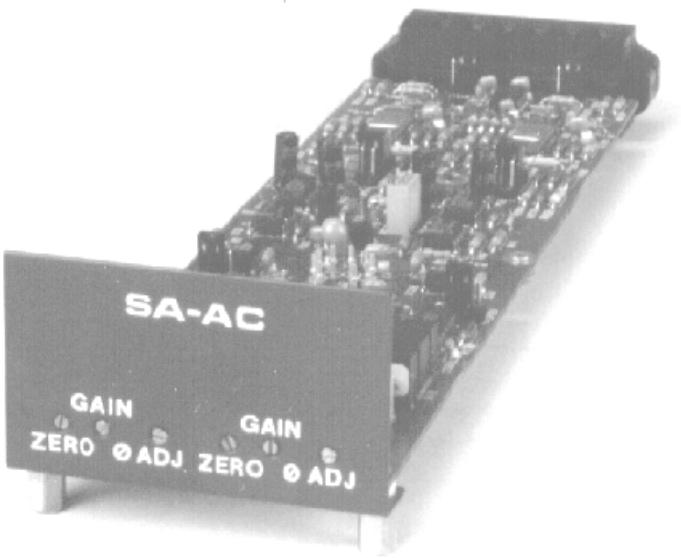
MODEL
SA-AC



SENSOTEC

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Sensotec, Inc.

Model SA-AC Instruction Manual
Sensotec Part Number: 008-0162-00
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IMPORTANT! IT IS RECOMMENDED THAT YOU READ THIS DOCUMENT THOROUGHLY BEFORE APPLYING POWER TO THIS UNIT. THIS DOCUMENT CONTAINS INFORMATION ON WIRING, CALIBRATION, AND USE OF FEATURES.

SA-AC DEMODULATOR

The SENSOTEC Model SA-AC Carrier Demodulator is a member of the SA- line of signal conditioners. The SA-AC is a dual channel unit which provides 5 KHz carrier excitation sufficient to drive LVDT's and variable reluctance devices. Excitation is provided at three volts RMS.

Amplification of transducer output is accomplished with a digitally-set instrumentation-type operational amplifier. Thus, gain and offset are tightly controlled.

Demodulation of the transducer signal is performed digitally by sampling of the modulated carrier waveform using a timing circuit and a sample-and-hold amplifier. The sampling time is locked precisely to the carrier waveform, since both are formed from the same source. This technique permits accurate demodulation with good stability of output.

Specifications

OUTPUT:	± 5V
OUTPUT IMPEDENCE:	Less than 1 ohm with a current drive of 2.5mA with overvoltage protection to +/- 25V.
GAIN RANGE:	.25 TO 500
INPUT IMPEDANCE:	600K ohms
EXCITATION:	3 volts RMS at 5 KHz

THEORY OF OPERATION

In conventional demodulation, a carrier transducer's (such as an LVDT) output signal is amplified, rectified, and then filtered to remove the carrier. The transducer response signal is nearly sinusoidal, varying in amplitude as a function of mechanical stimulus on the transducer input. Some transducers (such as variable reluctance devices) vary in phase as well.

Consider Figure 1. A 5 KHz transducer drive signal is shown. The transducer response output is also shown, both in its uncorrected and phase-corrected modes. The signal is next synchronously rectified, then filtered.

In the SA-AC, digital demodulation is performed rather than conventional demodulation. Consider Figure 2. The transducer drive and response signals are exactly as in Figure 1. In any form of demodulation, phase correction is merely time correction. With digital demodulation, phase alignment between the carrier and the response is not necessary, since the response is merely time-sampled to obtain a peak signal (for LVDTs), thereby achieving phase correction. A narrow sample signal is used to time the sample-and-hold amplifier, thereby producing the desired output without rectification and without filtering.

The accurate time relationship between the sampling signal and the carrier signal is established by generating both from the same source. Consider Figure 3. A 100 KHz square-wave oscillator generates a signal which is used to drive a 10-stage Johnson counter. The various counter outputs are summed algebraically to form a quasi-sinusoidal staircase output. The first harmonic present is the 31st, thus making filtering very easy. Since the sinusoidal transducer drive signal is generated by the Johnson counter, precise 18-degree markers may be obtained by using one of the 10 available outputs.

Further, by selecting the polarity of the signal used to drive the continuous time-delay circuit, both positive and negative phase shifts can be accommodated. The output of the continuously-variable delay feeds a fixed-delay circuit, used to provide the proper width sampling pulse to the sample-and-hold circuit. The digitally-controlled signal amplifier also feeds this circuit. Output is amplified by the output amplifier, which also gives a means for offsetting the zero if needed.

