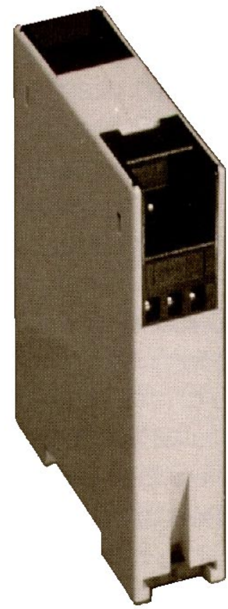
DLD SERIES
LVDT DEMODULATORS



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<u>DLD Series LVDT Demodulators</u>
Model DLD-VH (18-36 VDC supply, Voltage output)
Model DLD-CH (18-36 VDC supply, Current output)
Model DLD-VL (10-18 VDC supply, Voltage output)
Model DLD-CL (10-18 VDC supply, Current output)

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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.

TABLE OF CONTENTS

Chapter 1
INTRODUCTION
1.1 Overview 1-1
1.2 What is an LVDT? 1-1
1.3 What is the Purpose of a Demodulator? 1-2
1.4 Specifications 1-3
1.5 Layout 1-4

Chapter 2
INSTALLATION / SETUP
2.1 Mounting 2-1
2.2 Wiring 2-1

Chapter 3
CALIBRATION
3.1 Important Note 3-1
3.2 Calibration Theory and Overview 3-1
3.3 Calibration Procedure 3-2
3.3.1 Determining the Electrical Null 3-2
3.3.2 Locate Mechanical Null and Superimpose with Electrical Null 3-3
3.3.3 Set the Span switches 3-3
3.3.4 Set the Span Potentiometers 3-5
3.3.5 Offset the Demodulator (if needed) 3-6

Chapter 4
WARRANTY / REPAIR POLICY
4.1 Limited Warranty on Products 4-1
4.2 Service Under Warranty 4-1
4.3 Non-Warranty Service 4-2
4.4 Repair Warranty 4-2

Chapter 1
INTRODUCTION

1.1 Overview

The DLD Series of LVDT Demodulators feature 35mm DIN-rail mounting and connect between a LVDT and a readout instrument. These demodulators supply an AC excitation voltage to the LVDT and convert the modulated output signal from the LVDT into a demodulated signal.

Four models are available with various power supply and output options as illustrated in the table below.

Table 1: Available Options

Sensotec p/n	model	supply voltage	output
060-6879-01	DLD-VH	18-36 VDC	+/-5 volt or +/- 10 volt (field selectable)
060-6879-02	DLD-CH	18-36 VDC	4-20 mA
060-6879-03	DLD-VL	10-18 VDC	+/-5 volt or +/- 10 volt (field selectable)
060-6879-04	DLD-CL	10-18 VDC	4-20 mA

1.2 What is an LVDT?

Linear Variable Differential Transformers (LVDTs) are devices for the measurement of distances. They are used to measure tiny to large ranges, from millionths of an inch to many inches. Typically, LVDTs have one primary and two nearly-identical secondary windings. The primary serves to couple the excitation signal to the secondaries, which are hooked up in a series opposing configuration. Coupling to the secondaries depends upon the location of an armature, which moves with the mechanical motion of the device to which it is attached. If the armature is centered, equal coupling to both coils exists, and the signals from the coils cancel each other. If the armature is then displaced, coupling to one of the coils increases, and decreases to the other. The result will be an increase of signal, either in phase or out of phase with the excitation signal, depending upon which direction the armature is moved. Thus, the LVDT not only is very sensitive and accurate in detecting mechanical motion, it is also sensitive to the direction of the motion. Because LVDTs are transformers there is no electrical continuity between primary and secondary coils.

1.3 What is the Purpose of a Demodulator?

Because an LVDT is truly a transformer, it must be excited with alternating current, and therefore it is necessary to demodulate the output signal. Typically, the excitation (or "carrier") frequency is ten times the expected frequency of motion to be detected. Sensotec suggests that its LVDTs be excited with a 5k Hz carrier frequency; the LVDT demodulator provides this excitation. The output of the LVDT consists of the carrier, modulated by the frequency of the motion. Demodulation is the process of extracting the intelligence (the motion) from the modulated carrier. Because of the ratio (10:1) between the carrier and the motion frequency, most Sensotec LVDTs are usable to about 300 to 500 Hz motion frequency.

