

INSTRUCTION MANUAL

Model CD90 High Gain Carrier Demodulator Plug-in Module

May 1980

WARRANTY

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VALIDYNE will repair or replace any component found to be defective on its return to VALIDYNE within the time specified below:

1. Pressure Transducers and Pressure Transmitters (including transducers supplied as part of Digital Manometer Systems) within three (3) years of its original purchase.
2. Electronic products (Transducer indicator, carrier demodulators, plug-in signal conditioners, module cases, etc.) within one (1) year of its original purchase.

Buyer is requested to secure authorization of VALIDYNE, and to describe defect prior to return of equipment under warranty. Shipment to VALIDYNE shall be at Buyer's expense, with return at VALIDYNE's expense. NON-VERIFIED problems or malfunctions whether warranty or not are subject to a \$65.00 evaluation charge.

The warranty carries no liability, either expressed or implied, beyond our obligation to repair or replace, at VALIDYNE's option the unit which carries the warranty. Prices, specifications and designs subject to change without notice. This warranty is void if the product is subjected to misuse, accident, neglect or improper application, installation or operation.

REPAIR POLICY

Units returned to VALIDYNE for repair which are not under warranty will be subject to the following conditions.

1. A description of the problem or malfunction shall accompany the unit returned for repair, or be communicated to VALIDYNE prior to shipment. Otherwise there will be a minimum evaluation and/or calibration charge of \$65.00.
2. Unit will be repaired automatically if charge is less than 65% of current list price unless other specific instructions are received. Above 65%, VALIDYNE will request authorization by buyer.
3. If quotation is required before proceeding with repairs, unit should be accompanied by paper so stating, or information communicated to VALIDYNE prior to shipment.
4. Buyer is to secure authorization and shipping method from VALIDYNE prior to return of equipment or shipment will be rejected. (Applies to Canada only)

REPAIR WARRANTY

Warranty coverage on repairs is 90 days on work done, or to the end of the original warranty period, whichever is longest.



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REVISION PAGE

<u>DATE REVISED</u>	<u>PAGES REVISED</u>	<u>DESCRIPTION OF REVISION</u>	<u>REVISED BY</u>
10/78	All	Complete Rewrite	D.S.
5/79	Schematic	R2, R72 Change	J.H.
5/80	Warranty Figure 2 Cover	New Standard Page Added - new page New standard format	R.C.

MODEL CD90

HIGH-GAIN CARRIER DEMODULATOR

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SECTION 1

GENERAL

1.1 DESCRIPTION

The CD90 is a very high-gain carrier demodulator plug-in module to the Validyne MC1 Multi-Channel Transducer System. The module supplies isolated carrier excitation to a variety of half and full-bridge strain gage, variable reluctance, variable differential transformer (LVDT) transducers, and similar devices, amplifies the bridge output to provide ± 10 volts DC output.

Gain selector is provided so that full-scale output may be obtained with bridge sensitivities of 0.1, 0.25, 0.5, 1, 2.5, 5, 10, 25, 50 and 100 mV/V inputs. Additionally, this gain may be continuously varied from 0 to 100% at each input sensitivity level.

In phase and quadrature balance controls, as well as up to $\pm 90^\circ$ reference phase control for long line and reactive source operation, are provided.

Other features provided are plus and minus shunt calibration by an externally connected calibration resistor, internal selectable low-pass output filter and dual outputs.

The CD90 may be operated with any carrier frequency from 400 Hz to 20 kHz by changing internal plug-in control boards, making it possible to achieve a wide band frequency response of 5 kHz with a 20 kHz carrier frequency.



SECTION 2

SPECIFICATIONS

2.1 ELECTRICAL

Input Sensitivity:	0.1 mV/V for 10 VDC output (equivalent to 5 micro strain per volt of output, using a 4 active-arm strain-gage bridge with a gage factor of 2)
Gain Switch Steps:	0.1, 0.25, 0.5, 1.0, 2.5, 5.0, 10, 25, 50, and 100 mV/V
Input Attenuator:	Calibrated 10-turn potentiometer 0 to 100%
Maximum Input:	500 mV/V (2.5 V RMS) with gain switch in 100 mV/V position and attenuator at 20%
Bridge Configuration:	2 or 4-arm strain gage (min. 100 ohms), variable reluctance, vari- able differential transformers (LVDT) and similar transducers
Bridge Excitation:	Buffered, grounded center tap, 5 V RMS, into min. 100 ohm load, 3 kHz standard*
Bridge Balance:	In phase (R), calibrated 10-turn pot Quadrature (C), screwdriver adjust 15-turn
Balance Range:	High: ± 25 mV/V R & C Low: ± 2.5 mV/V R & C
Reference Phase:	Screwdriver adjust, single turn, $\pm 90^\circ$ adjustment
Third Harmonic Filter:	Low level third harmonic filter allows high gain operation with inductive devices having large third harmonic content in their output



2.1 ELECTRICAL (Continued)

Calibration:	Front panel jack for plug-in shunt calibration resistor. Toggle switch for plus-off-minus calibration control
Output A Signal:	± 10 VDC at 100 mA, short-circuit proof Maximum output ± 15 V
Output B Signal:	Attenuated from Output A by network mounted on bifurcated terminals. Standard network provides ± 1 VDC
Output Impedance:	
Output A:	Less than 10 ohms
Output B:	100 ohms standard
Output Filters:	Fixed 2-pole cascaded with 3-switch selectable 3-pole low-pass filters. Standard selectable frequencies are: 750 Hz, 150 Hz, and 30 Hz*
Output Noise:	Less than 10 mV RMS with 750 Hz filter, less than 1 mV RMS with 150 Hz or 30 Hz filter*
Linearity:	Less than $\pm 0.05\%$ of full scale
Temperature Range:	0°F to +160°F
Power Requirements:	± 15 VDC from MC1 Module Case; 2.5 V RMS 3 kHz* single-ended from MC1, or from external oscillator -- input impedance 12.4 K ohms shunted by 220 pF
*Alternate Carrier Operation:	CD90 may be operated at carrier frequencies from 400 Hz to 20 kHz. Each carrier frequency requires a separate plug-in "Frequency Determining card. The low-pass output filters may be altered to accommodate the various carriers by means of an "Output Filter" plug-in card. Standard cards are for 3 kHz carrier. Other cards available: 400 Hz, 1 kHz, 3 kHz, 5 kHz, 10 kHz, 20 kHz and any specific frequency on request.



2.2 MECHANICAL (Refer to Figure 2)

Controls & Functions Front Panel:

Gain Select, 10-position switch
Input Attenuator, 10-turn calibrated potentiometer
In phase (R) Balance, 10-turn calibrated potentiometer
Quadrature (C) Balance, 15-turn screwdriver adjust
Reference Phase, single-turn, screwdriver adjust
Calibration Switch, 3 position, center-off, toggle switch
Calibration Resistor Terminals
Test Point Terminals

Controls & Functions Behind Front Panel:

2 arm/4 arm operation, 2-position toggle switch
Hi/Lo Balance Range, 2-position toggle switch
Output Filter Select, 3-position switch
Plug-in Frequency determining board
Plug-in Filter Board
Output B Adjust Resistors

Width: 1.6 inches
Height: 3.7 inches
Weight: 14 ounces

Plugs into the Validyne MC1 Module Case

Input/Output Connections: WK-4-32S/XLR-32S on back panel of MC1 Case

Mating Connectors: WK-4-21C/XLR-3-11C



SECTION 3

INSTALLATION AND OPERATION

3.1 INSTALLATION

The Model CD90 may be plugged into or out of any available channel of the MC1 Module Case while power is on without damage and without affecting the adjacent channels.

