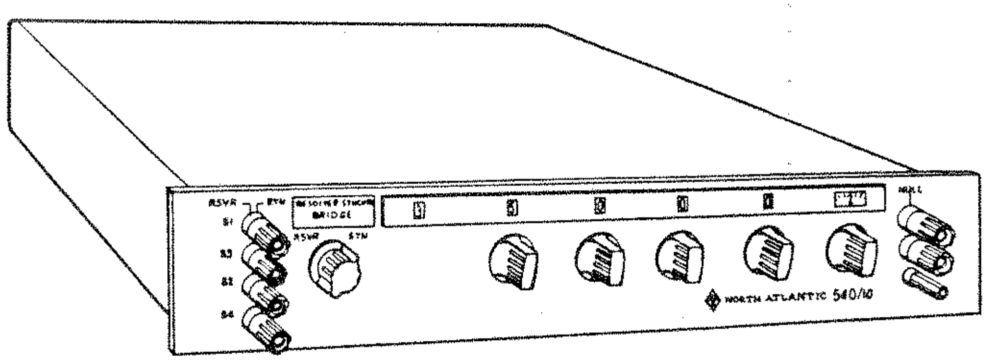

Figure 1-1. Synchro/Resolver Bridge, Model 540/10

*Accuracy of all North Atlantic Resolver/Synchro Bridges are verified by comparison to Ratio Standards which have records of calibrations traceable to the National Bureau of Standards.

1.4 SPECIFICATIONS

Table 1-1 provides physical and functional specifications for the Model 540/10.

Table 1-1. Specifications

Item	Specification
Voltage (L-L)	Nominal 11.8 to 115 V rms 0.8 f volts, where f = frequency in Herz 150 V rms, maximum 5 V rms, minimum
Accuracy	2 s at 400 Hz 4 s at 1 kHz 15 s at 2 kHz 60 s at 5 kHz
Nominal input impedance (at 400 Hz)*	
Synchro	500 K
Resolver	750 K
Resolution	0.0001°
Null voltage gradient	
Standard unit	$0.55 \times E_{L-L}$ µV/arc -s $2.0 \times E_{L-L}$ µV/.001° ±1%
Option 04	$4.95 \times E_{L-L}$ µV/arc -s $18.0 \times E_{L-L}$ µV/.001° ±1%
Transformer ratio	
Standard unit	9:1
Option 04	1:1
Output/input	Isolated
Size	3-1/2" x 19" x 15-1/8"
Weight	30 lbs., nominal

*Input impedance tested as follows:

Resolver mode - tested when excited with 115 V L-L, 400 Hz resolver data at 45° shaft angle.

Synchro mode - tested when excited with 115 V L-L, 400 Hz synchro data with odd lead open.

S1-S2 - 30° shaft angle
S1-S3 - 90° shaft angle
S2-S3 - 150° shaft angle

SECTION 2

INSTALLATION

The Model 540/10 is designed for either rack mounting or bench use. The compact 3-1/2" height and standard relay-rack width allows its installation into a large variety of test consoles with a minimum sacrifice of space. The all passive circuits used, generate no heat and, therefore, there need be no space allocated for cooling purposes.

An outline drawing of the Model 540/10 is illustrated in figure 2-1.

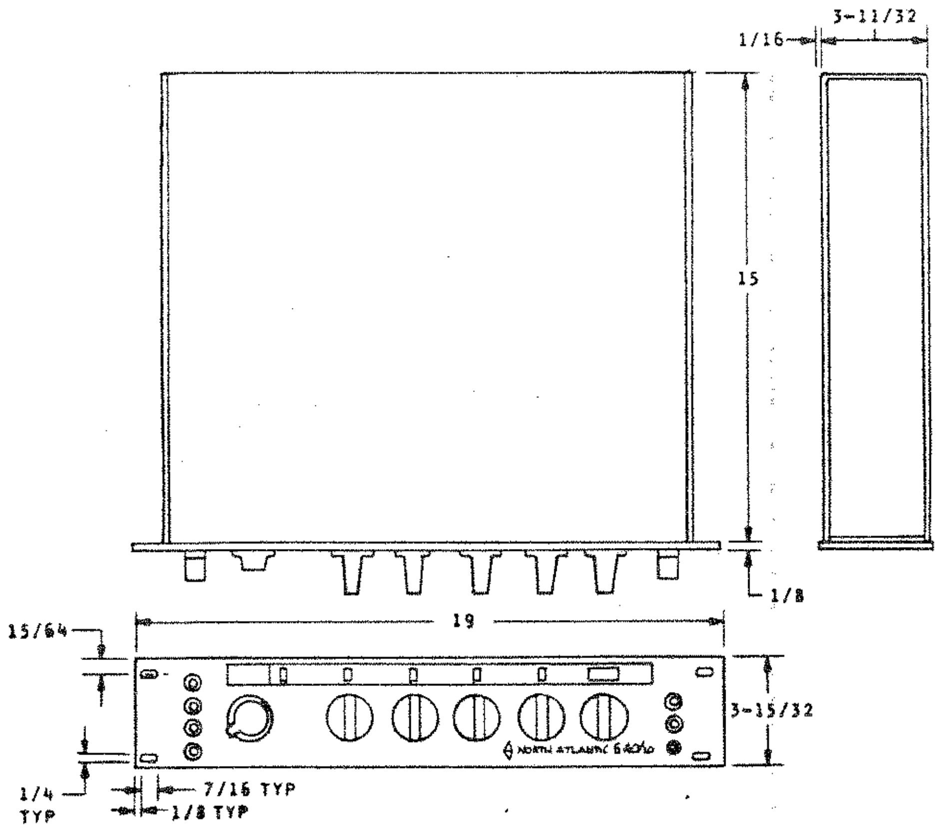

Figure 2-1. Model 540/10 Outline Drawing

SECTION 3

OPERATION

.1 GENERAL

his section provides operating instruc-
ions for the Model 540/10.

3.2 CONTROLS AND INDICATORS

The controls and indicators for the Model 540/10 are described in table 3-1 and illustrated in figure 3-1.

Table 3-1. Controls and Indicators

Control or indicator	Function
ode Selector switch	Selects synchro or resolver mode of operation. It also selects rear panel input terminals. This feature allows simultaneous application of resolver and synchro data to the appropriate rear panel terminals and alternately switching between them.
YN	Selects synchro mode of operation.
SVR	Selects resolver mode of operation.
ngle Select controls and In-line Decimal Readout	The electrical angular setting of the Model 540/10 is adjusted by means of the Angle Selector controls. The angle is read directly above these controls.
	The first switch controls the most significant digit and advances the angle in 10° steps. This control is continuous (no stops) enabling the user to go directly from 350° to 0°. The second control controls the units of degrees from 0° to 9°. The third and fourth switches control tenths and hundredths of degrees, respectively.
	The fifth control, a potentiometer, provides thousandths and ten thousandths of a degree resolution. The readout for this control has major divisions for each thousandth of a degree and a minor division for each ten thousandths of a degree, facilitating interpolation to one ten thousandth of a degree.
SYN and RSVR terminals (front and rear panel)	Three-wire synchro and four-wire resolver data of 5 to 115 V L-L available (front and rear panel) when Mode Selector switch is in SYN and RSVR position, respectively. By utilizing the rear panel terminals, the unit can be alternately switched from resolver to synchro operation without changing terminal connections.
.1 A fuse	The unit is protected by a .1 A fuse which is located on the rear panel.

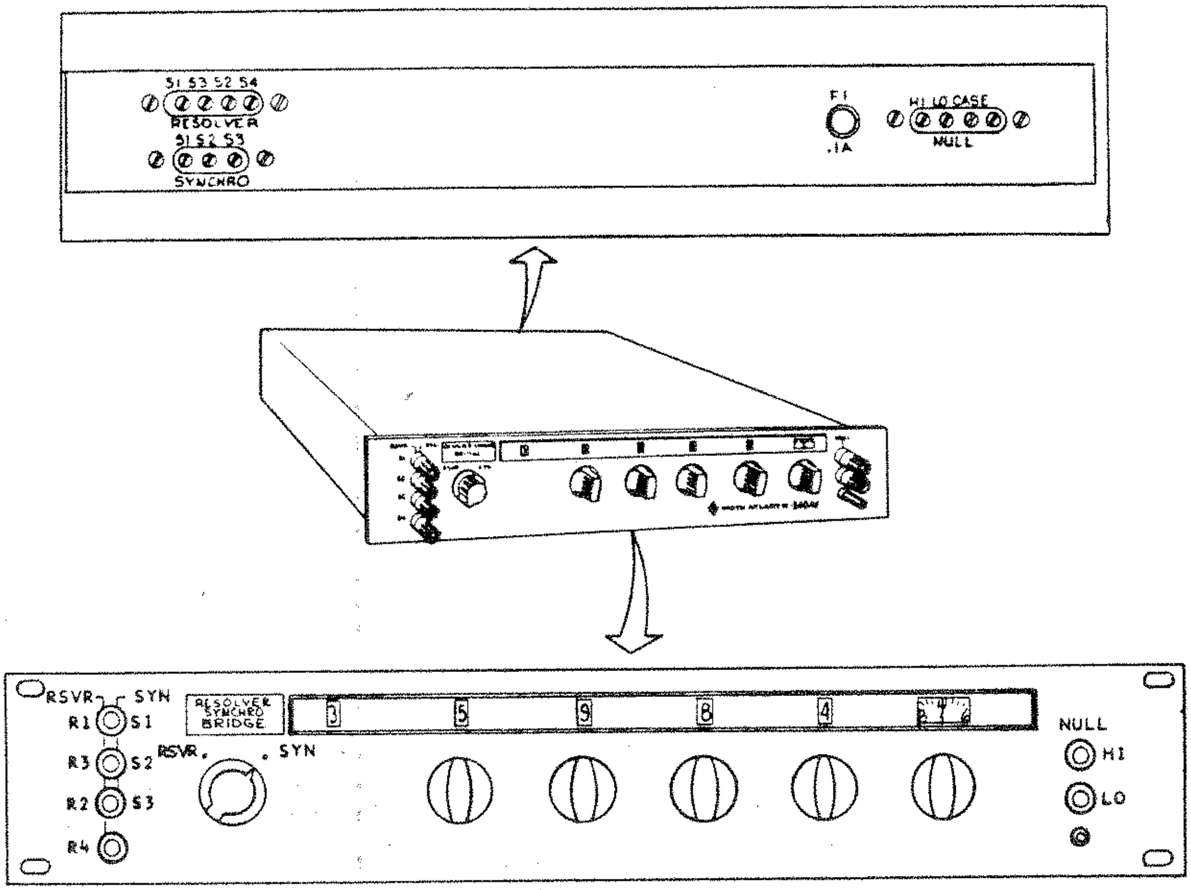

Figure 3-1. Controls and Indicators

3.3 HOOKUP WITH ASSOCIATED EQUIPMENT

The Model 540/10 is designed for use with an accompanying phase angle voltmeter such as North Atlantic's Model 213C, 225, or 321. The PAV detector should have its signal input terminals connected to the HI and LO null terminals (insulated and floated) on the front or rear panel of the Model 540/10. For most applications, the LO and CASE terminals may be jumpered in order to tie case ground to voltmeter ground.

The reference input to the voltmeter is usually taken directly from the line voltage used for synchro excitation. Figure 3-2 shows a typical hookup.

Normally, the isolated output of the Model 540/10 makes unnecessary any additional isolation in a measuring system. However, since grounds may be made via circuits over which the user has no control (e.g., the line may have one side grounded and/or the rack may ground the case of the Model 540/10), proper operation may require additional line, signal, or reference isolation.

Proper phasing of the PAV is achieved by setting the phase shifter in the PAV. For low accuracy measurements or when following test methods of MIL-S-20708A, the phase dial can be set at 0°. For higher accuracy or where system usage of component under test so dictates, the phase dial setting should be made in the manner described in paragraph 3.4.1.

3.4 USE AND APPLICATION

With resolver or synchro data applied to the proper input terminals, and the Mode switch in the correct position, the Model 540/10 may be used in one of the following

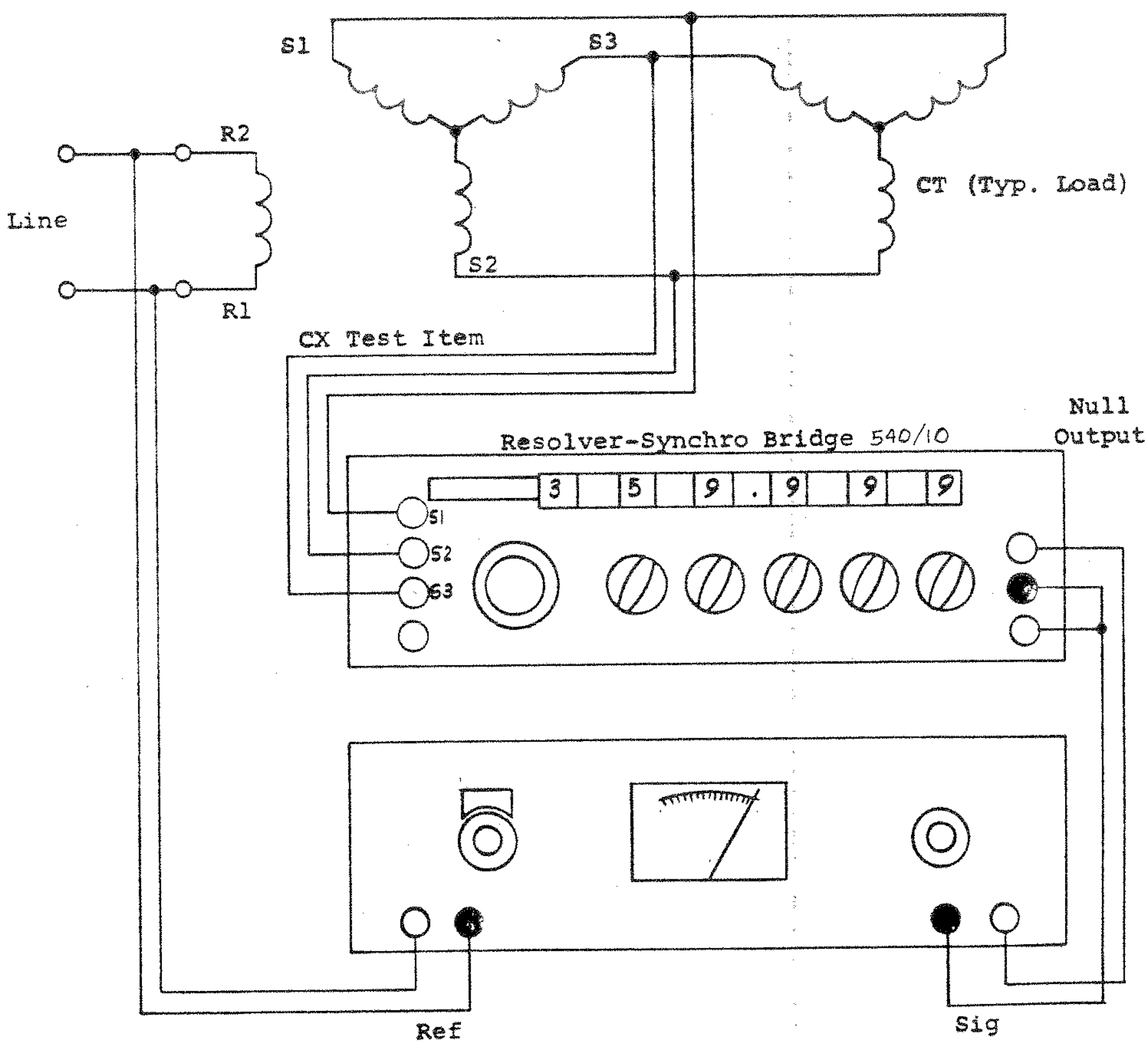

Figure 3-2. Typical Hookup

three manners:

3.4.1 Reading an Unknown Data Angle

a. Using the first Decade Angle Selector, adjust the Model 540/10 to obtain an approximate in-phase null, as read on the PAV. The PAV phase shifters should be set to 0°. At this point, increasing the Model 540/10 angle should result in a more negative deflection of the PAV. If a more positive deflection results, the Model 540/10 angle is in error by 180°. This is the false null described in the Theory of Operation. In that case, increase the Model 540/10 angle by 180° and again repeat the above check. With the first decade so adjusted, adjust the remaining decades, in the order of their relative significance, to obtain a complete null on the PAV. It will be necessary to down-scale the PAV while these adjustments are being made in order to obtain maximum sensitivity.

b. In step a, above, it was indicated that the phase shift of the PAV was set at 0° so as to produce an in-phase measurment consistant with MIL-S-20708A procedures.