WIRING THE TRANSDUCER TO THE SA-AC

All connections to the SA-AC may be made on the rear connector, for both channels. Functions for the various pins are:

FUNCTION	LEFT CHANNEL	RIGHT CHANNEL
+Drive Excitation	11	5
-Drive Excitation	12	6
+Transducer Output	9	3
-Transducer Output	10	4
+Channel Output	8	2
-Channel Output (gnd)	7	1

To connect standard 4- or 5- wire LVDT's to the SA-AC, connect as shown in Figure 4. 3-wire LVDT's and variable reluctance transducers connect as shown in Figure 5. Notice that 3-wire devices require an additional connection from the -Transducer Output pin to the - Channel Output pin. This connection may be made on the rear connector (pins 7 and 10, or pins 1 and 4 interconnected).

FIELD ADJUSTMENTS

EXCITATION ADJUST. This adjustment sets the transducer drive at 3 V RMS, and is normally not required, but may be necessary when transducers are exchanged. Using a good AC voltmeter capable of accurate readings at 5 KHz, adjust the excitation potential to give 3 V RMS at either transducer drive terminal. Both channels are adjusted simultaneously.

PHASE Adjustment. With some signal coming from the transducer, connect a voltmeter to the respective channel output. Rotate the corresponding 18 degree PHASE SHIFT switch (see Figure 6) to get a maximum output. Then rotate the front-panel PHASE potentiometer to yield a peak on the meter. Be sure you have a peak, and that the meter simply does not increase without a fall as you move the potentiometer further. If you find that a definite peak does not occur, change the 18 degree PHASE SHIFT switch to one of the neighboring positions (one way or the other) and try again. Sufficient adjustment exists in the potentiometer to cover more than 18 degrees, so the adjustment can always be made to see a peak condition.

ZERO Adjustment. Locate the transducer null output position if it is not already known. This may be accomplished by connecting a voltmeter capable of reading at 5 KHz across the transducer's output at the SA-AC's connector. (In the case of 3-wire devices, connect the voltmeter between transducer output and ground). Move the LVDT's armature to get the lowest reading possible (probably not 0). This is the mechanical null position. Mark it in some manner. Connect a voltmeter to the Channel Output terminals, and adjust the front panel ZERO control to give a reading of zero on the voltmeter.

GAIN SWITCHES. These switches are normally factory-set at the proper level for the transducer you are using. However, the proper setting can also be made simply in the field. Figure 6 shows the location of the switches, and gives a range table for the proper gain settings. To determine the gain needed, proceed as follows:

1. Determine the transducer output. Consider an LVDT that is rated at 2 millivolts per volt per mil displacement (2 mV/V/.001"). The SA-AC provides 3 V RMS drive, so each mil (.001") of physical displacement will yield 6 millivolts of signal (3 x 2). Thus, if the desired full-scale displacement is 20 mils (0.020"), the full-scale output of the transducer will be 6 x 20 = 120 millivolts. Because the SA-AC uses peak values, this number must be multiplied by 1.414 to yield the proper number:

   120 x 1.414 = 169.7

2. Determine the gain:

$$A = \frac{\text{Desired Channel Output}}{\text{Peak Transducer Output}}$$

For example, with the above transducer, suppose the full-scale output is to be 5 volts:

$$A = \frac{5000 \text{ millivolts}}{169.7 \text{ millivolts}} = 29.46$$

Set the gain switches as shown in the table, for the bracketing gain level.

POLARITY Adjustment. If, with motion of the LVDT, the polarity of the change in output is incorrect, move the 180 degree PHASE SHIFT switch (see Figure 6) to its opposite position.

GAIN Adjustment. Finally, the transducer may be excited with a known stimulus (known displacement or pressure). Adjust the front panel GAIN potentiometer to give the desired output.