3.2 TRANSDUCER CONNECTIONS

Transducers are connected to the CD90 by means of the WK-4-32S connector on the back of the MC1 Module Case. The CD90 outputs A and B come from separate XLR-3-32S connectors on the back of the MC1 Module Case. Table 3-1 describes the transducer pin connections. Figure 3-1 illustrates the suggested cabling method of connecting the transducer to the MC1 input connections. Figure 3-2 illustrates the cable types (both acceptable and unacceptable) for half-bridge transducer connections. Cable shields should be connected to the shells of the mating connectors. In cases where the transducer body is grounded, the shield connection at the transducer end should be left open in order to eliminate noise from possible ground currents.

TABLE 3-1. MC1 TRANSDUCER INPUT PIN CONNECTIONS

MC1 INPUT CONNECTIONS (WK4)	
<u>Pin No.</u>	<u>Function</u>
1	5 volt RMS, 3 kHz carrier
2	+ Input signal from transducer
3	- Input signal from transducer
4	5 volt RMS, 3 kHz carrier
MC1 OUTPUT CONNECTIONS (XLR)	
<u>Pin No.</u>	<u>Function</u>
1	Output
2	Circuit Ground
3	Chassis Ground
NOTE: Pin connections are the same for both Output A and B.	



SECTION 3

INSTALLATION AND OPERATION

3.1 INSTALLATION

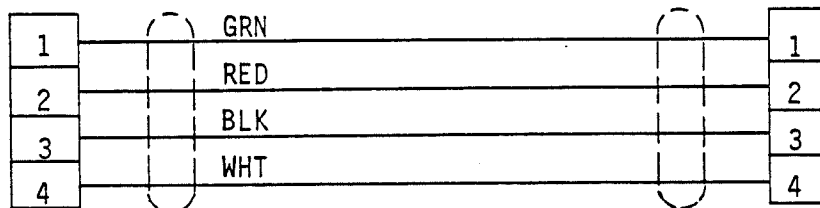
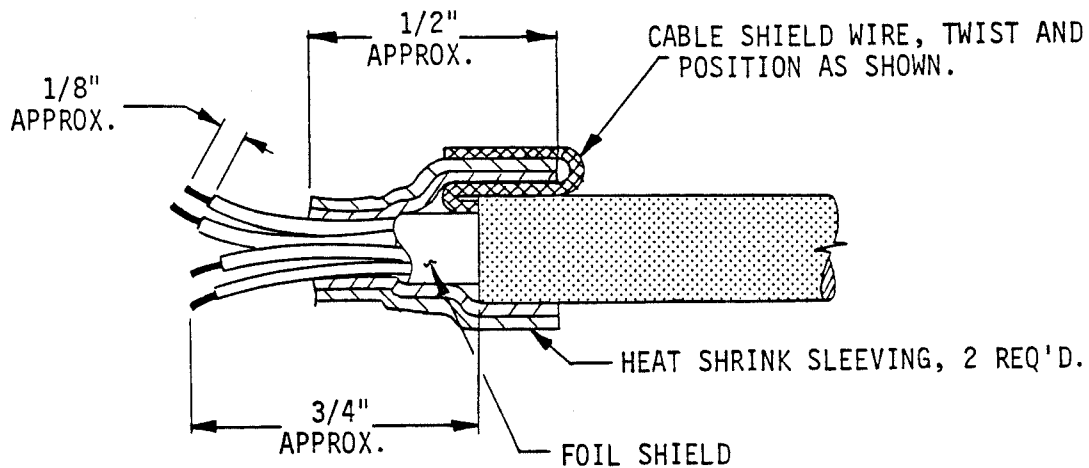
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2	Circuit Ground
3	Chassis Ground
NOTE: Pin connections are the same for both Output A and B.	



NOTES:

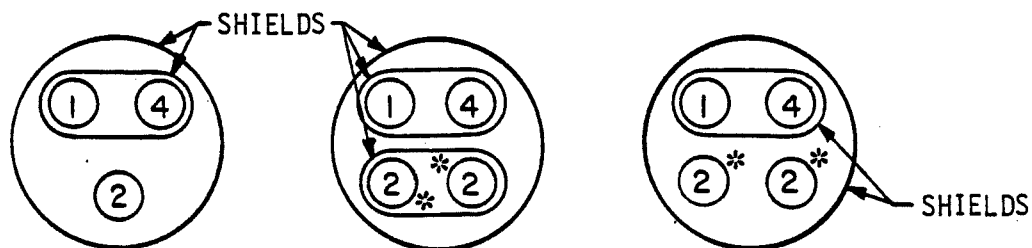
1. Cable shield should make contact with connector at cable clamps.
2. Leads for pins 1 and 4 should be in one shielded pair; signal leads 2 and 3 in the other shielded pair (provided two pairs are used).

Figure 3-1. Fabrication of Transducer Cable.



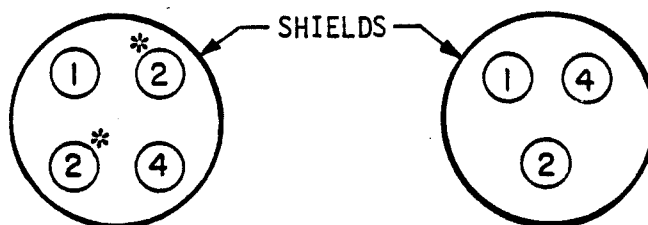
LEAD IDENTIFICATION: 1 - CARRIER EXCITATION
2 - OUTPUT SIGNAL
4 - CARRIER EXCITATION

*Signal lead can be either lead shown



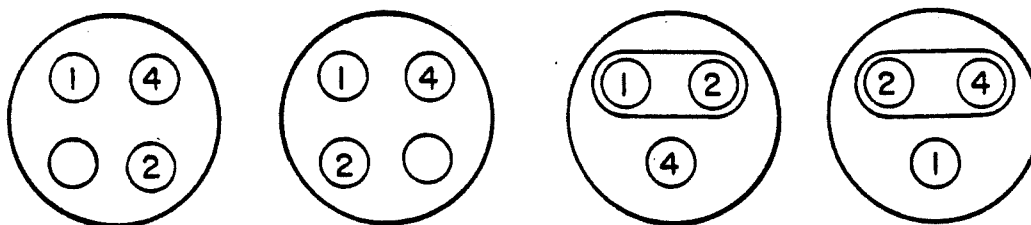
PREFERRED CABLE TYPES & ARRANGEMENTS

(Lengths to 1,000 ft. or more)



ACCEPTABLE CABLE TYPES & ARRANGEMENTS

(Lengths to approx. 100 ft.)



Unequal distance between
signal lead and each carrier lead -
capacitive unbalance

One carrier lead and signal lead
in common shield -
large capacitive unbalance

NOT RECOMMENDED

FIGURE 3-2. TRANSDUCER CABLING

3.2 TRANSDUCER CONNECTIONS (Continued)

NOTE: Figures 3-3 and 3-5 through 3-8 describe the different methods of connecting the variable reluctance, strain-gage, LVDT/RVDT and potentiometer transducers to the MCI input connector.

3.3 OPERATION

(See Figure 2 for switch and component locations.)

3.4 HALF-BRIDGE (TWO-ARM OPERATION) -- VARIABLE RELUCTANCE TRANSDUCERS

- A. Connect transducer as shown in Figure 3-5. S1 (2-ARM/4-ARM switch) should be in the 2-ARM position. If transducer is a high output type (between 20 and 166 mV/V), the Balance Range Switch S2 (HI/LO switch) may have to be in the HI position to balance the transducer output as required for systems operation. If the transducer is a low output type (between 1 and 20 mV/V), the output can usually be balanced to zero with S2 in the LO position.