3.4.2 Adjusting a Transmitter, or System, to a Pre-determined Angle

a. Using the five decade angle selectors, adjust the Model 540/10 to the desired angle. Then adjust the transmitter to obtain an approximate null on the PAV.

b. At this point, increasing the transmitter angle should result in a more positive deflection of the null meter assuming the system or components are hooked up in accordance with the convention of Section 4. If a more negative deflection results, the transmitter angle is in error by 180°. In that case, increase the transmitter angle by 180° and again perform the above check.

c. Set the PAV to a more sensitive scale and adjust the transmitter for a perfect null. Should system requirements reverse directions of rotation, the above rules should be modified.

3.4.3 Using the PAV for Reading Angular Error

This method is frequently used in testing synchro or resolver components where inputs are in the form of discreet shaft angle increments.

a. Mount a component in a device such as a dividing head.

b. Set the Model 540/10 and the dividing head to 0°, and adjust the component for 0° angle in the manner described in the previous paragraphs or by the electrical zero method of the applicable military specification.

c. Advance both the Model 540/10 and the dividing head in the desired increments. The amplitude of the null voltage, as read on the PAV, is related to the error angle and the line-to-line voltage for small deviation at all angle settings and either mode in accordance with the following formulas:

$$\mu v/s = 0.55 \times (L-L)$$
$$\mu v/0.001° = 2.0 \times (L-L)$$

Where (L-L) = Line to Line voltage for either sycnhro or resolver components

Since the above equations are nominal and in general lead to an odd number of seconds or minutes for full scale meter deflection, a voltmeter incorporating a range adjust vernier option should be used for maximum ease of operation.

3.4.4 Other Applications

See Section 7 for detailed information on testing synchro and resolver components.

SECTION 4

CONVENTIONS

4.1 GENERAL

Conventions for polarities, terminal designation, and direction of shaft rotation for synchros and resolvers are most frequently defined in accordance with military specifications MIL-S-20708A (synchros) and MIL-R-21530 (resolvers).

North Atlantic bridges and simulators all have terminal designations and electrical characteristics consistent with these same specifications. Thus, a bridge is used as though it were a receiving component such as a control transformer (CT or RC). Likewise, a simulator is comparable to a transmitting component (CX or RX).

In applying the conventions, caution must be exercized that:

- The manufacturer of the synchro or resolver followed the MIL SPEC conventions.
- System use of the component has not dictated a change in convention in order to achieve a difference in characteristic, such as direction reversal or mechanical shaft offset.

4.2 SYNCHRO TRANSMITTER CONVENTIONS

4.2.1 Synchro Transmitter (CX)

The equations describing an ideal Synchro Transmitter (CX) apply as well to the Model 530 Simulator. They are:

$$E_{(S1-S3)} = NE_{(R2-R1)} \text{ Sin } \theta$$

$$E_{(S3-S2)} = NE_{(R2-R1)} \text{ Sin } (\theta + 120°)$$

$$E_{(S2-S1)} = NE_{(R2-R1)} \text{ Sin } (\theta + 240°)$$

Where: $E_{(R2-R1)}$ is the voltage between rotor leads R1 and R2.

$E_{(S3-2)}$ is the voltage between stator leads S1 and S2. Other voltages are similarly defined.

N is the ratio of the maximum rms voltage between the secondary terminals (stator) and the primary rotor voltage.

θ is the shaft angle displacement from electrical zero which satisfies these equations.

The schematic representation for a Synchro Transmitter (CX) is shown in figure 4-1.

NOTE

Synchro is shown at $\theta = E_Z$ (electrical zero). This is defined as that angle for which coupled voltage between the rotor and $E_{(S1-S3)}$ is a minimum.

4.2.2 Synchro Simulator

The input and output terminals of the Model 530 in the synchro mode correspond to figure 4-1 and are indicated in figure 4-2.

4.3 SYNCHRO RECEIVER CONVENTIONS

4.3.1 Synchro Receiver (CT)

The equations describing an ideal synchro receiver or control transformer (CT) apply as well to all Series 540 Bridges. They are:

$$E_{(R2-R1)} = N[E_{(S3-2)} \text{Sin}\theta - E_{(S1-S3)} \text{Sin}(\theta+120)]$$

$$\theta = E_{(S1-S3)} + E_{(S3-S2)} + E_{(S2-S1)}$$

Where, symbols have meaning defined in paragraph 4.2.1.

The schematic representation for a synchro-receiver (CT) is shown in figure 4-3.

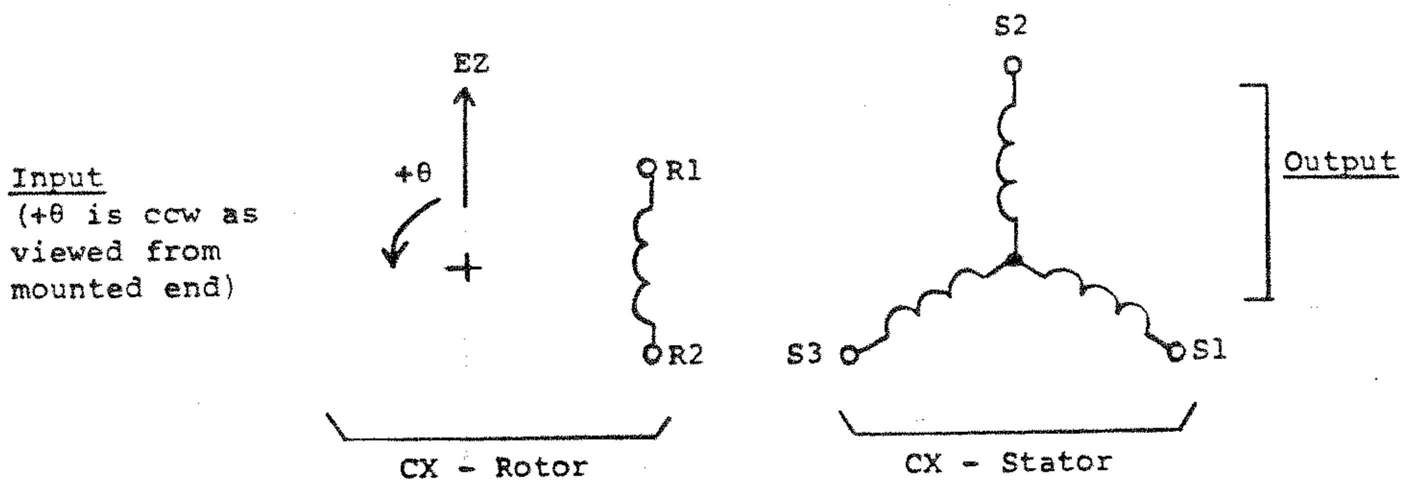

Figure 4-1. Synchro Transmitter (at EZ) - CX

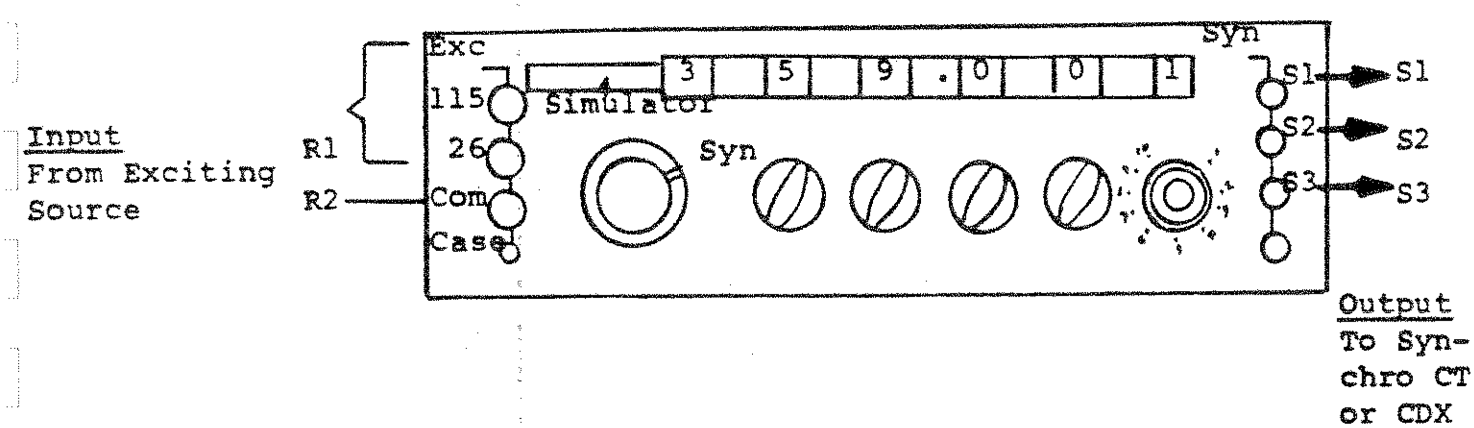

Figure 4-2. Model 530 Simulator - Synchro Mode

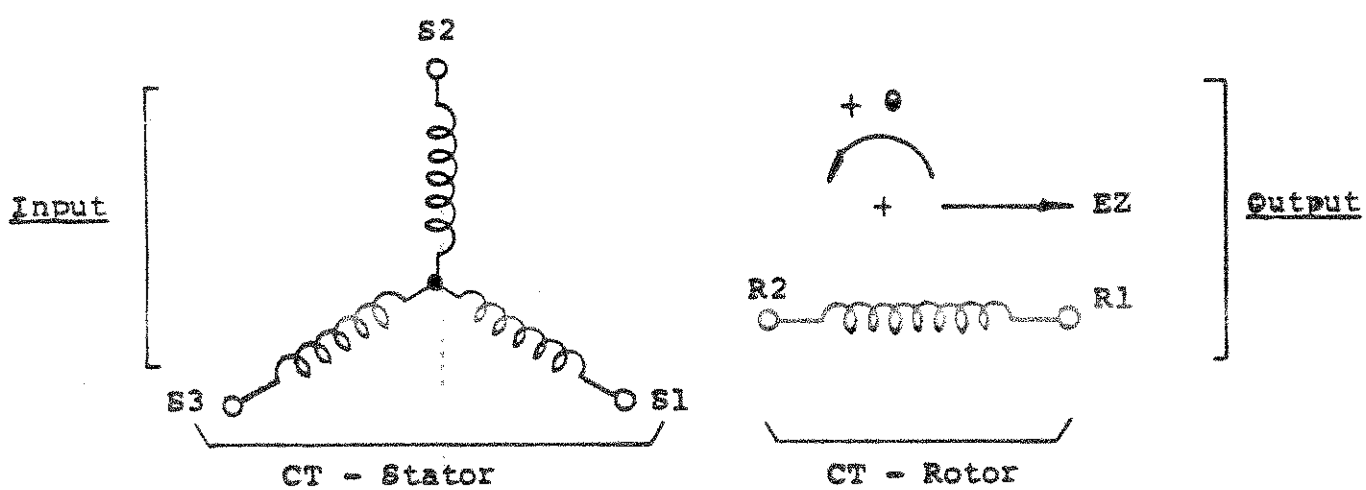

Figure 4-3. Synchro Receiver (at EZ) - CT

NOTE

Synchro is shown at $\theta = \theta_Z$ (electrical zero). This is defined as that angle for which the coupled voltage to the rotor is a minimum when the stators are excited between S2-S1, S3.

4.3.2 Synchro Bridge

The input and output terminals of the Model 540/10 in the synchro mode, are analogous to those of a synchro receiver (CT). The connections which correspond to figure 4-3 are shown in figure 4-4.

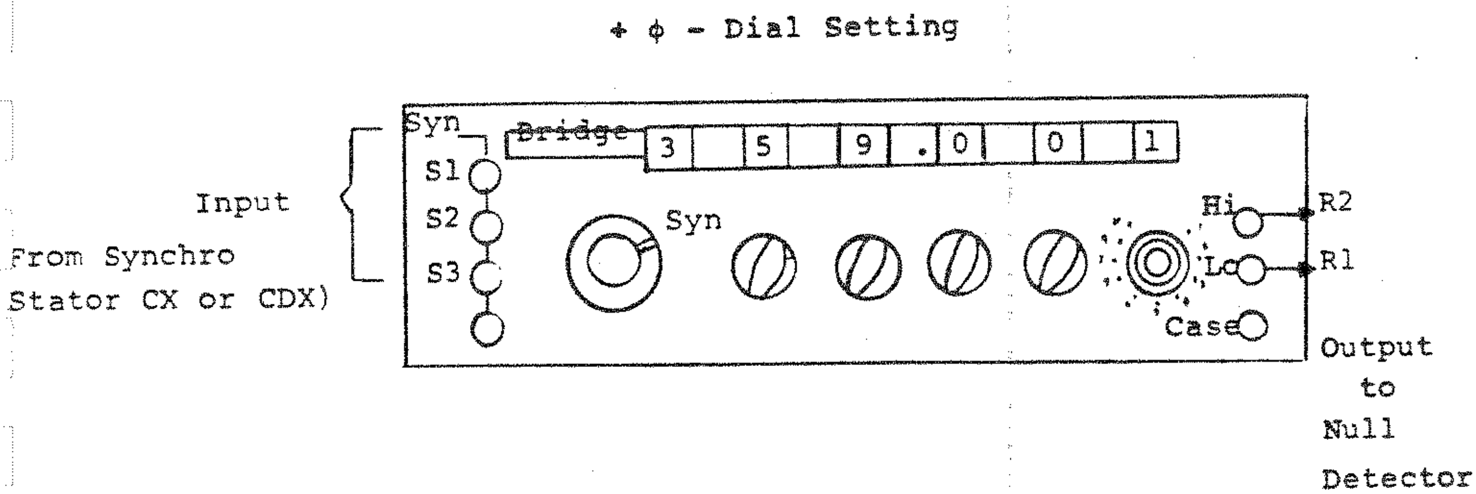

Figure 4-4. Model 540/10 Bridge - Synchro Mode

4.4 RESOLVER CONVENTIONS

4.4.1 Resolver Transmitter (RX), Control Transformer (RC), and Differential Resolver (RD)

The equation describing an ideal resolver apply as well to the Model 540/10 Bridge and Model 530 Simulator. They are:

For Rotor Energized Resolvers:

$$E_{(S1-S3)} = NE_{(R1-R3)} \cos\theta - NE_{(R2-R4)} \sin\theta$$

$$E_{(S2-S4)} = NE_{(R2-R4)} \cos\theta + NE_{(R1-R3)} \sin\theta$$

For Stator Energized Resolvers:

$$E_{(R1-R3)} = NE_{(S1-S3)} \cos\theta + NE_{(S2-S4)} \sin\theta$$

$$E_{(R2-R4)} = NE_{(S2-S4)} \cos\theta - NE_{(S1-S3)} \sin\theta$$

Where, symbols have meaning defined in paragraph 4.2.1.