1.4 Specifications

Power Requirements:	p/n 060-6879-01 and 060-6879-02: 18 - 36 volts DC @ 150 mA p/n 060-6879-03 and 060-6879-04: 10 - 18 volts DC @ 150 mA
LVDT Excitation:	3 volts RMS @ 5 kHz
Output Voltage Range:	Model DLD-V: +/- 5 volts or +/-10 VDC, field selectable Model DLD-C: 4-20 mA
Frequency Response:	0 to 300 Hz
Zero Adjustment Range:	+/- 100% coarse, +/- 20% fine adjustment range
Gain Adjustment Range:	Switch selectable (0.1 to 15 VRMS), +/-10% fine adjust
Linearity:	+/- 0.05% of full-scale
Enclosure Style:	35mm DIN rail mounting
Enclosure Size:	22.5mm x 75mm x 98.5mm (0.886” x 2.953” x 3.878”)
Operating Temperature:	-20 to 140 degrees F
Thermal Stability:	+/- 0.22% of full-scale maximum
Power Supply Isolation:	500V

1.5 Layout

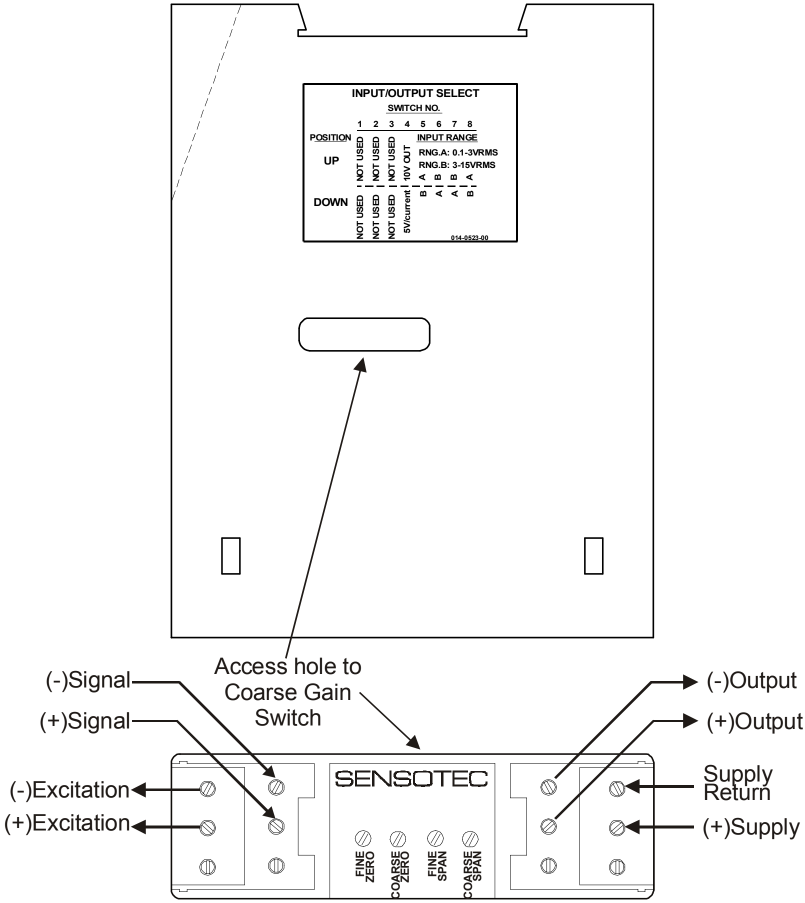

Figure 1-1: Layout and Wiring of Model DLD-V and Model DLD-C LVDT Demodulators

Chapter 2
INSTALLATION / SETUP

2.1 Mounting

The DLD Series of LVDT Demodulators snap onto standard 35mm DIN rails. One side of the enclosure is slotted and the other is unslotted. Hook the unslotted side of the enclosure onto the rail, then press the slotted side firmly until it snaps onto the rail.

To remove the enclosure from the DIN rail, place a small flat-bladed screwdriver in the slot and turn it slightly. This releases the rail clamp, and the enclosure may be removed.

2.2 Wiring

DLD Series LVDT Demodulators should be wired according to Figure 1-1.

LVDTs are usually supplied as four- or five-wire devices. Both types may be connected to these demodulators using four terminals, as shown in Figure 1-1. For four-wire LVDTs, the manufacurer has tied the two secondary coils in series-opposing configuration to get a single coil. In the case of five-wire devices, the fifth wire is the center tap of the secondary, and is not connected to these demodulators.