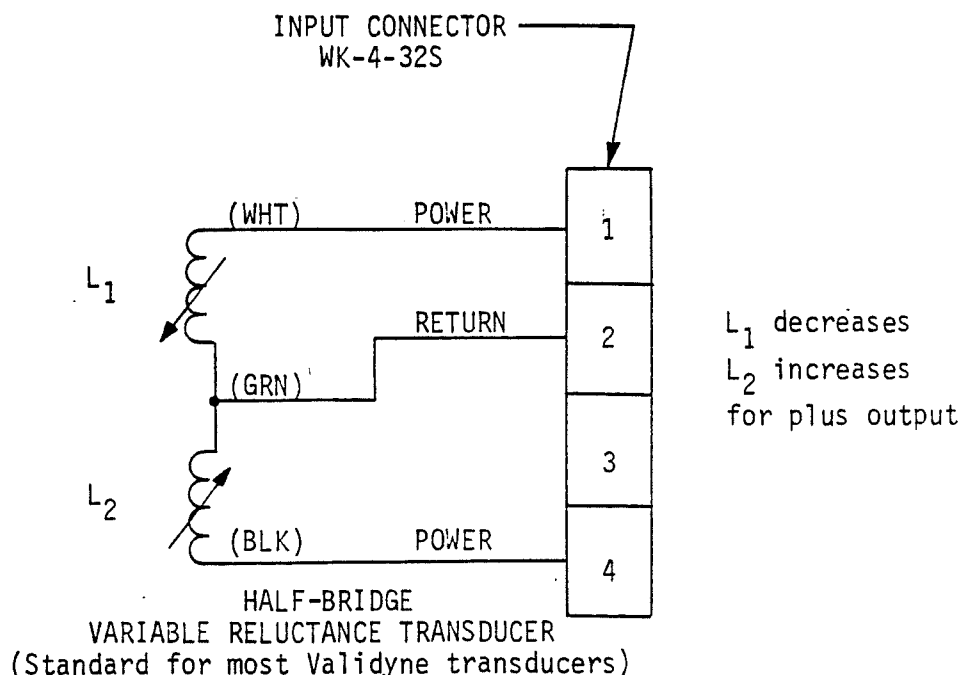
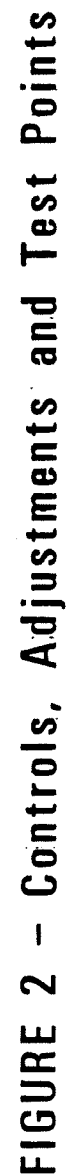


FIGURE 3-5. TRANSDUCER CONNECTIONS FOR HALF-BRIDGE, TWO-ARM OPERATION



3.4 HALF-BRIDGE (TWO-ARM OPERATION) -- VARIABLE RELUCTANCE TRANSDUCERS (Cont'd.)

- B. To balance the bridge with input device connected, connect an AC voltmeter (3 volt AC range) or an oscilloscope (1 V/cm range) to the front panel test points (TP and GND). With the GAIN switch in the 50 mV/V position, adjust the "R" and "C" controls alternately to reduce the amplitude of the 3 kHz sine wave to a minimum. Successively decrease the mV/V sensitivity with the GAIN switch, and continue to adjust the 3 kHz sine wave signal to a minimum at each step until the signal has been reduced to a null at the sensitivity required for the input device being employed. A complete null in this position is not necessary (± 2 V peak-to-peak is acceptable).
- C. With the 10-turn vernier GAIN control fully clockwise, the GAIN switch reads in millivolts per volt input necessary to obtain 10 volts DC output. The 10-turn GAIN control reduces the gain below this value to accommodate signals larger than that marked on the GAIN switch setting, yet below the level required by the next GAIN switch position. The maximum input signal for a particular GAIN switch setting should not exceed that which will produce 10 volts output with the 10-turn GAIN control turned no lower than a dial reading of 300 (fully clockwise is a reading of 1000). This corresponds to an input 3.33 times that of the GAIN switch setting (33 mV/V on the 10 mV/V range or 166 mV/V on the 50 mV/V range). Figure 3-4 shows the procedure for setting the digital dial vernier GAIN control. (See paragraph 2-20 for full-scale calibration as a system.)



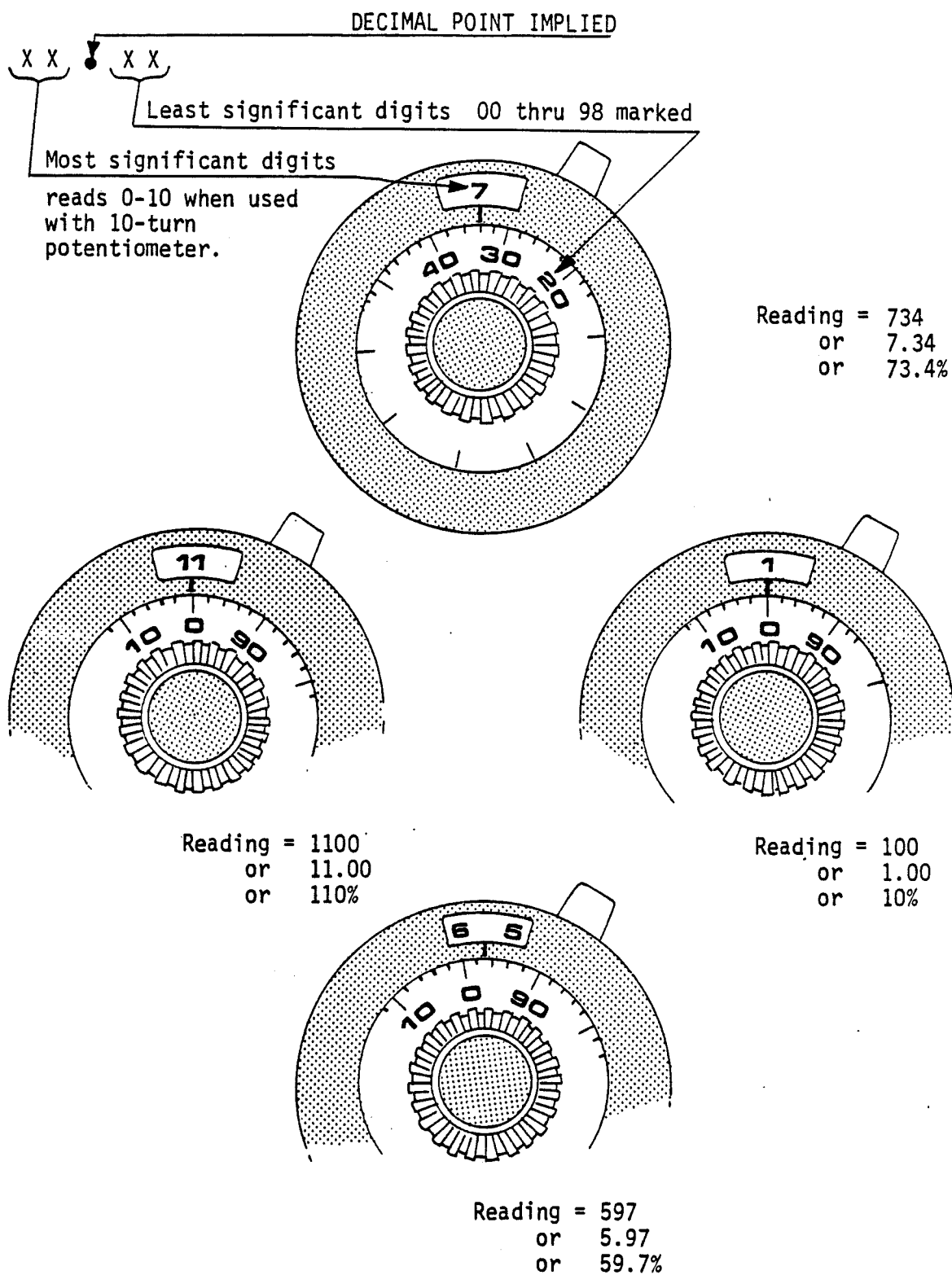


FIGURE 3-4. PROCEDURE FOR SETTING GAIN CONTROL

3.5 POTENTIOMETRIC TRANSDUCERS -- GENERAL

Potentiometric transducers, either rotary or linear-position types, are by definition high output devices producing essentially one volt output per volt of excitation (1 V/V) if used over the complete active area of the potentiometer element.