The schematic representation for a Resolver Transmitter (RX), Resolver Control Transformer (RC), or a Differential Resolver (RD) with the rotor excited is shown in figure 4-5. Input and output can be reversed for stator excited schematic.

NOTE

Resolver is shown at θ = EZ (electrical zero). This is defined as a minimum coupling from (R1-R3) to (S2-S4) for rotor excited case. For stator excited resolver EZ is defined for minimum coupling from (S1-S3) to (R2-R4).

4.4.2 Resolver Simulator

The input and output terminals of the Model 530 simulator in the resolver mode is analogous to that of a rotor excited Resolver Transmitter (RX). The connections which correspond to those shown in figure 4-5 are illustrated in figure 4-6 for a Model 530 Simulator in the resolver mode.

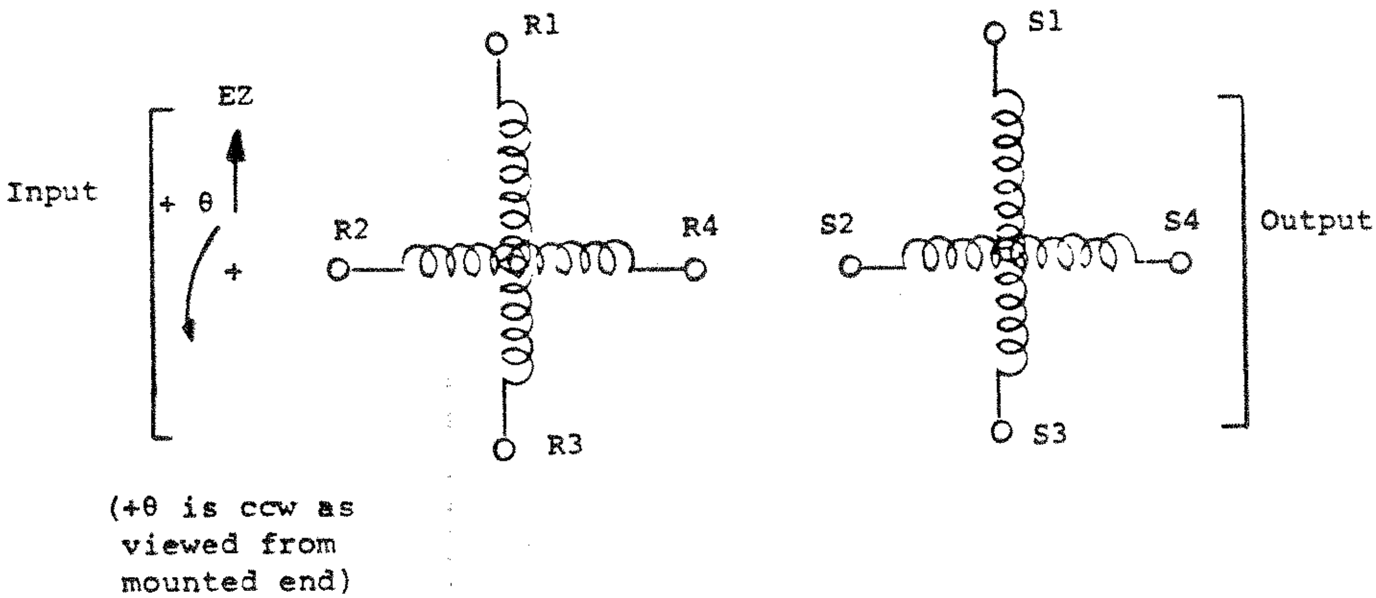

Figure 4-5. Rotor Excited Resolver at EZ, RX, RC, or RD

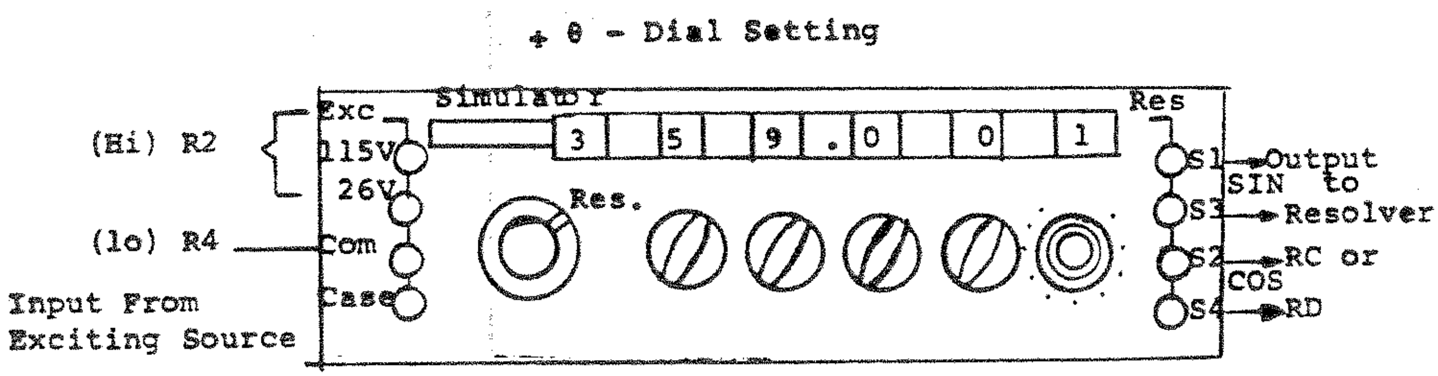

Figure 4-6. Model 530 Simulator - Resolver Mode

Alternate Resolver Simulator conventions (all assume CCW is positive rotation) are shown in figure 4-7.

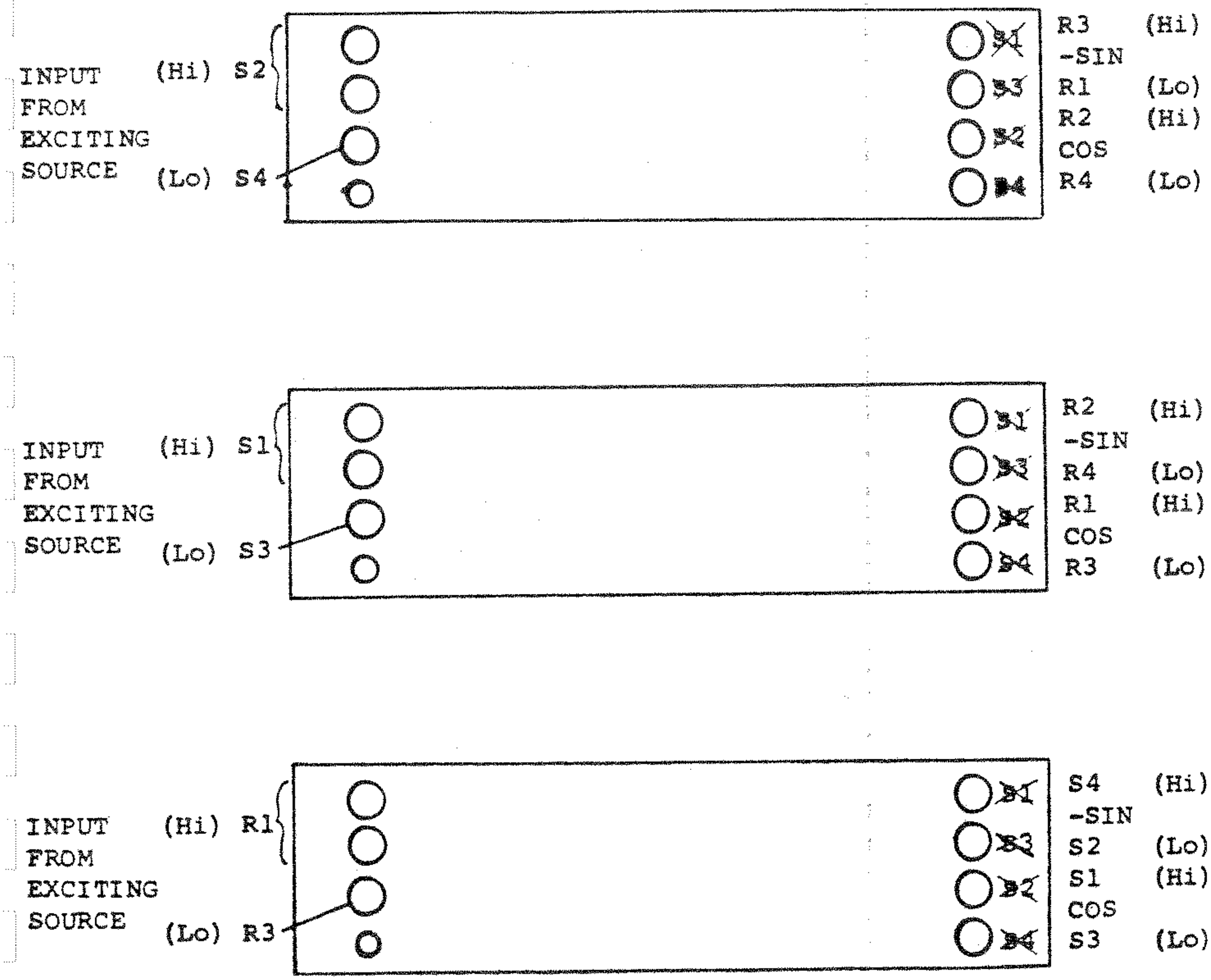

Figure 4-7. Model 530 Simulator - Resolver Mode (Alternate Convention)

4.5 RESOLVER BRIDGE

The input and output terminals of the Model 540/10 Bridge in the resolver mode are analogous to those of a stator excited resolver Control Transformer (RC). The connections which correspond to those shown in fiqure 4-5 are illustrated for a Model 540/10 Bridge in figure 4-8.

Alternate Resolver Bridge conventions (all assume CCW is positive rotation) is illustrated in figure 4-9.

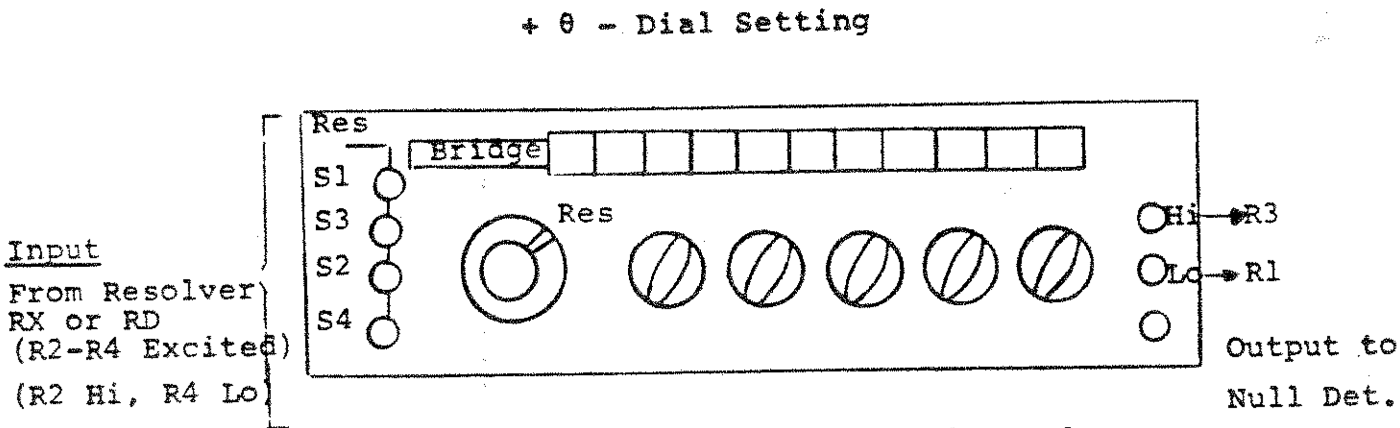

Figure 4-8. Model 540/10 Bridge, Resolver Mode

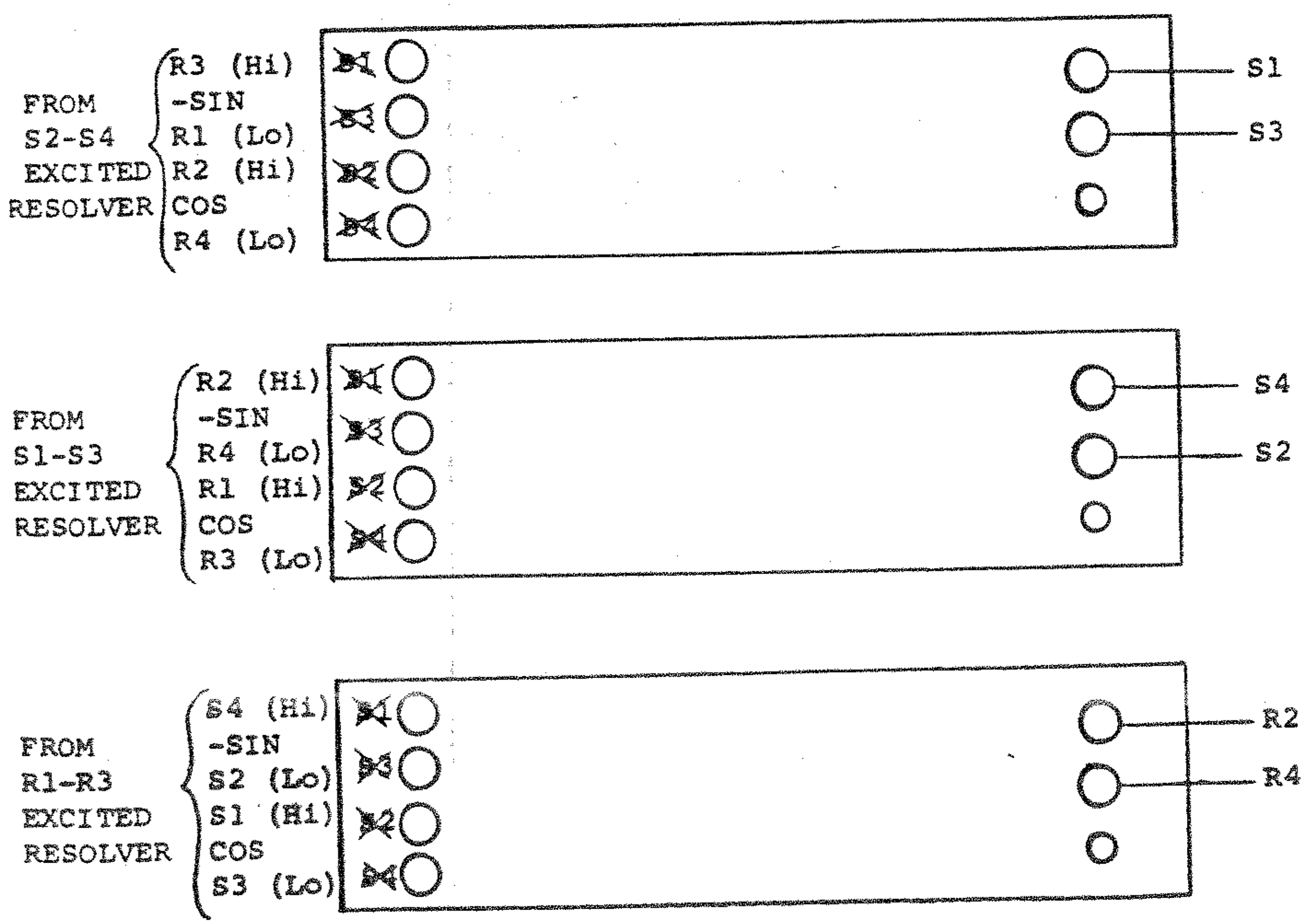

Figure 4-9. Model 540/10 Bridge - Resolver Mode (Alternate Convention)

SECTION 5

THEORY OF OPERATION

5.1 GENERAL

The Model 540/10 makes use of two basic transformer sections. The first section, Form Converter, is used to convert synchro data (3-wire) to resolver data (4-wire). It is also used to isolate the measuring circuit from the input lines. A second section, Bridge Circuit, is used to compute the input data angle.