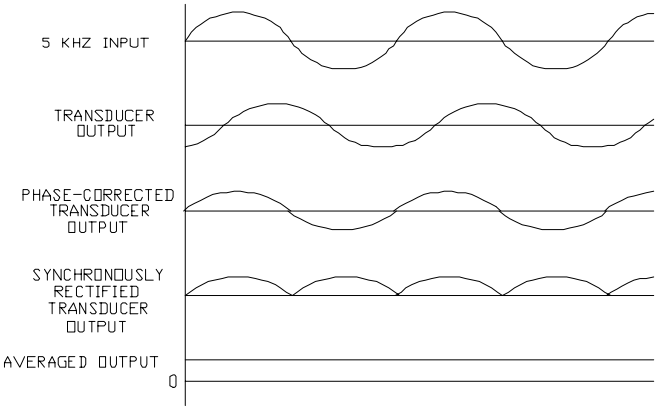


FIGURE 1 – CONVENTIONAL DEMODULATION

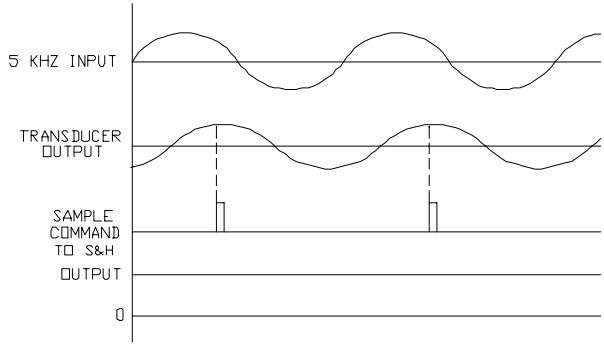


FIGURE 2 – DIGITAL DEMODULATION

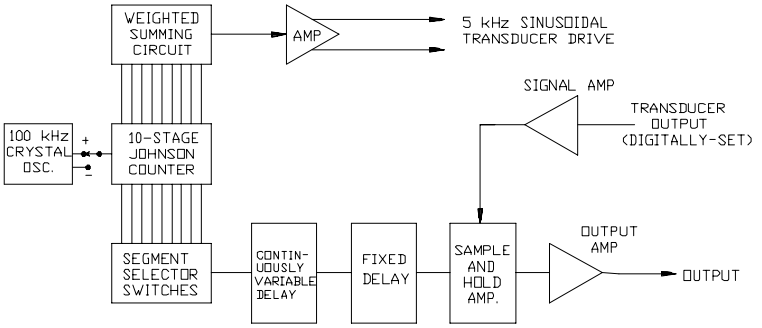


FIGURE 3 - DIGITAL DEMODULATOR BLOCK DIAGRAM

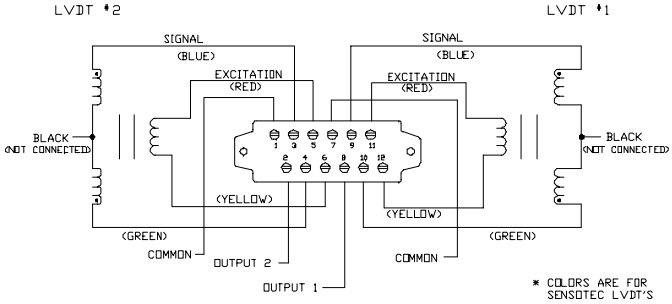


FIGURE 4: 4- AND 5-WIRE LVDT HOOKUP

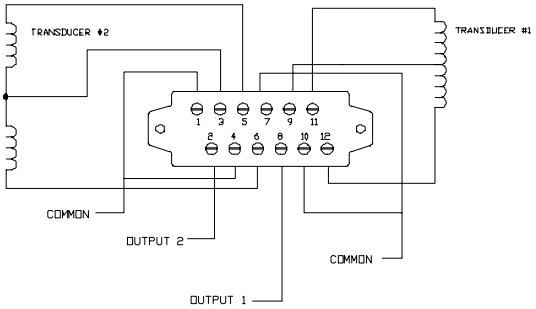
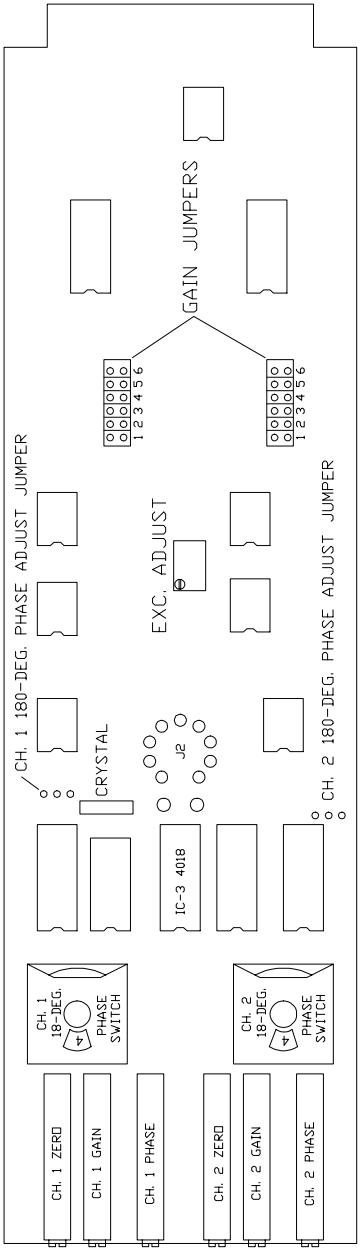