For compatibility with the CD90, a simple 2-resistor attenuator network can be used to keep the maximum signal within the desired ± 166 mV/V level of the CD90 input.

Figure 3-5(A) describes the suggested arrangement for bidirectional (center null) applications, and 3-5(B) the arrangement for a unidirectional device. Other Application Notes are available for connecting potentiometric transducers in other arrangements. Consult the factory for these Application Notes.

- A. Connect the transducer as shown in Figure 3-5(A) or (B). S1 (2-ARM/4-ARM switch) should be in the 2-ARM position; S2 (HI/LO switch) to be in the HI position; GAIN switch to be in the 50 mV/V position; and the vernier GAIN control set at approximately 300.
- B. To balance (null) the transducer, position the transducer actuating shaft in the zero, or null, position. Connect an AC voltmeter (3 volt AC range), or an oscilloscope (1 V/CM range) to the front panel test points (TP and GND).

NOTE

In the HI balance range position, approximately ± 20 mV/V of "R" balance range is provided. Depending on the actual resistance values of the fixed attenuator resistors and/or residual end resistance in the potentiometer, some mechanical phasing of the actuating shaft may be required to more closely balance the series resistance on either side of the pot wiper at the null position to stay within the "R" balance range. Proper phasing can be verified by rotating the "R" balance control over the full active range; if the actuating shaft is properly positioned, a "minimum" voltage level as measured at the Test Points should occur at approximately the center 1/3 of rotation of the "R" balance control.

If a minimum does not occur in this manner, the transducer actuating shaft must be repositioned in the "plus" direction if the Test Point voltage continued to decrease over the full clockwise adjustment of the "R" balance control; or, in the "minus" direction, if the Test Point voltage continued to decrease over full counter-clockwise rotation of the "R" balance control.



Adjust the "R" and "C" balance controls alternately to reduce the amplitude of the 3 kHz sine wave to a minimum (± 2 V peak-to-peak is the approximate minimum value). Following the initial system null calibration, the "R" balance control only is used for subsequent zero adjustments.

- C. To set the full-scale output, monitor the output at the Output A connector (Pin 1 - Output, Pin 2 - Circuit Ground) using a DC voltmeter (10 VDC scale).

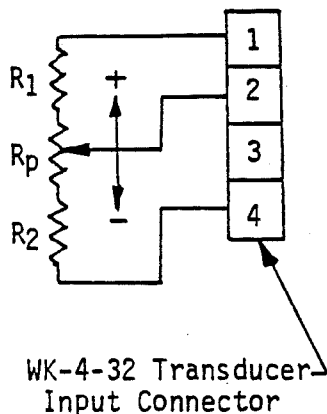
With the GAIN switch in the 50 mV/V position, the vernier GAIN control set at approximately 300 - 400, adjust the transducer actuating shaft to the desired full-scale position while observing the DC output level. If the DC output reaches 10 volts before full mechanical travel of the transducer is reached, reduce the vernier GAIN control setting accordingly. With the actuating shaft in the desired full-scale position, the vernier GAIN control is then adjusted to produce the precise output level. Again note that, following full-scale output adjustment, if the resultant vernier GAIN control setting is significantly less than 300, the values of R_1 and R_2 may have to be changed to drop the full-scale input, as described in Figure 3-5.

Figure 3-4 describes the dial reading conventions for the turns-counting dial used on the vernier GAIN control.

3.6 FULL-SCALE (FOUR-ARM OPERATION) -- STRAIN-GAGE BRIDGES AND TRANSDUCERS

- A. Connect transducer as shown in Figure 3-6. S1 (2-ARM/4-ARM switch) should be in the 4-ARM position. If transducer is a high output type (between 20 and 166 mV/V), the Balance Range switch S2 (HI/LO switch) may have to be in the HI position to balance the transducer output for your condition. If the transducer is a low output type (between 1 and 20 mV/V), the output can usually be balanced to zero with S2 in the LO position.
- B. Operate the same as described in paragraph 3-4B and C.

(A) Center Null, Bidirectional Motion



Where: $R_1 = R_2 =$ Fixed attenuator resistors
 $R_v =$ Variable portion of pot transducer resistance
 $R_p =$ Total resistance of transducer element
 $R_t = R_1 + R_2 + R_p$

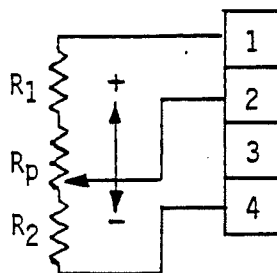
For partial* travels: $\frac{R_v}{R_1 + R_2 + R_p} \leq 0.332$

*Less than \pm full mechanical range.

For full mechanical travel: $\frac{R_p}{R_1 + R_2 + R_p} \leq 0.332$

And, $50\Omega \leq R_t \leq 10\text{ K}\Omega$

(B) Fully Retracted Null, Unidirectional Motion



Where: $R_1 =$ Fixed attenuator resistor
 $R_2 =$ Fixed attenuator resistor

NOTE: $R_1 + R_p = R_2$
 $R_v =$ Variable portion of total pot transducer resistance
 $R_p =$ Pot transducer total resistance
 $R_t = R_1 + R_2 + R_p$

For partial* travels: $\frac{R_v}{R_1 + R_2 + R_p} = 0.166$

*Less than full active electromechanical range.

For full travel: $\frac{R_p}{R_1 + R_2 + R_p} = 0.166$

And, $50\Omega \leq R_t \leq 10\text{ K}\Omega$

- NOTES:**
1. Resistors (R_1 and R_2) should be precision $\pm 1\%$ (or better) resistors.
 2. For optimum temperature performance, attenuator resistors R_1 and R_2 should be mounted in the same temperature environment as R_p , and have approximately the same temperature coefficient.
 3. The resistance ratios used above (0.332 for the bidirectional and 0.166 for the unidirectional arrangement) are based on a full-scale output of ± 10 VDC with maximum recommended vernier GAIN attenuation in the 50 mV/V GAIN position (Vernier GAIN Control setting of 300, minimum). If lesser full-scale output voltages are desired, the ratios must be reduced in direction proportion to the reduction in output voltage; i.e., for ± 5 VDC output, the bidirectional ratio becomes 0.166, and the unidirectional ratio becomes 0.083, etc.