Both sections consist of sets of precision toroidal transformers, arranged in a number of novel circuits (patents applied for) which facilitate the interpolation of angular data.

5.2 BLOCK DIAGRAM DESCRIPTION (Fig. 5-1)

Resolver or synchro information on 4- or 3-wire inputs, respectively, are isolated and presented to the switched bridge section by the Form Converter. A manual mode selector switch is used to arrange the precision transformer elements for either resolver or synchro data.

The measuring section of the Model 540/10 consists of two sets of trigonometric transformer dividers. Each divider set produces a ratio equivalent to the sine or cosine of the angle set into the Model 540/10 by the front panel knobs.

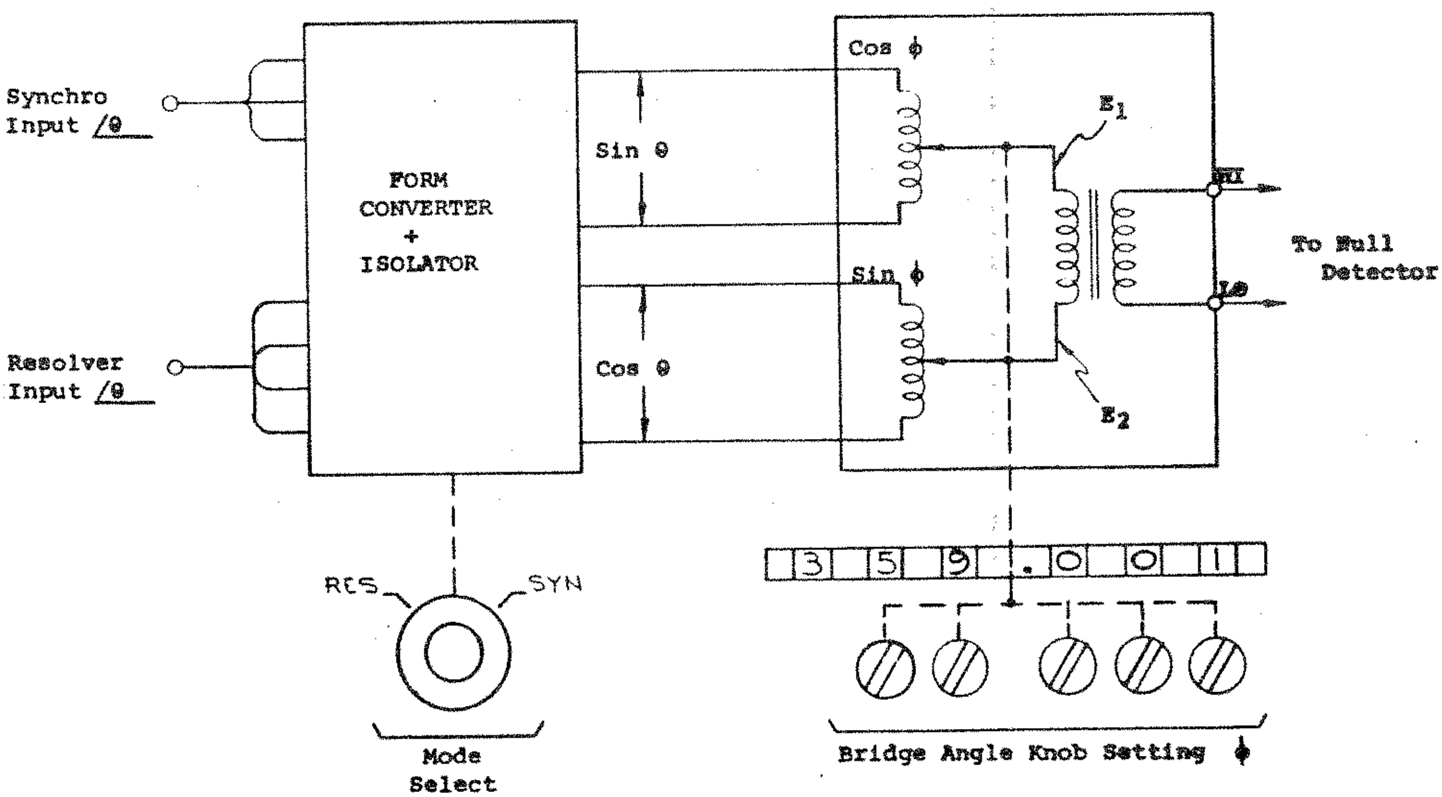

Figure 5-1. Model 540/10 Block Diagram

By exciting these two dividers with the complementing function of the input sine and cosine data coming from the Form Converter, two AC voltages are generated as follows:

$$E_1 = K_1 \sin\theta \cos\phi$$

$$E_2 = K_2 \cos\theta \sin\phi$$

Where K_1 and K_2 = Overall transfer function of sine and cosine transformer channels.

θ = Input data angle of resolver or synchro

ϕ = Set in angle of Bridge

For condition of Null

$$E_1 = E_2$$

Recognizing that $K_1 = K_2$ to an accuracy of 1 or 2 ppm, then,

$$\sin\theta \cos\phi = \cos\theta \sin\phi$$

This identity can only exist for the following two conditions:

$\phi = \theta$ (true null solution)

$\phi = \theta + \pi$ (false null solution)

By following the operating procedure for elimination of the false null indicated by the second solution, the correct solution is readily obtained.

It is important to realize that the angle measured on the Model 540/10 when properly nulled, is equivalent to the angle defined by the ratio of sin θ and cosine θ data inputs. Thus, the angle ϕ is a measure of the true composite angle which takes into account all imperfections in the input data. This applies equally to synchro or resolver data inputs.

When operating the Model 540/10 away from null, the output null voltage is very nearly linear with the amount of unbalance of the Model 540/10 for small angles in accordance with the following expression:

$$E_{out} = k \sin(\theta - \phi)$$

$$\cong k(\theta - \phi)$$

Where k is proportionality constant given in Section 3.

This useful characteristic is referred to as a constant null voltage gradient. It applies to any Model 540/10 angle which is close to null, for either the Resolver or Synchro mode of operation.

5.3 SWITCHING

The Model 540/10 contains inductive transformer sets which perform a basic 10° interpolation followed by succeeding decades of interpolation for 1°, 0.1°, and 0.01°.

The first or 10° switch is a unique design, original in North Atlantic equipment, which links the 10° knob to both a 350° total display range and a 90° quadrant switch (not displayed). By using this technique, an in-line non-ambiguous display of 0° to 350° in 10° increments with a direct return to zero is possible with no direction reversal and no need to mentally add dial readings.

All switches are designed with heavy duty silver alloy buttons for long life and have transient suppression resistors mounted directly on the switch decks.

SECTION 6

MAINTENANCE

6.1 GENERAL

This section contains periodic maintenance and calibration procedures for the Model 540/10. The unit contains highly accurate inductive circuits. Under normal operating conditions, the accuracy of these devices should remain within specified tolerances indefinitely. It should be noted, however, that application of dc voltages to the circuits could result in degradation of the operating characteristics.

6.2 DEGAUSSING

If dc has been applied to any of the terminals in the Model 540/10, the instrument may be degaussed by connecting the circuit shown in figure 6-1 to all input terminal pairs in sequence. For dual-mode degaussing, the three synchro inputs will cover both modes.

With all knobs set to zero, apply the 60 Hz voltage to the instrument by slowly raising from zero until the point at which saturation occurs.

This will be evidenced when further increasing the setting of the Variac results in a relatively small increase in the voltage applied across the instrument. Allow the instrument to remain under the saturated conditions for a short period (typically 5 to 10 minutes). Then, slowly, over about the same period, reduce the voltage to the instrument to zero. Any residual magnetism which has been stored in the core by the dc should now be removed and the instrument should function properly. If the instrument still does not function with the specified tolerance, it should be returned to the factory.

6.3 SWITCHES

All switches used for switching critical inductive circuits are designed for long life using heavy duty alloy button contacts.

For normal maintenance, switch contacts should be cleaned with a good grade solvent, such as alcohol, and relubricated with a very thin film of clean switch lubricant, such as petroleum jelly, every 4 to 6 months of use.

If an instrument has not been used for an extended period of time, it may be desirable to cycle switches several times so as to wipe contacts clean prior to making measurements. This routine can be considered normal for an instrument of this type.

Should a precision switch need to be replaced, remove all wire connections by

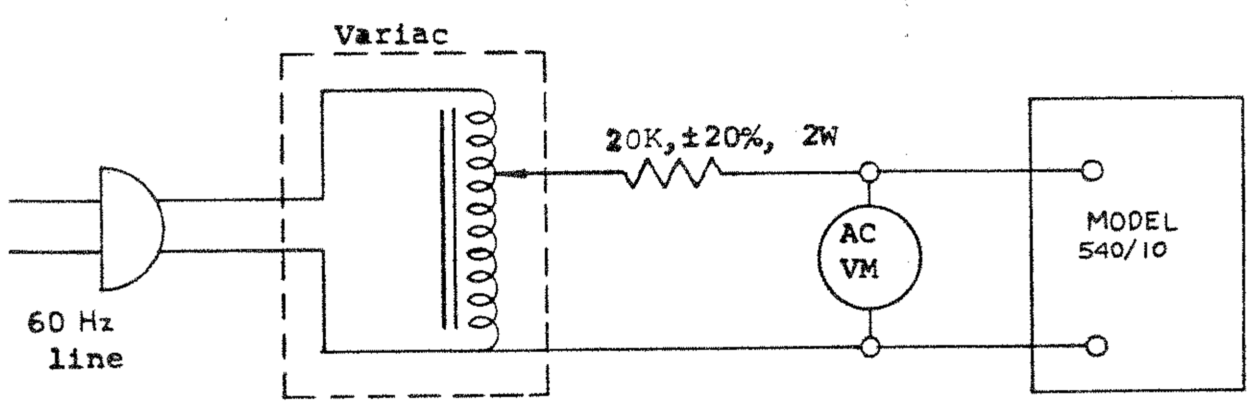

Figure 6-1. Degaussing Circuit

carefully sliding female Malco type wire connectors away from switch deck. This is readily accomplished by using a pair of long-nose pliers.

CAUTION

> Do not unnecessarily remove Malco terminals since excessive disassembly may impair self-clinching characteristic of the connector.

6.4 TRANSFORMERS

If a malfunction occurs which indicates that a transformer component is faulty, return the unit to the factory for overhaul and recalibration.

6.5 CALIBRATION

6.5.1 GENERAL

Routine recalibration of the Model 540/10 is normally not required except insofar as the customer quality assurance methods require these checks so as to be certain that no random failures have caused the instrument to malfunction.

The philosophy governing the calibration of a resolver/synchro simulator or bridge and the establishing of meaningful standards involves considerations similar to those encountered in the area of ac ratio boxes.

In both cases, calibration data is a matter of ratio accuracy. For the ratio box, it is the ratio of the output to the input. For the resolver bridge or simulator, it is the ratio of two ac voltages, while for a synchro bridge or simulator, it is the ratio of any two of the three line-to-line voltages.

Thus, ratio is the all important measurement, and herein lies the need for an appreciation of the difference between ratio certainty and a standard as defined by the Bureau of Standards. Ac ratio is not uniquely related to, or logically measurable in terms of, the usual physical concepts of mass, length, or time since it is a dimensionless quotient. As such, it is not traceable to any absolute electrical standard such as the ohm, volt, or ampere. Ac ratio, by its nature, can be known to an almost unlimited degree of precision depending upon the ingenuity of the person making the measurement and the stability of the equipment used. Typically, in the area of ac ratio measurements, measurements have been made at the National Bureau of Standards, as well as in industry, to precision in order of 0.01 ppm and better. Yet, at this time, no known set of circuit elements could be assembled into a single instrument which would provide a certainty of measurement of this order of magnitude for a reasonable range of voltages, temperature, frequency, ratio, or time. This, in effect, represents the present state of the art in ac ratio measurements.

Since the technique of ac ratio measurement is considerably better than any commercially available ratio reference, it must be readily apparent that an inductive ratio box, rated at 1.0 ppm accuracy, can be evaluated or calibrated so as to provide confidence in this rating over a reasonable period of time and under the rated conditions of voltage, frequency, temperature, and ratio range. The National Bureau of Standards provides such a calibration service and evidences their calibration in the form of a record of calibration as of the time the ratios were measured. It remains for the user and manufacturer to determine the period over which confidence in this rating can be maintained.

It is the experience of North Atlantic, over a period of many years, that a properly maintained inductive ratio device such as a ratio box, bridge, or simulator, will sustain its ratio accuracy to a confidence level of well under 1.0 ppm for a period of many years.

6.5.2 Simulator and Bridge Calibration

In the following procedure, a technique for calibrating both resolver/synchro simulators and bridges is presented which follows the philosophy just described. Through use of a ratio box, it is merely a matter of technique by which both bridges and simulators can be calibrated to a level of confidence comparable to the ratio reference itself. Noting that an uncertainty in ratio, equivalent to ±0.0 ppm (against unity ratio) is, in the worst case, equivalent to an angular uncertainty of only ±0.2 arc second, it is apparent that a high degree of confidence can be expected in the ultimate calibration data for resolver and synchro bridges and simulators.