Chapter 3
CALIBRATION

3.1 Important Note

A common error in setting up LVDTs with demodulators is failing to superimpose the mechanical and electrical nulls; the result of this is that the demodulator output will be non-linear.
Please read this chapter before calibrating the demodulator to the LVDT to insure proper operation.

3.2 Calibration Theory and Overview

LVDTs have a finite bilateral linear range. For example, if we have a 1-inch LVDT, we can expect it to be linear in a range slightly in excess of +/- 1 inches from its mechanical null position (see the figure below). We cannot expect it to be linear for a great distance in excess of the specified range. We can count on the fact that it will be non-linear long before the displacement gets to 1.5 inches. Further, we cannot expect the LVDT to be useful to us if we are operating outside its linear range.

The steps of the calibration procedure are:

- Determine where electrical null is
- Locate the mechanical null and superimpose it with the electrical null
- Set the SPAN switches
- Set the SPAN potentiometers
- Offset the demodulator, if required

Each step is detailed in the following section.

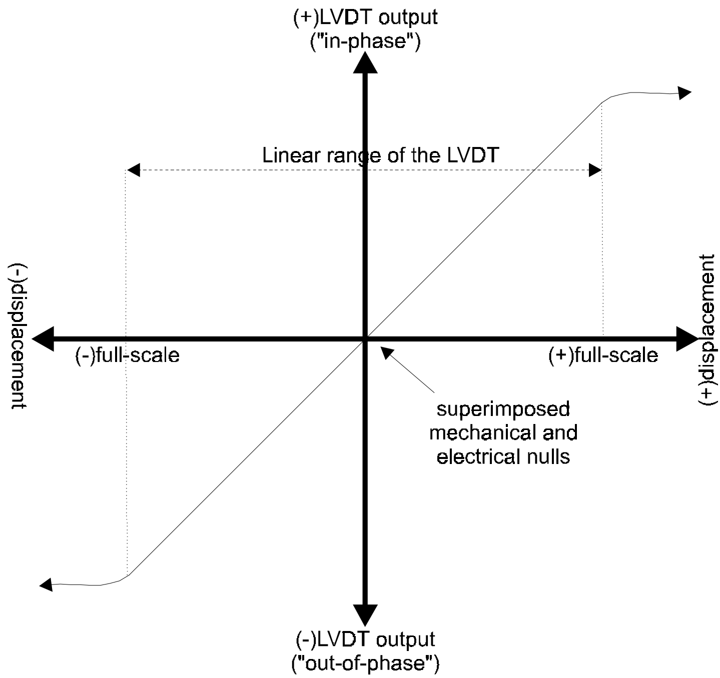

Figure 3-1: Linear Range of an LVDT

3.3 Calibration Procedure

<u>3.3.1 Determining the Electrical Null</u>

After connecting the LVDT to the demodulator, mount the LVDT in its holder. Hopefully, it is possible to move the body of the LVDT in the holder, so that the armature is in contact with the point to be measured, but that we can get the body to shift on the armature some distance. Do the following to find electrical null:

a. If you are using a Model DLD-VH or DLD-VL (voltage output), connect a digital voltmeter to the (+)Output and (-)Output terminals. If you are using a Model DLD-CH or DLD-CL (4-20mA current output), place a precision 100-ohm resistor between the output terminals and connect a voltmeter across it.

b. Install a jumper wire between (+)Signal and (-)Signal terminals. This insures that the demodulator has a true zero input signal.

c. Using the COARSE ZERO and FINE ZERO potentiometers, set the output so that it reads zero volts (Models DLD-VH/DLD-VL) or 0.4 volts (Models DLD-CH/DLD-CL). The present setting of the potentiometers now represents electrical null.

3.3.2 Locate Mechanical Null and Superimpose with Electrical Null

a. Remove the jumper between (+)Signal and (-)Signal terminals. Observe the voltmeter, and note that moving the body of the LVDT with reference to its armature will cause the output to vary. Slowly move the body of the LVDT so that the output voltage approaches zero (Models DLD-VH/DLD-VL) or 0.4 volts (Models DLD-CH/DLD-CL). Get it as close as you can, then clamp the body down. Mechanical null is now superimposed on electrical null.

b. Small errors in this setup can be cancelled out using the FINE ZERO potentiometer.