FIGURE 3-5. POTENTIOMETRIC TRANSDUCER CONNECTIONS

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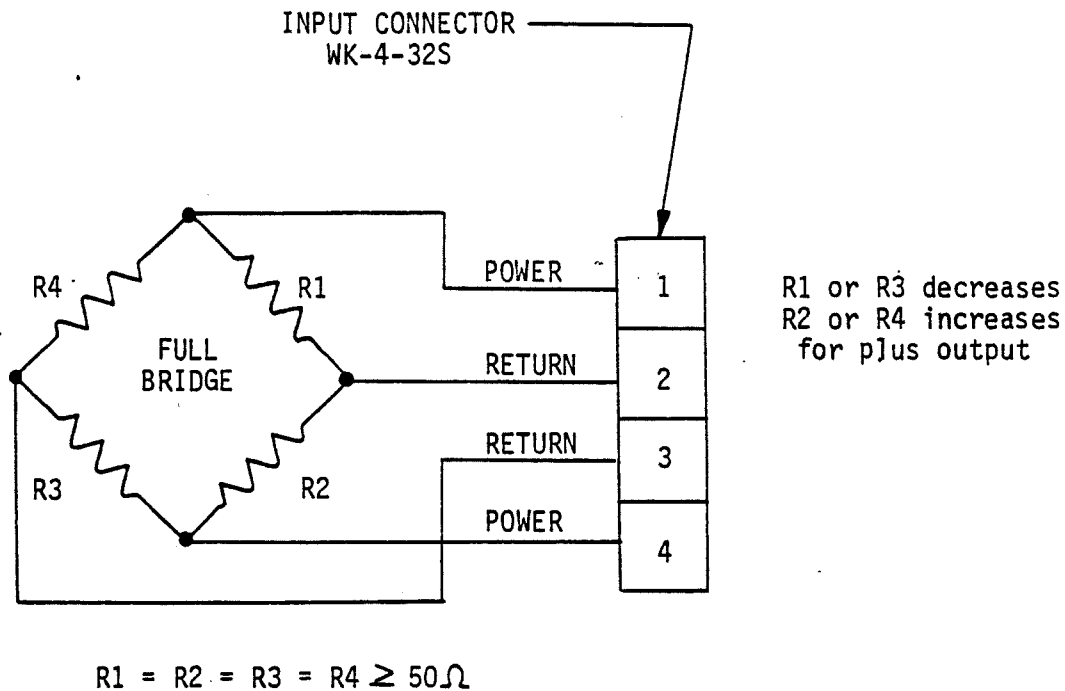


FIGURE 3-6. TRANSDUCER CONNECTIONS FOR FULL-BRIDGE, FOUR-ARM OPERATION

3.7 LVDT/RVDT TRANSDUCERS -- GENERAL

- A. Variable Differential Transformers, either Linear or Rotary-position types, are high output devices. The actual output voltage in mV/V of the LVDT/RVDT can be determined by multiplying the sensitivity by the displacement in thousands of an inch.

$$\text{Output Voltage} = \text{Sensitivity} \times \text{Displacement}$$

(obtained from mfg. data sheet) (obtained from mfg. data sheet)

- B. To avoid saturation of the CD90 input amplifier, two different methods of connection will be described in the following sections. The first method is for LVDT/RVDT output voltages less than 166 mV/V (paragraph 3-8, Figure 3-7), and the second method is for output voltages greater than 166 mV/V (paragraph 3-9, Figure 3-8).



3.7 LVDT/RVDT TRANSDUCERS -- GENERAL (Continued)

- C. The LVDT/RVDT is an electromechanical transducer which produces an electrical output proportional to the displacement of a separate movable core. When the primary or center coil is energized with alternating current, voltages are induced in the two outer coils. In the transformer installation, the outer or secondary coils are connected in series opposition so that the two voltages in the secondary circuit are opposite in phase, the net output of the transformer being the difference of these voltages. For one central position of the core, this output voltage will be zero. This is called the balance point or null position.

In practice, the output voltage does not quite become zero at the null position of the core because of small residual voltage components which do not cancel.

3.8 LVDT/RVDT TRANSDUCER OPERATION (OUTPUTS LESS THAN 166 mV/V)

- A. Connect the LVDT/RVDT as shown in Figure 3-7. S1 (2-ARM/4-ARM switch) should be in the 2-ARM position. If the LVDT/RVDT has an output voltage (as calculated in paragraph 3-7A) of 20 to 166 mV/V, the Balance Range Switch S2 (HI/LO switch) should be in the HI position. For output voltages of 0 to 20 mV/V the Balance Range switch should be in the LO position. The GAIN switch is to be in the 50 mV/V position and the vernier GAIN control set at approximately 300.

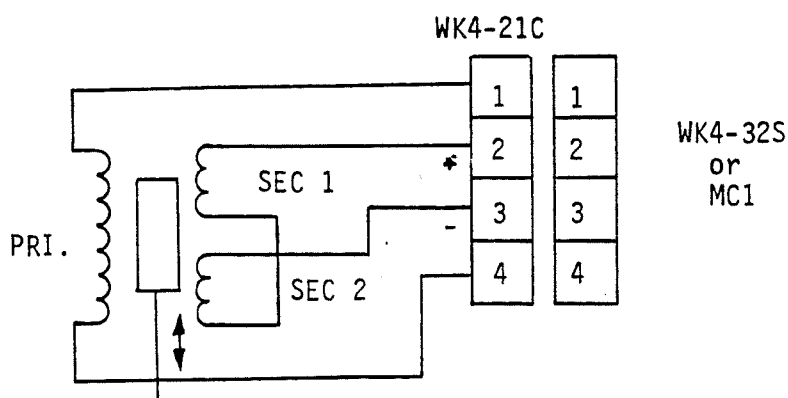


FIGURE 3-7. TRANSDUCER CONNECTIONS FOR LVDT OPERATION.
(LVDT's Less Than 166 mV/V)



3.8 LVDT/RVDT TRANSDUCER OPERATION (OUTPUTS LESS THAN 166 mV/V) (Continued)

- B. To balance (null) the transducer, position the transducer actuating shaft or core in the zero, or null position. Connect an AC voltmeter (3 VAC range), or an oscilloscope (1 V/cm range) to the front panel test points (TP and GND).

NOTE

1. In the HI balance-range position, approximately $\pm 20\text{mV/V}$ of "R" balance range is provided. In the LO balance-range position, approximately $\pm 2\text{ mV/V}$ of "R" balance range is provided.
2. The residual signal at null may be up to 10% of the full-scale output signal, as observed at the test points. If this condition exists, it may become necessary to mechanically move the actuating shaft or core slug very slightly to obtain the best mechanical null. Proper phasing can be verified by rotating the "R" balance control over the full-active range. If the actuating shaft or core is properly positioned, a minimum voltage level as measured at the test points should occur at approximately the center 1/3 of rotation of the "R" balance control.

Adjust the "R" and "C" balance controls alternately to reduce the amplitude of the 3 kHz sine wave to a minimum ($\pm 2\text{ V}$ peak-to-peak is the approximate maximum value). Following the initial system null calibration, the "R" balance control only is used for subsequent zero adjustment.

- C. To set the full-scale output, monitor the output at the "A" output connector (pin 1 - output, pin 2 - ground) using a DC voltmeter (10 VDC scale).