6.5.3 Calibration Period and Method

The frequency of calibration required for resolver/synchro bridges and simulators is necessarily dictated by the application and the established policies of the user. Since the construction of all North Atlantic bridges and simulators uses heavy-duty switches and quality toroidal transformers, it is recommended that full calibration (para. 6.5.5) will only infrequently be required. However, where quality control procedures require routine checks to make certain that no random equipment failures have occurred, the simpler calibration procedure (para. 6.5.4) may be used.

6.5.4 Calibration Procedure I

6.5.4.1 General

This procedure can be used to calibrate the Model 540/10, on a go-no-go basis. The validity for this type of comparison can be taken as the sum of the rated bridge error and the rated simulator error, or ±4 arc seconds. The procedure is recommended as a routine quality control calibration to verify proper operation of the equipment.

6.5.4.2 Test Equipment Required

Equipment required for calibration is listed below:

Qty	Equipment
1	North Atlantic Resolver/Synchro Simulator, Model 530
1	North Atlantic Phase Angle Voltmeter, Model 213C, Model 321, or Model 225
1	Adjustable source of 400 Hz ac voltage

6.5.4.3 Procedure

a. Connect equipment as shown in figure 6-2.

b. Adjust all knobs to read zero on both the bridge and simulator.

c. Adjust power supply to 26 V or 115 V, 400 Hz depending upon simulator input terminal used.

d. Adjust the PAV to read an in-phase null (Section 3).

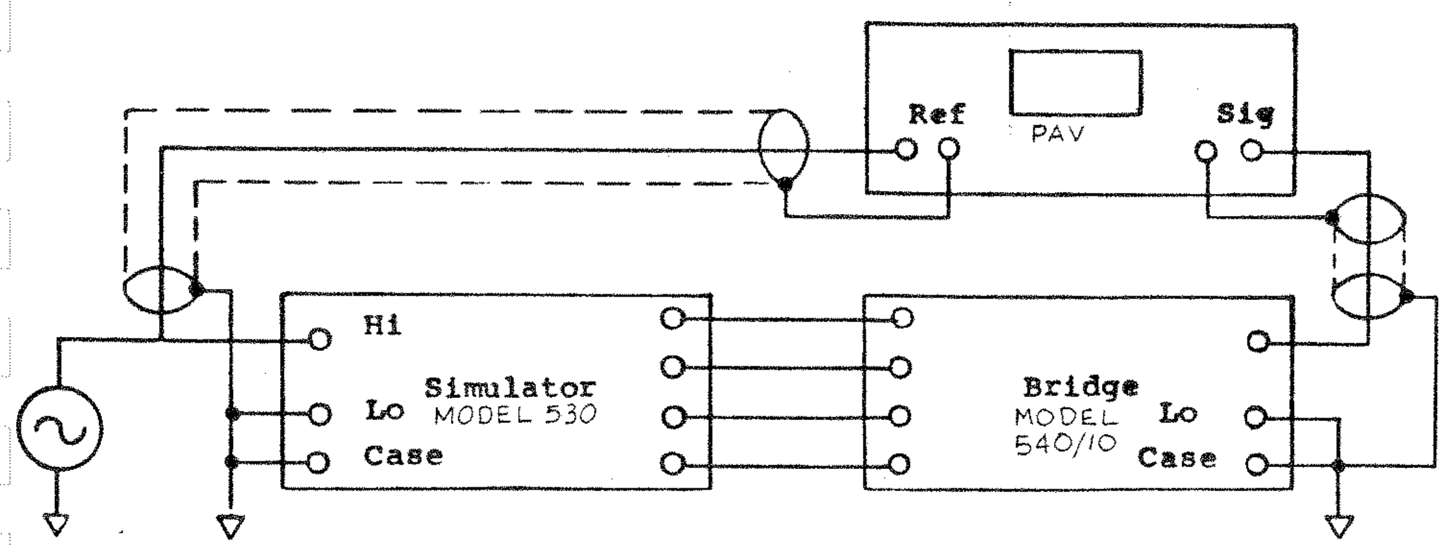

Figure 6-2. Hookup for Calibration Procedure I

e. Offset either the simulator or bridge by 0.02° or 72 seconds. Select convenient meter range where range vernier permits adjustment of reading to 72 on X10 scale. Meter is now appropriately scaled to measure the deviation between the bridge and simulator directly in seconds by ranging to any convenient scale.

f. Track both simulator and bridge through desired calibration angles, noting that all readings fall within ±4 arc seconds.

g. If in step f above, readings fall outside the ±4 second spread, recheck operation of the PAV and test circuit to be certain the hookup is correct and that no ground loops, ungrounded terminals, etc., exist. If the out-of-tolerance reading is reaffirmed, proceed to paragraph 6.5.5.

6.5.5 Calibration Procedure II

6.5.5.1 General

This calibration procedure is designed to provide what might be thought of as an ideal calibration. Means are taken to eliminate any errors due to loading of the source impedances by the bridge.

A word of caution should be made regarding the use of alternate methods of calibration such as those using a resistance bridge or methods utilizing single ratio box techniques. Although good results may be obtainable, insidious errors due to impedance loading, phase shift, etc., are easily overlooked. The procedures described are recommended principally because the simplicity of the setup does not need a particularly high degree of ingenuity or experience to achieve the accuracy sought.

6.5.5.2 Resolver Bridge Calibration

The following procedure can be used to calibrate the Model 540/10.

6.5.5.2.1 Equipment Required

Equipment required to calibrate the Model 540/10 is listed below:

Qty	Equipment
2	10 ppm Ratio Box
1	1.0 ppm Ratio Box
1	Shielded Bridge - Null Transformer
2	Phase Angle Voltmeter, North Atlantic Model 213C, 321, or 225
2	DPDT switch
1	Adjustable source of 400 Hz, ac voltage

6.5.5.2.2 Procedure

a. Connect equipment as shown in figure 6-3.

NOTE

In this arrangement, ratio boxes RB-1 and RB-2 serve to generate resolver voltages suitable for driving the inputs of the bridge being calibrated.

Since these boxes have finite output impedance which vary with ratio settings, some loading errors can be expected due to the input impedance of the bridge being tested.

To correct for this loading error, the 1.0 ppm ratio box, designated RS-S, is used as a precision ratio transfer device. Ratios can be set up on RB1 and RB2 while under load. The bridge null transformer and PAV 1, are used to make the comparison between the ratio reference, RB-S, and the driving ratio boxes, RB1 and RB2.

b. Adjust Variac T1, or variable source for desired line-to-line voltage (90, 11.8, etc.) to accuracy of ±5%.

c. Adjust phase angle voltmeter No. 1 for an in-phase null (0°).

d. With resolver bridge under test set at the angle being calibrated, set RB-S to desired sine (RB-2) ratio, using values from tables 6-1 through 6-6.

e. Connect null transformer lead A to the

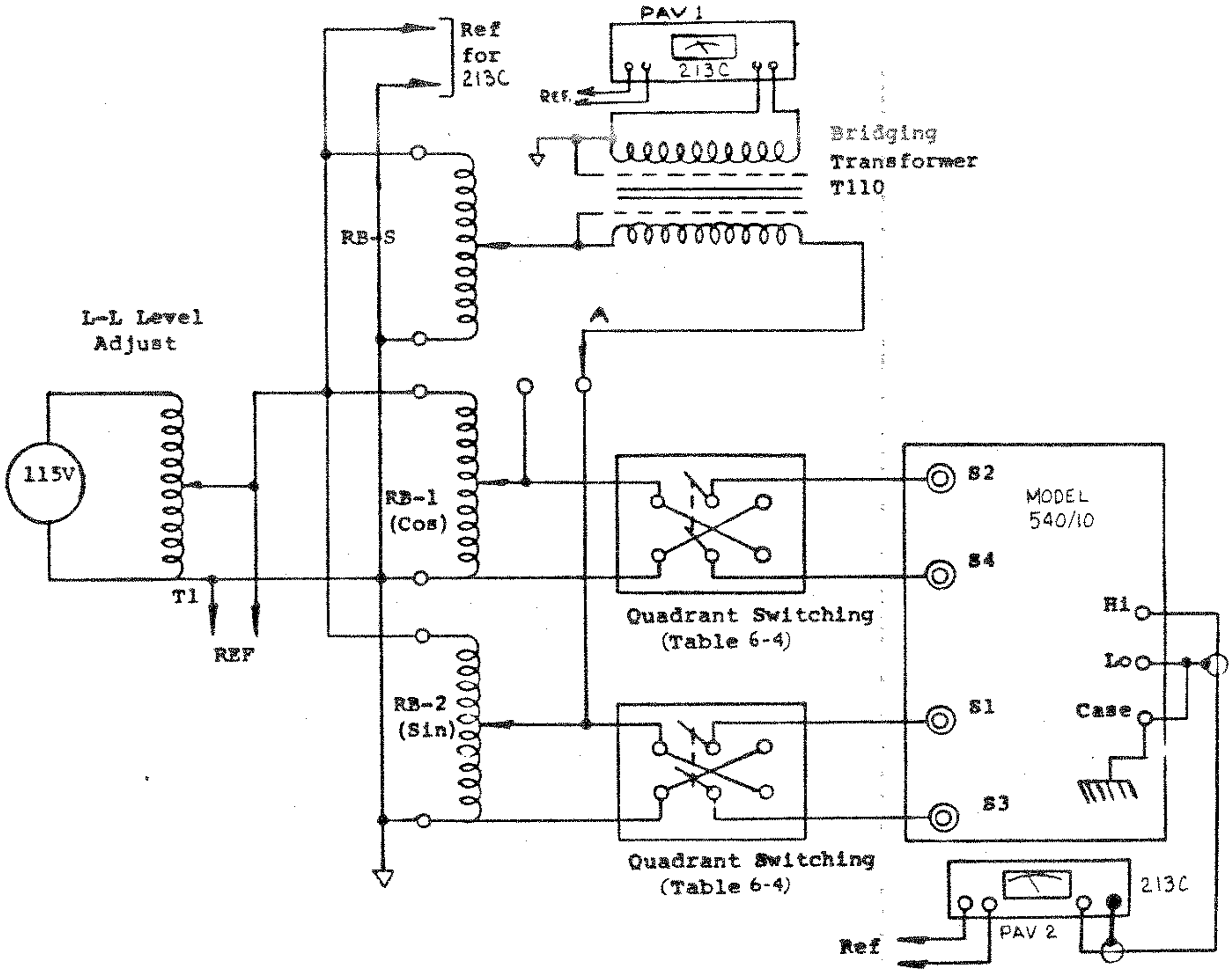

Figure 6-3. Hookup for Calibration Procedure II

output of ratio box RB-2 and adjust for null on phase angle voltmeter No. 1. Set to resolution of at least 1/3 ppm.

f. Repeat steps d and e for setting ratio box RB-1.

g. Input to bridges is now accurate to within ±0.2 s. Now adjust bridge to achieve in-phase null on phase angle voltmeter No. 2. Read and record calibration angle from bridge.

h. Repeat steps d through g for each angle to be calibrated. Note that tables 6-1 through 6-6 are given for the most commonly tested angles.

Table 6-1. Resolver Calibration - 0° to 360° (5° Increments)

Quad. I	Quad. II	Quad. III	Quad. IV	RB 1	RB 2
0°	180°	180°	360°	1.0000000	.0000000
5°	175°	185°	355°	.9961946	.0871557
10°	170°	190°	350°	.9848077	.1736480
15°	165°	195°	345°	.9659258	.2588190
20°	160°	200°	340°	.9396926	.3420201
25°	155°	205°	335°	.9063077	.4226182
30°	150°	210°	330°	.8660254	.5000000
35°	145°	215°	325°	.8191520	.5735764
40°	140°	220°	320°	.7660444	.6427876
45°	135°	225°	315°	.7071067	.7071067
50°	130°	230°	310°	.6427876	.7660444
55°	125°	235°	305°	.5735764	.8191520
60°	120°	240°	300°	.5000000	.8660254
65°	115°	245°	295°	.4226182	.9063077
70°	110°	250°	290°	.3420201	.9396926
75°	105°	255°	285°	.2588190	.9659258
80°	100°	260°	280°	.1736480	.9848077
85°	95°	265°	275°	.0871557	.9961946
90°	90°	270°	270°	.0000000	1.0000000

Table 6-2. Resolver Calibration
40° to 49°
(1° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40°	.7660444	.6427876
41°	.7547096	.6560590
42°	.7431448	.6691306
43°	.7313537	.6819984
44°	.7193398	.6946584
45°	.7071068	.7071068
46°	.6946584	.7193398
47°	.6819984	.7313537
48°	.6691306	.7431448
49°	.6560590	.7547096

Table 6-3. Resolver Calibration
40.1° to 40.9°
(0.1° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.1°	.7649214	.6441236
40.2°	.7637960	.6454577
40.3°	.7626683	.6467898
40.4°	.7615383	.6481199
40.5°	.7604060	.6494480
40.6°	.7592713	.6507742
40.7°	.7581343	.6520984
40.8°	.7569951	.6534206
40.9°	.7558535	.6547408

Table 6-4. Resolver Calibration
40.01° to 40.09°
(0.01° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.01°	.7659322	.6429213
40.02°	.7658200	.6430550
40.03°	.7657078	.6431886
40.04°	.7655955	.6433223
40.05°	.7654832	.6434559
40.06°	.7653709	.6435895
40.07°	.7652586	.6437230
40.08°	.7651461	.6438566
40.09°	.7650338	.6439901

Table 6-5. Resolver Calibration
40.001° to 40.009°
(0.001° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.001°	.7660332	.6428010
40.002°	.7660220	.6428143
40.003°	.7660107	.6428277
40.004°	.7659995	.6428411
40.005°	.7659883	.6428545
40.006°	.7659771	.6428678
40.007°	.7659659	.6428812
40.008°	.7659546	.6428946
40.009°	.7659434	.6429073

Table 6-6. Resolver Calibration - Quadrant Switching

Quadrant	Angle	Hi	Lo	Hi	Lo
I	0-90°	S2	S4	S3	S1
II	90-180°	S4	S2	S3	S1
III	180-270°	S4	S2	S1	S3
IV	270-360°	S2	S4	S1	S2

.5.5.3 Synchro Bridge Calibration

.5.5.3.1 Equipment Required

The same test equipment is required as in paragraph 6.5.5.2.1 except that three SPDT switches are needed.

6.5.5.3.2 Procedure

Connect equipment as shown in figure 6-4.

NOTE

In this arrangement ratio boxes RB-1 and RB-2 serve to generate synchro input voltages suitable for driving the inputs of the bridge being calibrated. Since these boxes have finite output impedances which vary with ratio settings, some loading errors can be expected due to the input impedance of the bridge being tested.

To correct for this loading error, the 1.0 ppm ratio box designated RB-S is used as a precision ratio transfer device by which the proper voltage ratios can be set up on RB-1 and RB-2 while under load. The bridge null transformer and phase angle voltmeter No. 1, are used to make the comparison between the ratio reference RB-S and driving ratio boxes RB-1 and RB-2.

a. Adjust Variac T1, or variable source, for desired line-to-line voltage (90, 11.8, etc.) to accuracy of ±5%.

b. Adjust phase angle voltmeter No. 1 for an in-phase null (0°).

c. With synchro bridge under test set at the angle being calibrated, set RB-S to desired setting of RB-2 obtained from tables 6-7 through 6-12.

d. Connect null transformer lead A to the output of RB-2 and adjust for a null on phase angle voltmeter No. 1 set to a resolution of at least 1/3 ppm.

e. Repeat steps c and d for setting on RB-1.

f. Input to bridge is now accurate to within ±0.2 seconds. Now adjust bridge to achieve in-phase null on phase angle voltmeter No. 2. Read and record calibration angle from bridge.

g. Repeat steps through f for each angle to be calibrated. Note that tables 6-7 through 6-12 are given for the most commonly tested angles.