FIGURE 5: 3-WIRE TRANSDUCER HOOKUP


CH. 1 180-DEG. PHASE ADJUST JUMPER
CRYSTAL
J2
EXC. ADJUST
GAIN JUMPERS
1 2 3 4 5 6
1 2 3 4 5 6
CH. 2 180-DEG. PHASE ADJUST JUMPER
IC-3 4018
CH. 1 18-DEG. PHASE SWITCH
CH. 2 18-DEG. PHASE SWITCH
CH. 1 ZERO
CH. 1 GAIN
CH. 1 PHASE
CH. 2 ZERO
CH. 2 GAIN
CH. 2 PHASE

Gain Jumpers in Place	Minimum	Maximum
1	.24	.72
2	.64	1.93
1 + 2	.81	2.43
3	2.33	7.00
1 + 2 + 3	2.86	9.20
4	8.95	26.77
1 + 2 + 3 + 4	11.95	35.82
5	32.40	97.20
1 + 2 + 3 + 4 + 5	44.30	132.70
6	124.20	372.70
1 + 2 + 3 + 4 + 5 + 6	168.00	505.30

APPENDIX

A.1.1 LIMITED WARRANTY ON PRODUCTS

Any of our products which, under normal operating conditions, proves defective in material in workmanship within one year from the date of shipment by SENSOTEC, will be repaired or replaced free of charge provided that you obtain a return material authorization from SENSOTEC and send the defective product, transportation charges prepaid with notice of the defect, and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage. Replacement product will be shipped F.O.B. our plant. The terms of this warranty do not extend to any product or part thereof which, under normal usage, has an inherently shorter useful life than one year. The replacement warranty detailed here is the buyer's exclusive remedy, and will satisfy all obligations of SENSOTEC whether based on contract, negligence, or otherwise. SENSOTEC is not responsible for any incidental or consequential loss or damage which might result from a failure of any SENSOTEC product. This express warranty is made in lieu of any and all other warranties, express or implied, including implied warranty of merchantability or fitness for particular purpose. Any unauthorized disassembly or attempt to repair voids this warranty.

A.1.2 SERVICE UNDER WARRANTY

Advanced authorization is required prior to the return to SENSOTEC. Before returning the items, either write to the Customer Service Department c/o SENSOTEC, Inc., 2080 Arlingate Lane, Columbus, Ohio 43228, or call (800) 848-6564 with: 1) a part number; 2) a serial number for the defective product; 3) a technical description* of the defect; 4) a no-charge purchase order number (so products can be returned to you correctly); and 5) ship and bill addresses. Shipment to SENSOTEC shall be at Buyer's expense and repaired or replacement items will be shipped F.O.B. our plant in Columbus, Ohio. Non-verified problems or defects may be subject to an evaluation charge. Please return the original calibration data with the unit.

A.1.3 NON-WARRANTY SERVICE

Advance authorization is required prior to the return to SENSOTEC. Before returning the item, either write to the Customer Service Department c/o SENSOTEC, Inc., 2080 Arlingate Lane, Columbus, Ohio 43228, or call (800) 848-6564 with: 1) a model number; 2) a serial number for the defective product; 3) a technical description* of the malfunction; 4) a purchase order number to cover SENSOTEC's repair cost; and 5) ship and bill addresses. After the product is evaluated by SENSOTEC, we will contact you to provide the estimated repair costs before proceeding. Shipment to SENSOTEC shall be at Buyer's expense and repaired items will be shipped to you F.O.B., our plant in Columbus, Ohio. Please return the original calibration data with the unit.

A.1.4 REPAIR WARRANTY

All repairs of SENSOTEC products are warranted for a period of 90 days from date of shipment. This warranty applies only to those items which were found defective and repaired, it does not apply to products in which no defect was found and returned as is or merely recalibrated. Out of warranty products may not be capable of being returned to the exact original specifications or dimensions.

* Technical description of the defect: In order to properly repair a product, it is necessary for SENSOTEC to receive information specifying the reason the product is being returned. Specific test data, written observations on the failure and the specific corrective action you require, are needed.