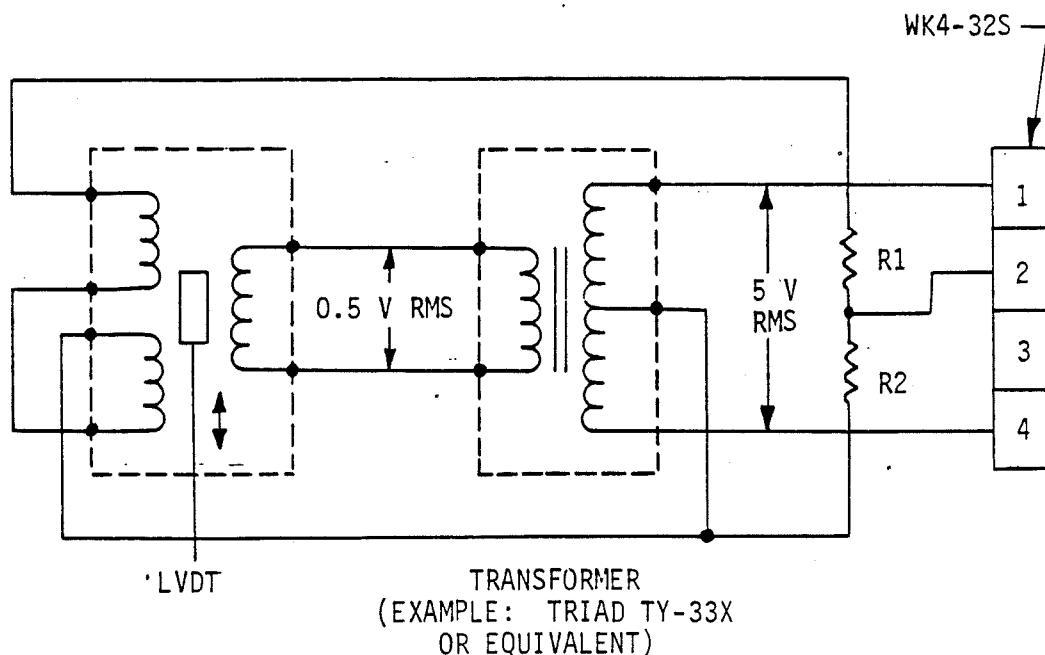
With the GAIN switch in the 50 mV/V position and vernier GAIN control set at approximately 300-400, adjust the transducer actuator shaft or core to the desired full-scale position while observing the DC output level. If the DC output reaches 10 volts before full mechanical travel of the transducer is reached, reduce the vernier GAIN control setting accordingly. With the actuating shaft or core in the desired full-scale position, the vernier GAIN control is then adjusted to produce its precise output level.

3.9 LVDT/RVDT TRANSDUCER OPERATION (OUTPUTS GREATER THAN 166 mV/V)

- A. Outputs greater than 166 mV/V may cause saturation of the CD90 input amplifier. The following methods are for compensating for this condition:

3.9 LVDT/RVDT TRANSDUCER OPERATION (OUTPUTS GREATER THAN 166 mV/V) (Continued)

1. Calculate the output voltage of the transducer as described in paragraph 3-7A. If the output voltage as calculated is greater than 166 mV/V, proceed as follows in paragraph B.
- B. Connect a step-down transformer between the excitation output and the transducer input as shown in Figure 3-8. Further attenuation can be provided by resistors R1 and R2 connected as shown. Values for R1 and R2 should not exceed 50 K ohms, or be less than 10 K ohms for most applications. Full-scale output (the voltage between terminal 2 and the transformer center tap) should be adjusted to a maximum of 150 mV/V and a minimum 15 mV/V.



LVDT connection for use with CD90 when output of LVDT is greater than 166 mV/V.

$$R_1 = \frac{(E_o - 166) R_2}{166}$$

Where E_o is LVDT output in mV/V, and R_2 is 10 K ohms. Use metal film or wire wound resistors.

FIGURE 3-8. TRANSDUCER CONNECTIONS FOR LVDT OPERATION
(LVDT's Output in Excess of 166 mV/V When Direct
Input to CD90 Exceeds 166 mV)



3.9 LVDT/RVDT TRANSDUCER OPERATION (OUTPUTS GREATER THAN 166 mV/V) (Continued)

- C. Another method of reducing the signal at the CD90 is by installing a large capacitor in parallel at the CD90 input. This will virtually eliminate the effects of cable capacitance upon the signal from the LVDT. Since the LVDT is a high-inductance device, the effective transmitting impedance is typically on the order of 5 K to 10 K ohms.

When adequate shunt capacitance is installed, the phase shift of the input signal is 180° , thus reducing the effective input signal level at the CD90.

- D. Place the Balance Range Switch S2 (HI/LO switch) in the HI position for a balance range of ± 20 mV/V.
- E. Operate the same as described in paragraph 3-8B and C.

3.10 OUTPUT CONNECTIONS

- 3.10.1 The two outputs are obtained from two separate Cannon XLR-3-32S receptacles on the rear panel of the MCI Module Case marked "Output A" and "Output B". The pin assignments are the same for both receptacles and are as follows:

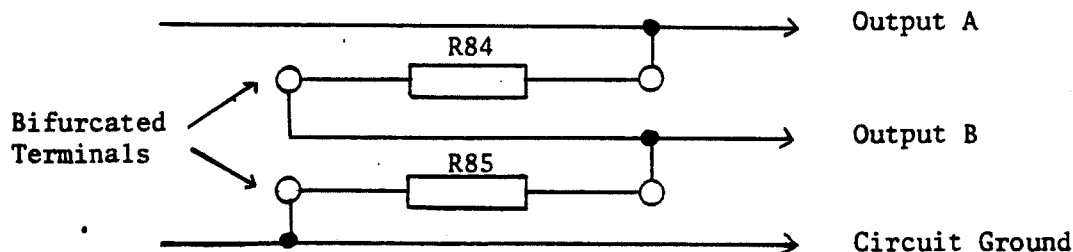
Pin 1 - Output

Pin 2 - System Ground

Pin 3 - Chassis Ground

The mating connectors are Cannon XLR-3-11C.

- 3.10.2 Output B is set at the factory to be one-tenth of Output A or nominally ± 1 volt DC full-scale. This relationship may be changed by changing the two resistors in the bifurcated terminals on the printed circuit board. Referring to Figure 2, these resistors are arranged schematically as follows:



$$\text{Output B} = \frac{R_{85}}{R_{84} + R_{85}} \times 10 \text{ volts}$$

$$\text{where } R_{84} + R_{85} = 1000$$

3.10 OUTPUT CONNECTIONS (Continued)

- 3.10.3 Output B may be used to drive galvanometers in which case resistors R_{84} and R_{85} would be used for impedance matching and galvo damping. Care should be taken to see that the total current load, that is, Output A load, plus R_{84} and R_{85} load, plus galvo load, does not exceed 100 ma.

For most applications involving fluid-damped galvanometers, a resistor in the R_{84} terminals of the proper value will provide the necessary damping resistance. It is recommended in general, that the value of R_{84} never be lower than 50 ohms. If a damping resistance of less than 50 ohms is required, it is recommended that a value for R_{85} be calculated to obtain the correct damping:

$$R_{85} = \frac{50 R_D}{50 - R_D} \quad \text{Where } R_D = \text{Required galvo-damping resistance}$$

Then, $R_{84} = 50$ ohms and $R_{85} =$ calculated value.

For low frequency magnetically-damped-type galvanometers, a high-source impedance or R_{84} resistance will be required to obtain the proper galvo current.

Using a value of $R_{84} = 100$ K ohms, for example, the value of R_{85} will, for all practical purposes, be equal to the required galvo-damping resistance. Thus, $R_{84} = 100$ K ohms and $R_{85} =$ specified galvo-damping resistance. If the galvo deflection is too great, R_{84} should be increased. Doubling R_{84} will decrease the deflection by 50%.