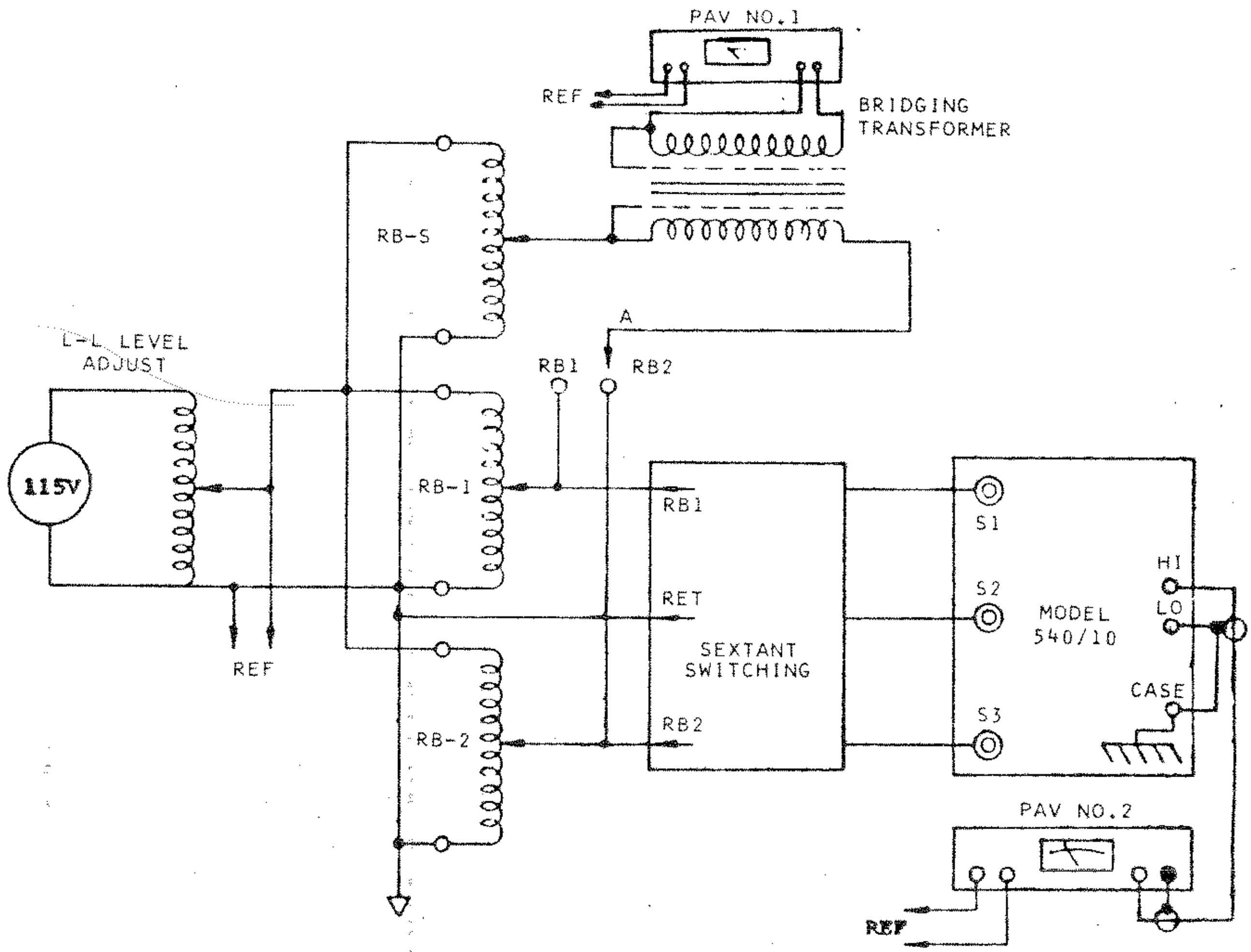

Figure 6-4. Synchro Bridge Calibration Hookup

Table 6-7. Synchro Calibration - 0° to 360° (5° Increments)

I	II	III	IV	V	VI	RB1	RB2
0°	120°	120°	240°	240°	360°	.8660254	.000000
5°	115°	125°	235°	245°	355°	.9063077	.0871557
10°	110°	130°	230°	250°	350°	.9396926	.1736480
15°	105°	135°	225°	255°	345°	.9659258	.2588190
20°	100°	140°	220°	260°	340°	.9848077	.3420201
25°	95°	145°	215°	265°	335°	.9961946	.4226182
30°	90°	150°	210°	270°	330°	1.0000000	.5000000
35°	85°	155°	205°	275°	325°	.9961946	.5735764
40°	80°	160°	200°	280°	320°	.9848077	.6427876
45°	75°	165°	195°	285°	315°	.9659258	.7071067
50°	70°	170°	190°	290°	310°	.9396926	.766044
55°	65°	175°	185°	295°	305°	.9063077	.8191520
60°	60°	180°	180°	300°	300°	.8660254	.8660254

Table 6-8. Synchro Calibration—
40° to 49°
(1° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40°	.9848077	.6427876
41°	.9816272	.6560590
42°	.9781476	.6691306
43°	.9743701	.6819984
44°	.9702957	.6946584
45°	.9659258	.7071067
46°	.9612617	.7193398
47°	.9563048	.7313537
48°	.9510565	.7431448
49°	.9455186	.7547096

Table 6-9. Synchro Calibration—
40.1° to 40.9°
(0.1° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.1°	.9845032	.6441236
40.2°	.9841956	.6454577
40.3°	.9838850	.6467898
40.4°	.9835715	.6481199
40.5°	.9832549	.6494480
40.6	.9829353	.6507742
40.7°	.9826128	.6520984
40.8°	.9822873	.6534206
40.9°	.9819587	.6547408

Table 6-10. Synchro Calibration—
40.01° to 40.09°
(0.01° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.01°	.9847774	.6429213
40.02°	.9847471	.6430550
40.03°	.9847167	.6431886
40.04°	.9846863	.6433223
40.05°	.9846558	.6434559
40.06°	.9846254	.6435895
40.07°	.9845949	.6437230
40.08°	.9845643	.6438566
40.09°	.9845338	.6439901

Table 6-11. Synchro Calibration—
40.001° to 40.009°
(0.001° Increments)

Angle	RB1 (Cos)	RB2 (Sin)
40.001°	.9848047	.6428010
40.002°	.9848016	.6428143
40.003°	.9847986	.6428277
40.004°	.9847956	.6428411
40.005°	.9847926	.6428545
40.006°	.9847895	.6428678
40.007°	.9847865	.6428812
40.008°	.9847835	.6428946
40.009°	.9847804	.6429073

Table 6-12. Synchro Calibration
Sextant Switching

Sextant	Angle	RB1 Hi	Ret	RB2 Lo
I	0-60°	S2	S1	S3
II	60-120°	S3	S1	S2
III	120-180°	S3	S2	S1
IV	180-240°	S1	S2	S3
V	240-300°	S1	S3	S2
VI	300-360°	S2	S3	S1

SECTION 7

ROTARY COMPONENT MEASUREMENT

7.1 GENERAL

This section provides a detailed step-by-step procedure for precise test of the most commonly encountered types of synchros and resolvers using North Atlantic Model 530 Resolver/Synchro Simulator and Model 540/10 Resolver/Synchro Bridge.

7.2 SYNCHRO TRANSMITTER (CX) TEST

7.2.1 Phasing, Electrical Zero, and Angular Accuracy

a. Connect equipment as shown in figure 7-1. Rotate CX shaft counterclockwise as viewed from shaft end until phase angle voltmeter (PAV) reads zero. Note that the meter approaches 0 from left to right. For 115 V excitation, use 100 V range of the PAV.

b. With synchro shaft at the null point, switch Model 540/10 to 5°. The PAV should deflect to the left. Set Model 540/10 back to 0.

c. If the requirements of steps a and b are met, the phase is correct, and the null point is electrical zero.

d. Mount CX in a dividing head.

e. With the dividing head at 0°, CX must be at electrical zero, as described in steps a and b.

f. Set PAV Function selector to 90°.

g. Set Model 540/10 to 90°.

h. Rotate Phase dial on the PAV until a quadrature null is reached.

i. The angle read on the Phase Angle dial is approximately equal to the phase shift of the CX.

j. With the Phase dial at this setting, return Model 540/10 and the Function selector to 0°.

k. Re-zero CX in dividing head if necessary.

l. With CX at 0°, offset the dividing head an amount equal to the maximum allowable error of the CX.

m. Down scale the Range selector until the first off-scale meter reading is reached. Turn the Range selector to the next up-scale range. Record the deflection on the PAV. This is the maximum allowable error voltage.

n. Return the dividing head to 0°.

o. Advance the Model 540/10 and the dividing head in the required increments. The null error, as noted on the PAV, should be less than that obtained in step m.

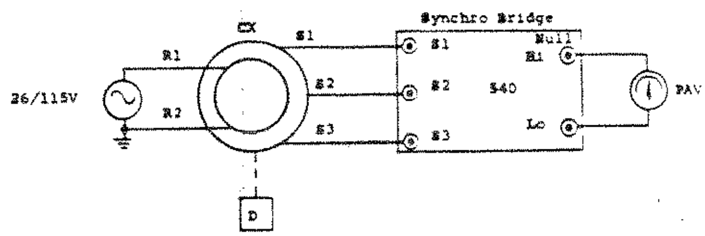

Figure 7-1. Angular Accuracy (CX)

7.2.2 Null Test, Total and Fundamental

a. With the CX still mounted in the dividing head, set up equipment shown in figure 7-2.

b. Rotate dividing head to 120°.

c. Set the PAV Function selector to 0°, and adjust the dividing head for a null.

d. Read the nulls in both Total and Fundamental modes.

e. Attach PAV leads to S2 and S3 of the CX, and rotate the dividing head to 240°.

f. Repeat steps c and d.

g. Attach PAV leads to S1 and S3 of the CX, and rotate the dividing head to 0°.

h. Repeat steps c and d.

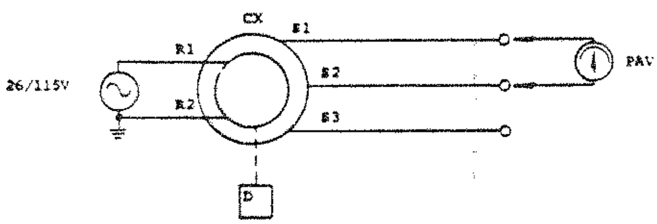

Figure 7-2. Null Test (CX)

7.2.3 Transformation Ratio Test

a. Turn Phase Angle dial to 0°.

b. With the CX still mounted in a dividing head, set up equipment as shown in figure 7-3.

c. Set Function selector to 0°.

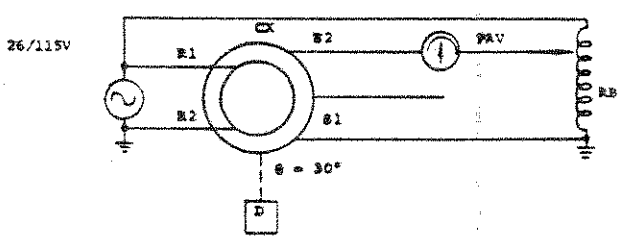

Figure 7-3. Transformation Ratio Test (CX)

d. Set the dividing head to 30°, and adjust ratio box for a null. Record ratio reading (transformation ratio).

7.2.4 Phase Shift Test

a. With the CX still mounted in the dividing head, set up equipment as shown in figure 7-4.

b. Set PAV Function selector to 90° position.

c. With dividing head at 30°, adjust the Phase Angle dial on the PAV for a quadrature null.

d. The phase shift of the CX may be read directly from the Phase Angle dial.

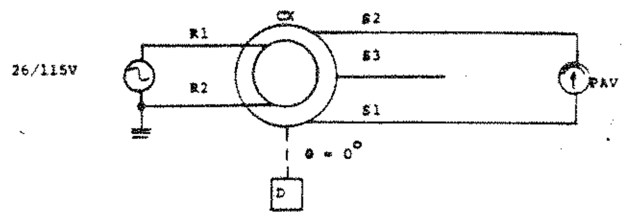

Figure 7-4. Phase Shift Test (CX)

7.2.5 Input Current Test

a. Set up equipment as shown in figure 7-5

b. Turn PAV Function selector to the Total position.

c. The input current of the CX is read directly in amperes on the PAV, i.e., 0.1 volt = 0.1 amperes.

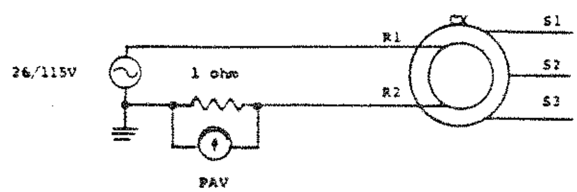

Figure 7-5. Input Current Test (CX)

7.3 SYNCHRO DIFFERENTIAL TRANSMITTE (CDX) TEST

7.3.1 Phasing, Electrical Zero, and Angular Accuracy Test

a. Set up equipment as shown in figure 7-6

b. Set Models 530 and 540/10 to 0°.

c. Rotate CDX shaft counterclockwise, as viewed from the shaft end, until the meter reads zero. Note that the needle approaches zero from left to right.

For 115 V excitation, use 30 V range of the PAV.

d. With synchro shaft at null, set the Model 540/10 to 5°. The PAV should deflect to the left. Return to 0°.

e. Set Model 530 to 5°. The PAV should deflect to the left. Return the Model 530 to 0°.

f. If the requirements of steps c, d, and e are met, the phasing is correct, and the null point is electrical zero.

g. Mount CDX in the dividing head.

h. With the dividing head at 0°, CDX must be at electrical zero, as defined by steps c through e.

i. Set PAV Function selector to 90°.

j. Set Model 540/10 to 90°.

k. Rotate the Phase Angle dial until quadrature null is reached.

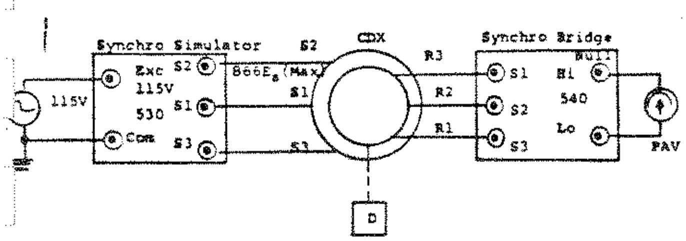

Figure 7-6. Angular Accuracy (Rotor)(CDX)

l. The angle read on the Phase Angle dial is approximately equal to the phase shift of the CDX.

m. With the Phase Angle dial left at this setting, return the Model 540/10 and the Function selector to 0°.

n. Re-zero CDX in the dividing head if necessary.

o. With the CDX at zero, offset dividing head by an amount equal to the maximum allowable error of the CDX.

p. Down-scale the Range selector until the first off-scale meter reading is reached. Turn the Range selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

q. Return dividing head to 0°.

r. Advance the Model 530 and the dividing head in the required increments. The null as noted on the PAV should be less than that obtained in step p.

s. Set up equipment as shown in figure 7-7, with CDX still mounted in the dividing head.

t. Check that CDX is zero and dividing head is set to zero.

u. Advance the Model 530 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in step p.