3.3.3 Set the Span switches

Five switches are used to set span and output voltages. They are accessed through the side of the enclosure. Eight switches are visible, but three of these (nos. 1, 2, 3) have no function in the demodulator. The switches are set from a knowledge of the desired output voltage, and the LVDT full-scale output.

a. Determine the desired output signal type from the demodulator. For the Models DLD-VH or DLD-VL (voltage output) use switch 4 to select +/-5 volt or +/-10 volt output. For the Models DLD-CH or DLD-CL (current output) switch 4 should always be set to OFF to enable the 4-20mA output.

b. Determine the output of the LVDT assuming 3 volts excitation, and the desired full-scale. Generally, outputs of LVDTs are given in units of “volts-per-volt-per-mil” where the term "mil" refers to 0.001 inches. Therefore, multiply the full-scale range of the LVDT (in thousandths of an inch) by its sensitivity (in volts-per-volt-per mil) by 3 (representing the fact that the excitation voltage is 3 volts RMS). As an example, assume that we have an LVDT with a sensitivity of 5 millivolts per volt per mil, and we are using it over a range of 0 to 0.5 inches. The full-scale output of this LVDT is therefore:

$$(.005)(500)(3) = 7.5 \text{ vRMS}$$

c. Note on the diagram near the switches that there are only two ranges listed, “Range A: 0.1 to 3 vRMS” and “Range B: 3 to 15vRMS”. Move the four switches to correspond to the LVDT output calculated in Step b. For our example, this would be the “3 to 15vRMS” since our example gives 7.5 vRMS.

SPECIAL NOTE: Many LVDT users prefer to use their sensors over the full range of the device, but set up their demodulators for unidirectional output only. As an example, suppose that there is a measurement of two inches to be made. One alternative (the better one) is to use a +/- 2" LVDT, and use it from null to positive full scale. Thus, when this LVDT is at 0, an output of 0 volts is obtained, and when it is at 2", an output of + full-scale (say, 5 volts) is obtained. An alternative is to use a +/- 1" LVDT and offset the output, so that when the LVDT is at - 1", an output of 0 volts is obtained, and when it is at +1" (from null) an output of + full scale is obtained. This second alternative, while popular, is not quite as accurate as the first one, because LVDTs have slightly different sensitivity values each side of null due to slight differences in the winding of the coils. The reason for mentioning this alternative at this point is that different span settings may be required for the two alternatives. When determining the input voltage, this needs to be kept in mind. If you are planning on using your LVDT in this offset fashion, set up the LVDT to give half of the full-scale output voltage when a full-scale displacement is placed on it. Later, this will be corrected when we offset the demodulator.

3.3.4 Set the Span Potentiometers

Next, the COARSE SPAN and FINE SPAN potentiometers will be set so that the span range is correct. In doing this, we will offset the LVDT by a known amount, and set the potentiometers to give the proper voltage output.

a. Set the LVDT at its null position, and verify that the output voltage from the demodulator is zero volts (Models DLD-VH/DLD-VL) or 0.4 volts (Models DLD-CH/DLD-CL). If it is not, adjust the FINE SPAN potentiometer as needed.

b. Displace the LVDT to its full-scale displacement, and adjust the COARSE SPAN and FINE SPAN controls to give the full-scale output. The full-scale output would either be 5 or 10 volts (Models DLD-VH/DLD-VL) or 2 volts (Models DLD-CH/DLD-CL). If it is not possible to displace the full-scale amount and a lesser amount is necessary, scale the setup voltage by the ratio of this amount and full-scale.

SPECIAL NOTE: Inexpensive gage blocks are available that greatly facilitate setup and checkout of systems employing LVDTs. They give a quick method to verify setup accuracy, particularly when working with machines on a shop floor.

3.3.5 Offset the Demodulator (if needed)

Up until this point in the setup procedure, we have assumed a bidirectional (+/-) LVDT setup, except for a note regarding unidirectional capability. At this point, we will offset the demodulator to cover the unidirectional setup for users doing this. If you are using your LVDT bidirectionally (a negative displacement gives a negative value, and a positive displacement gives a positive value), please skip this section.

a. Set the LVDT for a negative full-scale displacement. Adjust the COARSE ZERO and FINE ZERO to give an output of zero volts.

b. Set the LVDT for positive full-scale displacement. Adjust the COARSE SPAN and FINE SPAN for the positive full-scale output.

c. Again set the LVDT for negative full-scale displacement. Check to see if the voltage is still at zero volts (Models DLD-VH/DLD-VL) or 0.4 volts (Models DLD-CH/DLD-CL). If not, set it again. Frequently it is necessary to repeat steps a and b several times, because of interaction.

This completes the calibration procedure.

Chapter 4
WARRANTY / REPAIR POLICY

4.1 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.

4.2 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.

4.3 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.

4.4 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 is needed.