3.11 GAIN SWITCH AND VERNIER GAIN CONTROL

Both Output A and Output B are controlled by the gain switch and vernier gain control. With the 10-turn vernier gain control in the full clockwise position (1000 on the dial) the gain switch positions are calibrated as marked in millivolts per volt input necessary to produce rate +10 VDC at Output A. The vernier control reduces the gain below this value to accommodate signals between a setting and the next higher setting.

The maximum input signal for a particular gain switch setting should not be more than will produce a 10 volt output with a minimum vernier gain control dial reading of 200. This corresponds to an input of approximately 5 times that of the gain switch setting (50 mV/V at the 10 mV/V position; 500 mV/V at the 100 mV/V position, etc.).



3.12 R AND C BALANCE ADJUSTMENTS

- 3.12.1 To balance the transducer bridge, connect an AC voltmeter (3 volt range) or an oscilloscope (1 V/cm range) to the front panel test points. If the transducer is a high output type, such as variable reluctance, the "balance range" switch, also located on the printed circuit board, should be placed in the "HI" position. Place the switch in the "LO" position if the transducer is a low output type such as a strain-gage.

With zero stimulus on the transducer, the gain switch in the 100 mV/V position and the vernier gain control at 1000, adjust the R and C controls alternately to reduce the amplitude of the sine wave signal. Increase the gain with gain switch, step-by-step, continuing the R and C control adjustments until the signal is nulled out, or at a minimum, at the 0.1 mV/V position.

- 3.12.2 Set the gain switch to a position appropriate to the requirement of the transducer being used. A final adjustment of the R control may be necessary to bring the DC output at the output terminals to zero.

- 3.12.3 The R control will subsequently be used for transducer zero balance.

3.13 OUTPUT FILTER SELECTION

- 3.13.1 Referring to Figure 2, the low-pass output filter select switch (S4) is located on the "filter board". The three-switch positions provide cutoff frequencies of:

Position 1 = $\frac{1}{4}$ X carrier frequency

Position 2 = $\frac{1}{20}$ X carrier frequency

Position 3 = $\frac{1}{100}$ X carrier frequency

With a 3 kHz carrier, the cutoff frequencies are:

Position 1 = 750 Hz

Position 2 = 150 Hz

Position 3 = 30 Hz

- 3.13.2 As the CD90 may be operated with other carrier frequencies, (see paragraph 3.8, "Alternate Carrier Frequency Operation") the filter board is an exchangeable component. The filter characteristics are determined by the specific carrier frequency for which the board has been designed. Therefore, the filter selection switch positions actually represent:



3.13 OUTPUT FILTER SELECTION (Continued)

3.13.2 (Continued)

Position 1 = $\frac{1}{4}$ X filter board design carrier frequency

Position 2 = $\frac{1}{20}$ X filter board design carrier frequency

Position 3 = $\frac{1}{100}$ X filter board design carrier frequency

It can be seen, therefore, that by using a filter board designed for a lower carrier frequency than that being actually used, it is possible to obtain a lower frequency cutoff point, and different intermediate frequency cutoff points, than those supplied on the matching filter board. For example, when operating on a 3 kHz carrier frequency a 1 kHz filter board may be used to obtain cutoff frequencies as follows:

Position 1 = $\frac{1}{4}$ X 1000 Hz = 250 Hz

Position 2 = $\frac{1}{20}$ X 1000 Hz = 50 Hz

Position 3 = $\frac{1}{100}$ X 1000 Hz = 10 Hz

Using a filter board with a design carrier frequency higher than that being used will yield another set of cutoff frequency points.

The highest cutoff frequency obtainable, however, will be limited by other circuit components in the CD90. This limit is approximately $\frac{1}{3}$ of the actual carrier frequency being used; however, the DC output will have a higher noise content if the cutoff frequency is higher than $\frac{1}{4}$ of the actual carrier frequency.

3.14 REFERENCE PHASE ADJUSTMENT

3.14.1 The screwdriver adjust "Ref. \emptyset " control on the front panel is provided to correct for phase shift due to long line and reactive source operation. This correction is more significant when operating at higher carrier frequencies (10 Hz - 20 Hz).

3.14.2 With the transducer connected at its operating terminus, an input less than full scale is applied. Looking at the DC output, adjust the "Ref. \emptyset " control for a maximum reading.

3.14.3 When making the phase shift correction using a four-arm bridge transducer, the input may be simulated by connecting an appropriate resistor to the "Cal R" terminals and unbalance the bridge using the calibrate switch. (See paragraph 3.7, "Calibration Resistor Selection".) This scheme will not work with a two-arm bridge transducer.



3.14 REFERENCE PHASE ADJUSTMENT

- 3.14.4 If it is impossible to apply a pressure to a two-arm bridge transducer in place, it is best to leave the "Ref \emptyset " control in the "0⁰" position.
- 3.14.5 The basic effect of not compensating for this phase shift is an apparent decrease in transducer sensitivity. In extreme cases, this could result in over-driving the input amplifier when the gain is increased to compensate for the apparent decreased sensitivity.

3.15 EXTERNAL CALIBRATION RESISTOR SELECTION

- 3.15.1 The Calibration switch on the front panel is a three-position, "center off", switch that provides either a plus or minus shunt resistor calibration. The shunt resistor is externally connected at the "Cal R" terminals provided on the front panel. Any plus or minus percentage of full-scale may be simulated by proper selection of the calibration resistor.

The "R" balance control is scaled to balance zero offsets up to ± 25 mV/V. In applications where offset capability is desired, a potentiometer can be connected at the "Cal R" terminals and the "Cal +/-" operated continuously.

- 3.15.2 The following formulas may be used to calculate the appropriate value for the calibration resistor:

2-Arm Bridge Operation:

$$R_c = 250 \frac{(1000 - 2E_{\text{Cal}})}{E_{\text{Cal}}}$$

4-Arm Bridge Operation:

$$R_c = \frac{R_B}{4} \frac{(1000 - 2E_{\text{Cal}})}{E_{\text{Cal}}}$$

Where:

R_c = calibration resistor in ohms,

R_B = transducer bridge resistance in ohms,

E_{Cal} = desired calibration voltage sensitivity in mV/V

3.16 ALTERNATE CARRIER FREQUENCY OPERATION

- 3.16.1 The CD90 is designed so that it may be operated with any carrier frequency of from 400 Hz to 20 kHz by a simple procedure of changing the "Frequency Determining Board" (P/N 7722) and the "Filter Board" (P/N 7723) plugged into the main circuit board behind the front panel. Refer to Figure 2.
- 3.16.2 When shipped from the factory, the unit contains boards for a 3 kHz carrier frequency unless otherwise specified. Boards designed for carrier frequencies of 400 Hz, 1 kHz, 3 kHz, 5 kHz, 10 kHz and 20 kHz are available as standard parts. However, boards for any carrier frequency between 400 Hz and 20 kHz can be supplied. Section 3.16.7, Page 24 gives board specifications.
- 3.16.3 Referring to Figure 2, the "Frequency Determining Board" is changed by removing the 2-56 mounting screw in the center of the board and pulling straight up. Replace with a board marked with the desired carrier frequency, taking care to see that the pins of the inter-board connector are properly mated. If properly mated, the mounting screw hole in the board will line up with the mounting stand-off on the main board. Replace the 2-56 mounting screw.
- 3.16.4 The "Filter Board" is changed by removing the two 4-40 mounting screws at opposite corners of the board and pulling the board straight up, taking care not to bend the inter-board connector. Replace with a board marked with the desired carrier frequency. Match the notched corner of the board with the HI/LO switch sub-panel, sighting through the mounting screw holes and aligning the holes with the standoffs on the main board and pushing down over the inter-board connector at the left end of the board. Replace the two 4-40 mounting screws.
- 3.16.5 At times, it may be desirable to operate with a Filter Board which has a design carrier frequency different from the actual carrier frequency being used. See paragraph 3.5.2 for the details.
- 3.16.6 The CD90 may be operated separately using a mating PC board connector. (+) 15 VDC is connected to Pin 3; (-) 15 VDC is connected to Pin 7; Pin 15 is circuit ground and a single-ended frequency source is connected to Pin 2. Again, refer to Figure 2. A good quality laboratory-type signal generator should be used having a very high degree of amplitude and frequency stability, and capable of producing 2.5 volts RMS into 12.4 K ohms, shunted by 220 pF.
- Output A appears at Pin 12 and Output B at Pin 14. Proper Frequency Determining and Filter Boards must be used as described above.