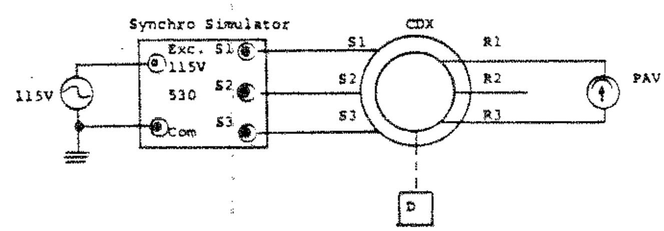

Figure 7-7. Angular Accuracy (Stator)(CDX)

7.3.2 Null Test, Fundamental and Total

a. Set up equipment as shown in figure 7-8.

b. Attach PAV leads to R1 and R2.

c. Set Model 530 to 120° and dividing head to 0°.

d. Set PAV Function selector to 0° and adjust dividing head vernier for a null.

e. In the Total and Fundamental positions of the Function selector, read the respective nulls.

f. Set Model 530 to 240° and dividing head to 120°.

g. Repeat steps d and e.

h. Set Model 530 to 0° and dividing head to 240°.

i. Repeat steps d and e.

j. Attach PAV leads to R2 and R3.

k. Set Model 530 to 240° and dividing head to 0°.

l. Repeat steps d and e.

m. Set Model 530 to 0° and dividing head to 120°.

n. Repeat steps d and e.

o. Set Model 530 to 120° and dividing head to 240°.

p. Repeat steps d and e.

q. Attach PAV leads to R1 and R3.

r. Set Model 530 to 120° and dividing head to 0°.

s. Repeat steps d and e.

t. Set Model 530 and dividing head to 120°, and repeat steps d and e.

u. Set Model 530 and dividing head to 240°, and repeat steps d and e.

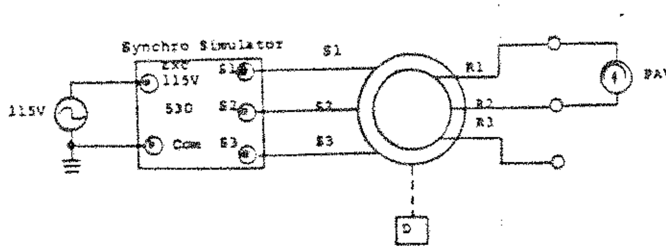

Figure 7-8. Null Test (CDX)

7.3.3 Transformation Ratio Test

a. Set up equipment as shown in figure 7-9.

b. Set Phase Angle dial to 0°.

c. Set dividing head to 30°.

d. Switch PAV Function selector to 0°.

e. Set ratio box for a null on the PAV.

f. Record ratio reading.

g. Transformation ratio is obtained by dividing in-phase ratio by cos 30° (.866).

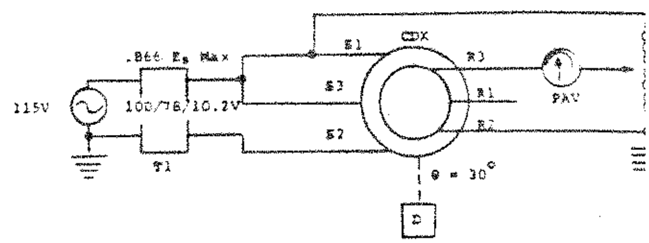

Figure 7-9. Transformation Ratio Test (

7.3.4 Phase Shift Test

a. Set up equipment as shown in figure 7-10.

b. Set Function selector to 90°.

c. Set dividing head to 30° and rotate Phase Angle dial for quadrature nul

d. The phase shift of the CDX may be r directly from the Phase Angle dial.

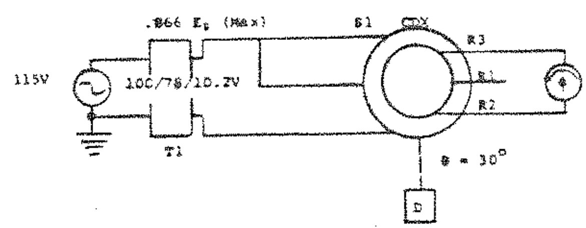

Figure 7-10. Phase Shift Test (CDX)

7.3.5 Input Current Test

a. Set up equipment as shown in figure

b. Set PAV Function selector to Total.

c. The input current of the CDX is rea

directly in amperes on the PAV, i.e., 0.1 V = 0.1 A.

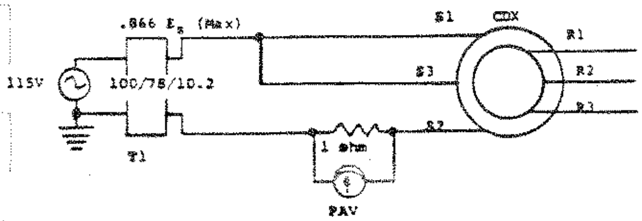

Figure 7-11. Input Current Test (CDX)

7.4 SYNCHRO TRANSFORMER (CT) TEST

7.4.1 Phasing, Electrical Zero, and Angular Accuracy

a. Set up equipment as shown in figure 7-12.

b. Set Model 530 to 0°.

c. Rotate CR shaft counterclockwise, as viewed from the shaft end, until the meter reads zero. Note that the needle approaches zero from left to right. For 115 V or 90 V excitation, use the 100 V range of the PAV. For 11.8 V excitation, use the 10 V range of the PAV.

d. With synchro shaft at the null point, switch Model 530 to 5°. The PAV should deflect to the left.

e. Return the Model 530 to 0°.

f. If requirements of steps c and d are met, the phasing is correct, and the null point is electrical zero.

g. Mount CR in the dividing head.

h. With the dividing head at 0°, CT must be at electrical zero, as defined in steps c and d.

i. Set PAV Function selector to 90°.

j. Set Model 530 to 90°.

k. Rotate the Phase Angle dial until quadrature null is reached.

l. With Phase Angle dial left at this setting, return the Model 530 to 0°, and set the Function selector to 0°.

m. Re-zero CR in the dividing head if necessary.

n. With CT at zero, offset dividing head by an amount equal to the maximum allowable error of the CT.

o. Down-scale the Range selector until the off-scale meter reading is reached. Turn the Range selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

p. Return the dividing head to 0°.

q. Advance the Model 530 and the dividing head in required increments. The null error as noted on the PAV should be less than that obtained in step o.

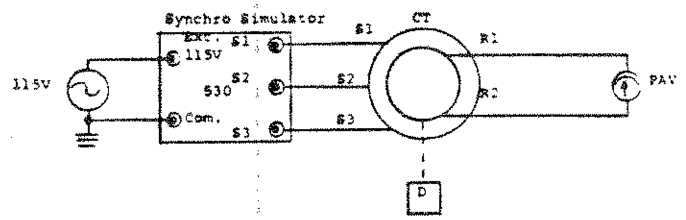

Figure 7-12. Angular Accuracy (CT)

7.4.2 Null Test, Fundamental and Total

a. Set up equipment as shown in figure 7-13.

b. Set Model 530 and dividing head to 0°.

c. Set the PAV Function selector to 0° and adjust dividing head vernier for a null.

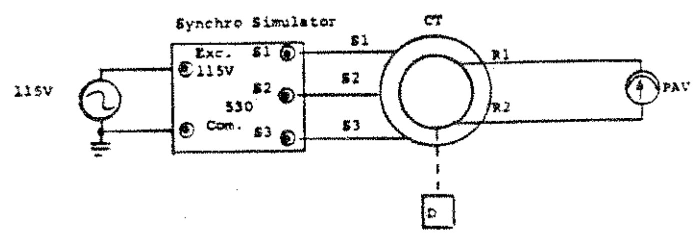

Figure 7-13. Null Test (CT)

d. Read the null in the Total and Fundamental position of the Function selector.

7.4.3 Transformation Ratio Test

a. Set up equipment as shown in figure 7-14.

b. Turn Phase Angle dial to 0°.

c. Set dividing head to 270°.

d. Set PAV Function selector to 0°.

e. Adjust ratio box for a null on the meter.

f. Record ratio box reading.

g. Transformation ratio is obtained by dividing in-phase ratio by cos 30° (.866).

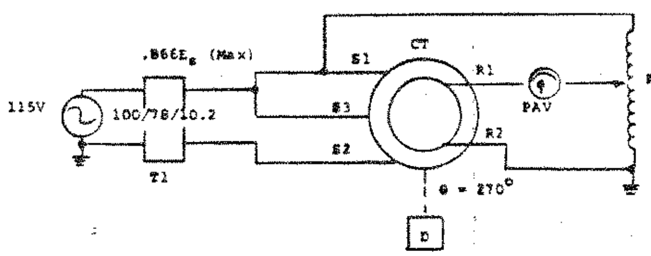

Figure 7-14. Transformation Ratio Test (CT)

7.4.4 Phase Shift Test

a. Set up equipment as shown in figure 7-15.

-t PAV Function selector to 90°.

With dividing head at 270°, rotate Phase Angle dial on the PAV for a null.

d. The phase shift of the CT may be read directly from the Phase Angle dial.

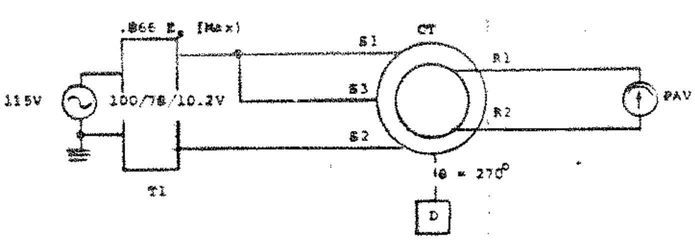

Figure 7-15. Phase Shift Test (CT)

7.4.5 Input Current Test

a. Set up equipment as shown in figure 7-16.

b. Set PAV Function selector to Total.

c. The input current of the CT is read directly in amperes on the voltmeter, i.e., .1 V = .1 A.

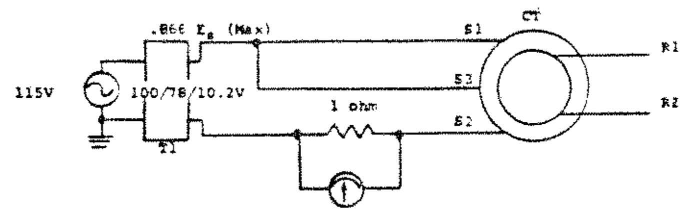

Figure 7-16. Input Current Test (CT)

7.5 RESOLVER TRANSMITTER (RX)

7.5.1 Phasing, Electrical Zero, and Angular Accuracy

a. Set up equipment as shown in figure 7-17.

b. Set Model 540/10 to 0°.

c. Rotate RX shaft counterclockwise, as viewed from the shaft end, until meter reads zero. Note that the needle approaches zero from right to left.

d. For 115 V excitation, use 100 V range of the PAV. For 26 V excitation, use 30 V range of the PAV.

e. With resolver shaft at the null point, switch Model 540/10 to 5°.

f. Return the Model 540/10 to 0°.

g. If the requirements of steps c and e are met, the phasing is correct, and the null point is electrical zero.

h. Mount RX in a dividing head.

i. With the dividing head at 0°, RX must be at electrical zero as described in steps c and e.

j. Set PAV Function selector to 90°.

k. Set Model 540/10 to 90°.

l. Rotate Phase Angle dial until quadrature null is reached.

m. The angle read on the Phase Angle dial is approximately equal to the phase shift of the RX.

n. With the Phase Angle dial left at this setting, return the Model 540/10 and the Function selector to 0°.

o. Re-zero the CX and the dividing head if necessary.

p. With RX at zero, offset the dividing head by the maximum allowable error.

q. Down-scale the Range selector until the first off-scale meter reading is reached. Turn the Range selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

r. Return the dividing head to 0°.

s. Advance Model 540/10 and the dividing head in required increments. The null error as noted on the PAV should be less than that obtained in step q.

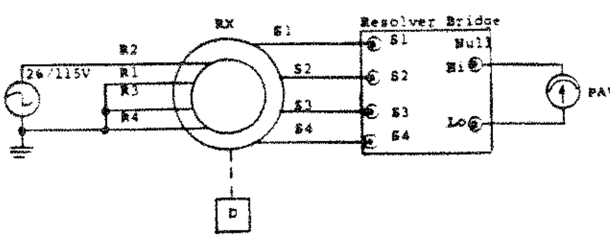

Figure 7-17. Angular Accuracy Test (RX)

7.5.2 Null Test, Fundamental and Total

a. Set up equipment as shown in figure 7-18.

b. Set dividing head to 0°.

c. Set Function selector to 0°, and adjust dividing head vernier for a null.

d. Read null in Total and Fundamental positions of the Function selector.

e. Connect PAV leads to S2 and S4 and rotate dividing head to 90°.

f. Repeat steps c and d, above.

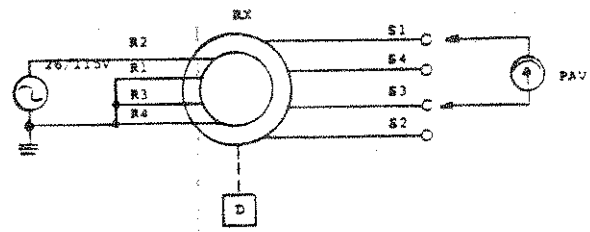

Figure 7-18. Null Test (RX)

7.5.3 Transformation Ratio Test

a. Set up equipment as shown in figure 7-19.

b. Set PAV Phase Angle dial to 0°.

c. Set PAV Function selector to 0°.

d. Set dividing head to 0°, and adjust ratio box for a null.

e. Record ratio reading (transformation ratio).

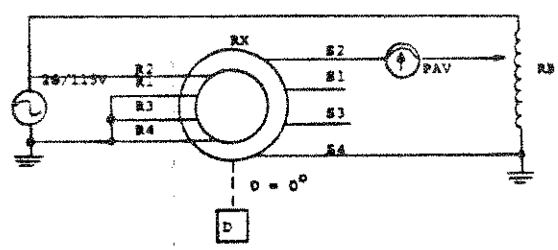

Figure 7-19. Transformation Ratio Test (RX)

7.5.4 Input Current Test

a. Set up equipment as shown in figure 7-20.

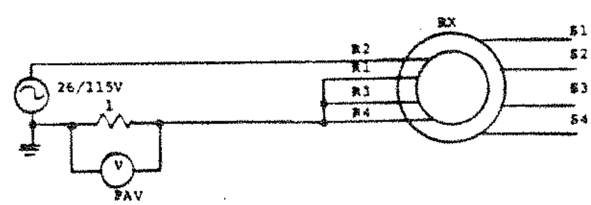

Figure 7-20. Input Current Test (RX)

b. Set PAV Function selector to Total.

c. The input current of the RX is read directly in amperes on the voltmeter, i.e., .1 V = .1 A.