3.16 ALTERNATE CARRIER FREQUENCY OPERATION (Continued)

3.16.7 "Frequency Determining Boards" and "Filter Boards" for the CD90 are identified by Validyne part numbers 7722-X and 7723-X respectively. Dash numbers and corresponding frequencies appear below:

A. "Frequency Determining Board", V.E. #7722-(X)

Board Dash #	-1	-2	-3	-4	-5
Carrier Freq.	3 kHz	5 kHz	10 kHz	20 kHz	400 Hz

B. "Filter Board", V.E. #7723-(X)

Board Dash #	-1	-2	-3	-4	-5
Carrier Freq.	3 kHz	5 kHz	10 kHz	20 kHz	400 Hz
Position 1	750 Hz	1250 Hz	2500 Hz	5000 Hz	100 Hz
Position 2	150 Hz	250 Hz	500 Hz	1000 Hz	20 Hz
Position 3	30 Hz	50 Hz	100 Hz	200 Hz	4 Hz

The CD90 may be operated with any carrier frequency from 400 Hz to 20 kHz by changing internal plug-in control boards, making it possible to achieve a wide-band frequency response of 5 kHz with a 20 kHz carrier frequency.



SECTION 4

4.1 THEORY OF OPERATION

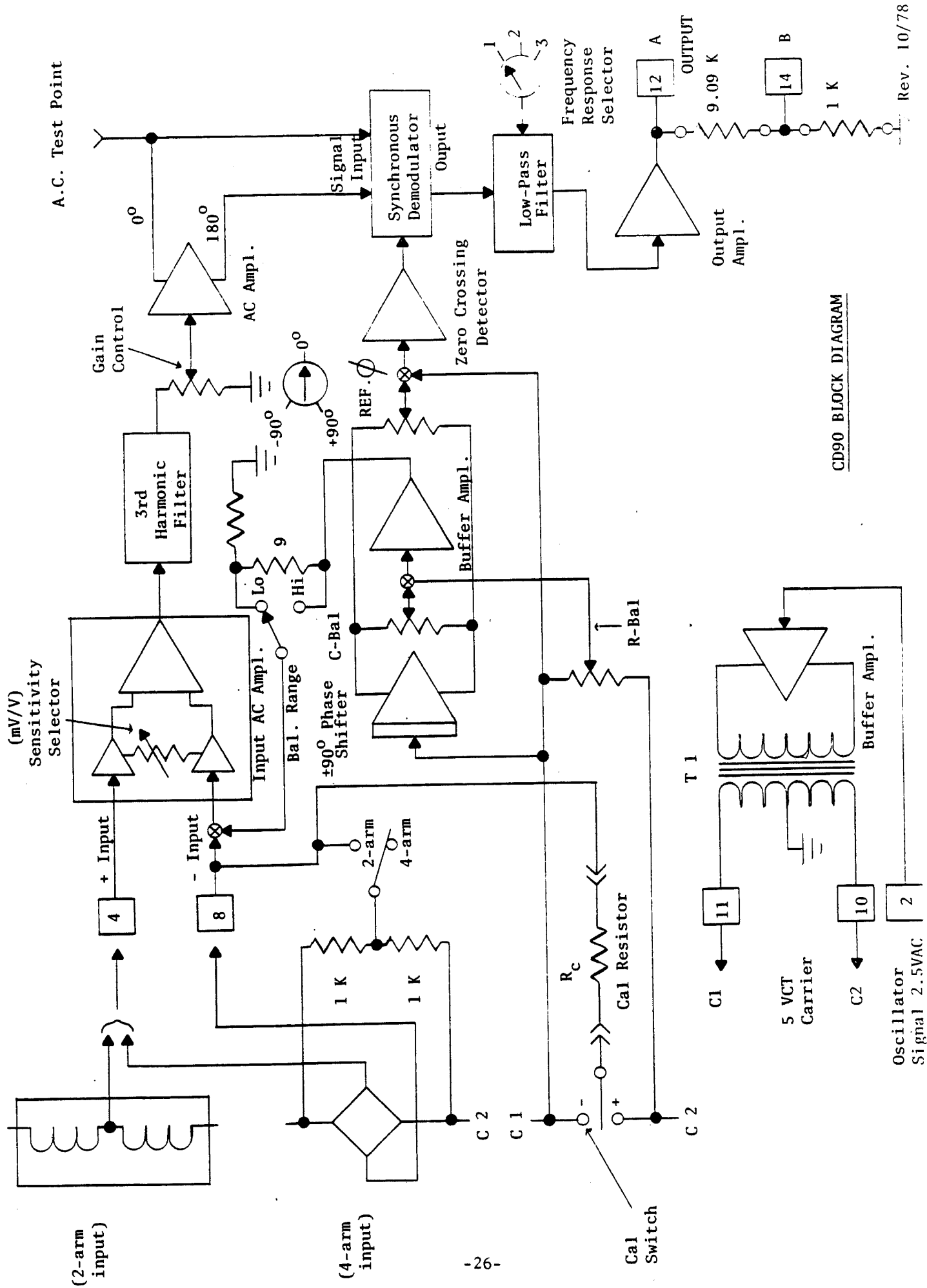
A sophisticated carrier demodulator design is needed to accurately condition signals ranging in level down to 0.1 mV/V. The CD90 contains the necessary flexibility to operate with two and four-arm input signal sources. A third-harmonic filter rejects magnetic sensor waveform distortions to allow high AC gain prior to demodulation. A variable phase control enables the demodulator excitation to be adjusted to agree with the signal phase reaching the CD90. Plug-in boards allow the CD90 to be normalized for frequencies ranging between 400 Hz and 20 kHz.

The CD90 block diagram shows the balanced input amplifier configuration with 2-arm or 4-arm input selector, and plug-in calibration resistor features. The input AC amplifier has a 10-position sensitivity selector ranging from 0.1 mV/V to 100 mV/V in a 1, 2.5, 5 step sequence.

A 90° phase shifter enables a C balance, or quadrature signal to be summed with an R-balance, or in-phase balance signal. A balance range switch gives a 10:1 authority selection for the balance signal. The balance controls are adjusted to obtain a null indication at the AC test point at the demodulator input. Absence of waveform clipping at the test point during full-scale signal excursions assures linear output signal response. The reference phase control allows the synchronous demodulator to be tuned for maximum sensitivity.

Frequency response of the low-pass filter is selected at 0.25, 0.05, or 0.01 times the carrier frequency. The output amplifier provides up to ± 100 mA at ± 10 VDC to the A-output, and a ± 1 VDC signal to the B-output.

A buffered carrier signal is provided by the CD90. This configuration virtually eliminates channel crosstalk when many high-gain channels are used in a system application. The 5 VAC carrier excitation provided by the CD90 is compatible with a 100 ohm or greater load.



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