7.5.5 Phase Shift Test

a. Set up equipment as shown in figure 7-21.

b. Set Function selector to 90°.

c. With the dividing head at 0°, rotate the Phase Angle dial on the PAV for a null.

d. The phase shift of the RX may be read directly from the Phase Angle dial.

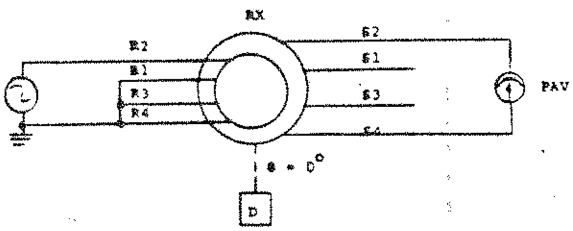

Figure 7-21. Phase Shift Test (RX)

7.6 DIFFERENTIAL RESOLVER AND TRANSFORMER (RD/RC) TESTS

7.6.1 Phasing, Electrical Zero, and Angular Accuracy

a. Set up equipment as shown in figure 7-22.

b. Set Models 530 and 540/10 to 0°.

c. Turn control panel power on, and rotate RD/RC shaft counterclockwise as viewed from the shaft end until the meter reads 0°. Note that the needle approaches zero from left to right. For 115 V excitation, use 100 V range of the PAV. For 11.8 V excitation, use 10 V range of the PAV.

d. With RD/RC shaft at null point, set Model 540/10 to 5°.

e. The PAV should deflect to the left. Return the Model 540/10 to 0°.

f. Set Model 530 to 5°. The meter should deflect to the left.

g. Return Model 530 to 0°.

h. If requirements of steps c through f are met, phasing is correct, and the null point is electrical zero.

i. Mount RD/RC in a dividing head.

j. With the dividing head at 0°, RD/RC must be at electrical zero as described in steps c through f.

k. Set Model 530 to 90°.

l. Set PAV Function selector to 90°.

m. Rotate Phase Angle dial until quadrature null is reached.

n. The angle read on the Phase Angle dial is approximately equal to the phase shift of the RD/RC.

o. Re-zero RD/RC in the dividing head if necessary.

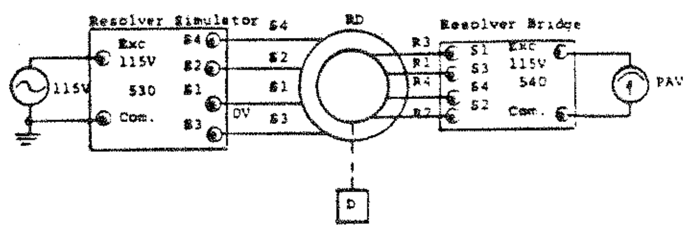

Figure 7-22. Angular Accuracy (RD Rotor)

p. With RD/RC at zero, offset the dividing head by an amount equal to the maximum allowable error of the RD/RC.

q. Down-scale the Range selector until the first off-scale meter reading is reached. Turn the Range selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

r. Return the dividing head to 0°.

s. Advance Model 540/10 and the dividing head in required increments. The null error as noted on the PAV should be less than that obtained in step q.

t. Set up equipment as shown in figure 7-23.

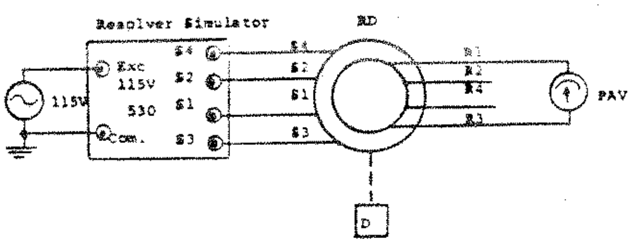

Figure 7-23. Angular Accuracy (RD and RC Stator)

u. Re-zero RD in the dividing head if necessary.

v. Advance Model 530 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in step q.

7.6.2 Null Test, Fundamental and Total

a. Set up equipment as shown in figure 7-24.

b. Set Model 530 and dividing head to 0°.

c. Set Function selector to 0°, and adjust the dividing head vernier for a null.

d. Read the null in both Total and Fundamental positions of the Function selector.

e. Set Model 530 and dividing head to 90°.

f. Repeat steps c and d.

g. Connect PAV leads to R2 and R4.

h. Set Model 530 to 90° and dividing head to 0°.

i. Repeat steps c and d.

j. Set Model 530 to 0° and dividing head to 90°.

k. Repeat steps c and d.

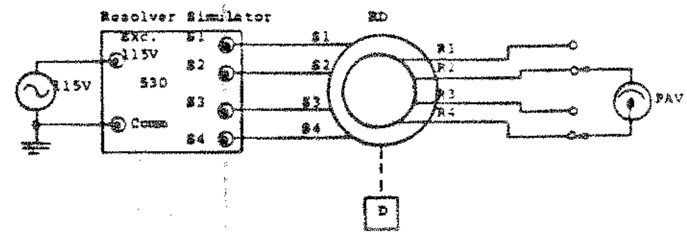

Figure 7-24. Null Test (RD/RC)

7.6.3 Transformation Ratio Test

a. Set up equipment as shown in figure 7-25.

b. Turn Phase Angle dial to 0°.

c. Turn PAV Function selector to 0°.

d. Set dividing head to 0°.

e. Adjust ratio box for a null on the PAV.

f. Record ratio box reading (transformation ratio).

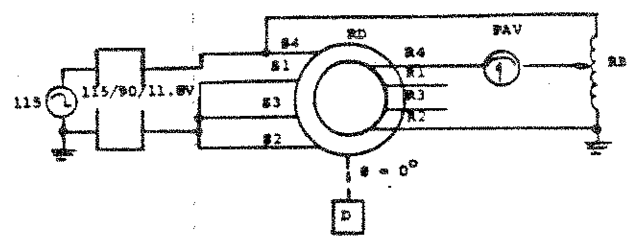

Figure 7-25. Transformation Ratio Test (RD/RC)

7.6.4 Phase Shift Test

a. Set up equipment as shown in figure 7-26.

b. Set PAV Function selector to 90°.

c. With the dividing head at 0°, rotate

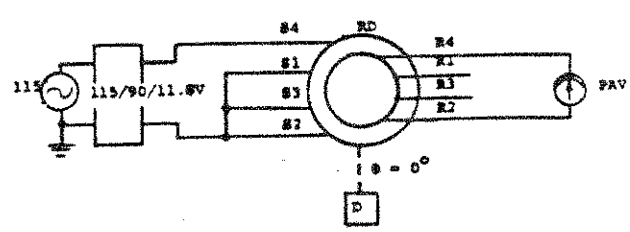

Figure 7-26. Phase Shift Test (RD/RC)

the Phase Angle dial on the PAV for a null.

d. The phase shift of the RD/RC may be read directly from the Phase Angle dial.

7.6.5 Input Current Test

a. Set up equipment as shown in figure 7-27.

b. Set PAV Function selector to Total.

c. The input current of the RD/RC is read directly in amperes on the PAV, i.e., .1 V = .1 A.

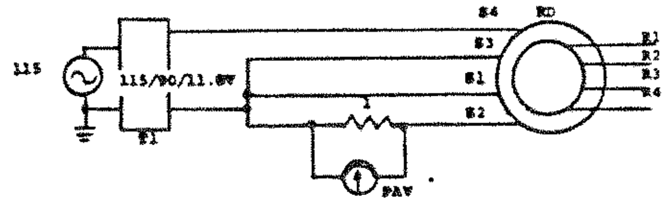

Figure 7-27. Input Current Test (RD/RC)

SECTION 8

REPLACEMENT PARTS LIST AND SCHEMATIC

This section contains a vendor codes list, parts list, and a schematic for the Model 540/10 Resolver/Synchro Bridge.

LIST OF MANUFACTURERS

Code	Name and Address	Code	Name and Address
07342	North Atlantic Industries, Inc. 60 Plant Avenue Hauppauge, New York 11788	75915	Littlefuse, Inc. 800 ENW Highway Des Plaines, Illinois
71785	Cinch Manufacturing Co., Inc. 1026 South Homan Avenue Chicago, Illinois 60624	81073	Grayhill Inc. 561 Hillgrove Avenue LaGrange, Illinois 60525
72136	Elmenco South Park & John Streets Willimantic, Connecticut	83330	H.H. Smith 812 Snediker Avenue Brooklyn, New York 11207

Replacement Parts List: Resolver/Synchro Bridge, Model 540/10

Ref. Des.	Description	NAI P/N	Code	MFR P/N	Qty
.1	Rheostat	808811			1
S1	Switch Assembly, 1°	782163			1
2	Switch Assembly, .1°	782164			1
3	Switch Assembly, .01°	782173			1
S18	Switch Assembly, 10°	782159			1
1*	Transformer Assembly	787014			1
2*	Transformer Assembly	783107			1
	Dial Assembly, 100°	500395-1			1
	Dial Assembly, 10°	201955			1
	Dial Assembly, 1°, .1°, 01°	500395-2			1
	Dial Assembly, .0001°	500395-3			1
	Knob, Bar	201979			1
	Knob	201719-1			1
	Binding Post, Red	800119	81083	29-1R	1
	Binding Post, Black	800120	81073	29-1B	1
	Binding Post, Gnd.	800546	83330	137	1
	Terminal Strip - 3 terminals	800895	71785	1788	1
	Terminal Strip - 4 terminals	801652	71785	17-A	1
1	Fuse .1 amp	800938	75915	312.100	1
1	Capacitor, Ceramic 750pf	802315	72136	DM15-751J	1

Due to calibration requirements, these assemblies must be factory installed.

S.W. POSITIONS	WIPER S2-B-2	WIPER S2-B-1	WIPER S2-A-13	WIPER S2-A-14
0	S2-B-13	S2-B-4	S2-A-10	S2-A-1
5	S2-B-12	S2-B-5	S2-A-9	S2-A-2
10	S2-B-11	S2-B-6	S2-A-8	S2-A-3
15	S2-B-10	S2-B-7	S2-A-7	S2-A-4
20	S2-B-9	S2-B-8	S2-A-6	S2-A-5
25	S2-B-8	S2-B-9	S2-A-5	S2-A-6
30	S2-B-7	S2-B-10	S2-A-4	S2-A-7
35	S2-B-6	S2-B-11	S2-A-3	S2-A-8
40	S2-B-5	S2-B-12	S2-A-2	S2-A-9

S2 SWITCHING CHART

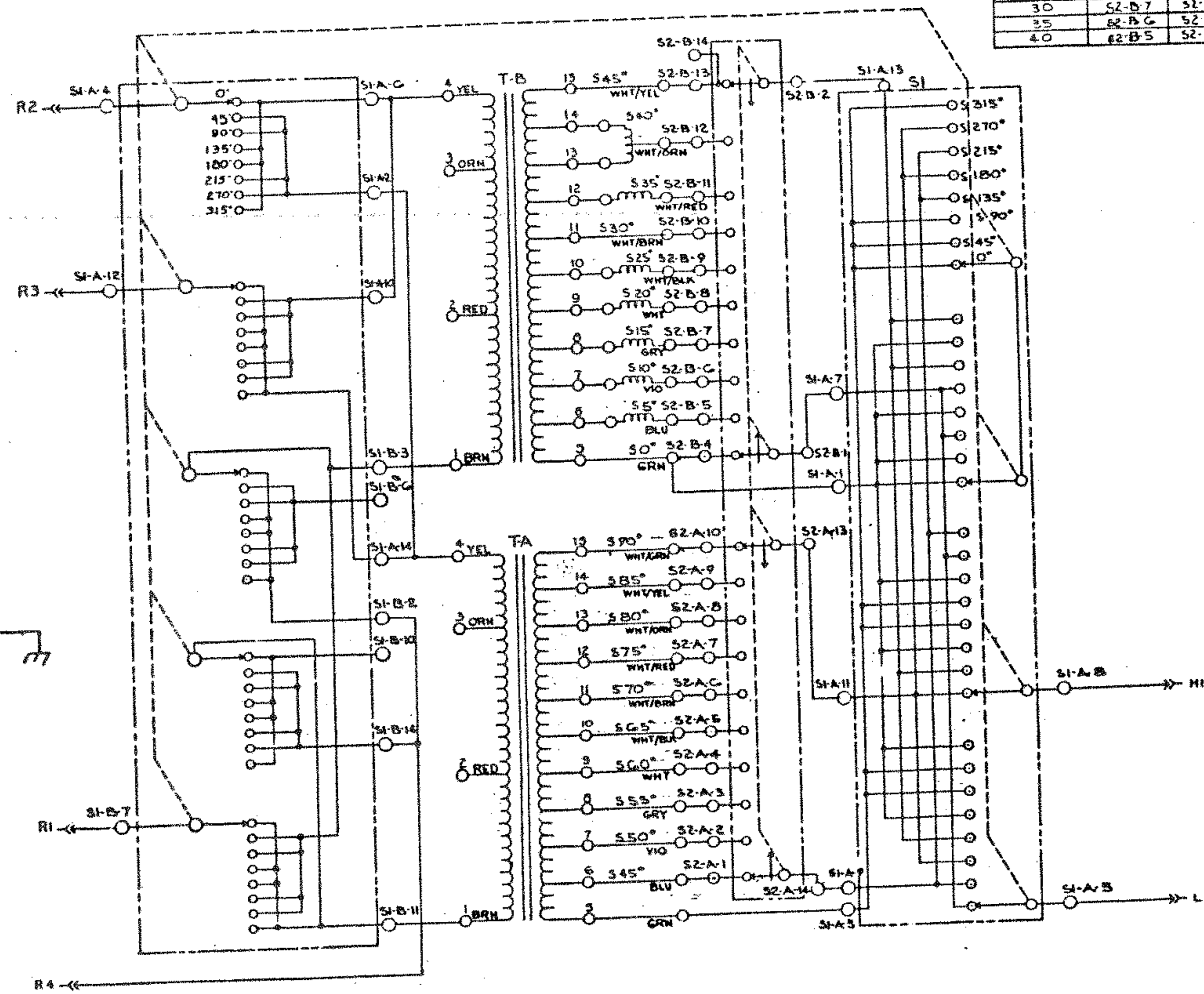

Figure 7-1. Model 541/10, System Schematic

WARRANTY

A. The Seller warrants Products against defects in material and workmanship for one year from the date of original shipment. The Seller's liability is limited to the repair or replacement of Products which prove to be defective during the Warranty period. There is no charge under the Warranty except for transportation charges. The Purchaser shall be responsible for Products shipped until received by the Seller.

B. The Seller specifically excludes from the Warranty 1) calibration, 2) fuses, and 3) normal mechanical wear, e.g.; end-of-life on assemblies such as switches, relays, gear trains, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the Warranty period.

C. The Seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of Products.

D. The Warranty is voided if there is evidence that Products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The Seller reserves the right to make changes and improvements to Products without any liability for incorporating such changes or improvements in any Products previously sold, or for any notification to the Purchaser prior to shipment. In the event the Purchaser should require subsequently manufactured lots to be identical to those covered by this Quotation, the Seller will, upon written request, provide a quotation upon a change control program.

F. No other Warranty expressed or implied is offered by the Seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the Product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions, then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.