DEMOD - DVRT® -2

Displacement Sensor Signal Conditioner

The DEMOD - DVRT® -2 is a high-performance signal conditioning module used with LORD MicroStrain® Differential Variable Reluctance Transducers (DVRT®). The signal conditioner provides a precision excitation source for the DVRT as well as filtering and buffering of the output signal. The DEMOD - DVRT -2 signal conditioner produces an analog voltage output that is fit to the full scale range of the sensor using the provided linear, multi-segmented, and polynomial calibration models. The factory calibration is performed with the DVRT sensor and cable that will be used in the final application and must remain as a set to ensure system accuracy.

The DEMOD - DVRT -2 comes with several components (see Components List on page 1). DVRT sensors are purchased separately based on what is suitable for the application. Several accessories are available for the DEMOD - DVRT -2 including a four module backplane for multi-sensor applications.

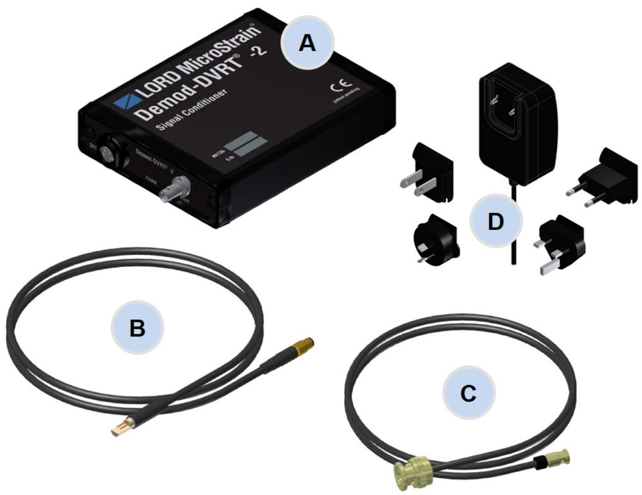
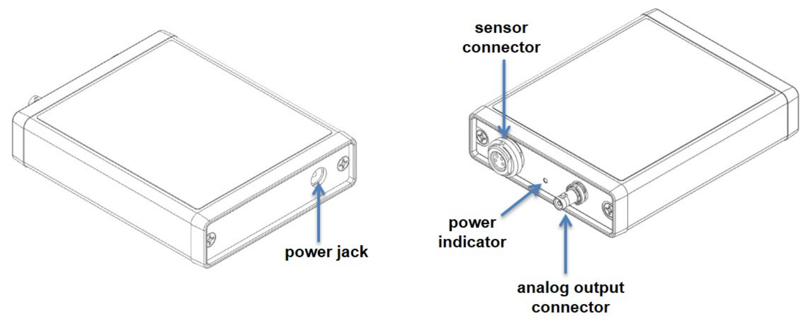


Figure 1 - Signal Conditioner Components

Item	Description	Quantity
A	DEMOD - DVRT® -2 signal conditioner	1
B	Sensor cable (4-pin to 4-pin mini, 6.5 feet)	1
C	Output cable (HD-BNC to BNC, 3 feet)	1
D	Power supply with plug adapter kit	1
--	Calibration Certificate	1

Table 1 - Components List

The DEMOD - DVRT -2 interface includes a sensor connector, an analog output connector, a power input jack for providing power to the module, and a power status indicator.



Indicator	Behavior	Power Status
Power indicator	OFF	Module is powered off
	ON green	Module is powered on and ready to use

Figure 2 - Interface and Indicators

QUICK START INSTRUCTIONS

1. Make System Connections

Connect the sensor and analog measurement device to the signal conditioner, and then apply power to the signal conditioner. Observe the power indicator to verify the module is on. The sensor and analog output cable connectors are keyed and can only be installed in one orientation.

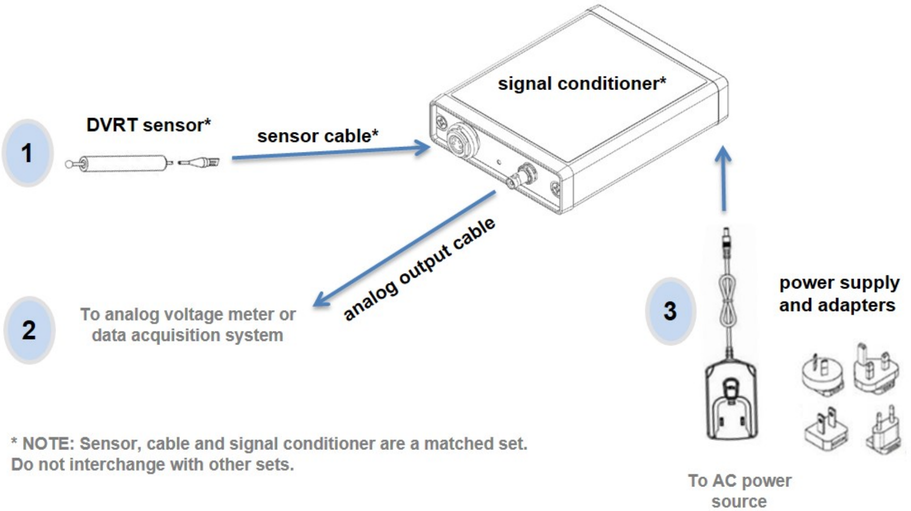


Figure 3 - System Connections

> **NOTE**
>
> To ensure system stabilization and measurement accuracy, allow the devices to warm-up for five minutes after power-up before taking measurements.

2. Test the System

There are many styles and sizes of sensors available, but all have the same basic components: a sensing element, means of actuating that element, a sensing target, a body, and an integrated cable and connector. Contact-type sensors have an actuation mechanism, known as the core, which moves in and out of the sensor body. The sensing element is in the sensor body and the sensing target is in the end of the core. Non-contact sensors have no core, and the sensing element is embedded in the end of the sensor body. The non-contact sensor is actuated by proximity to an external metallic sensing target.

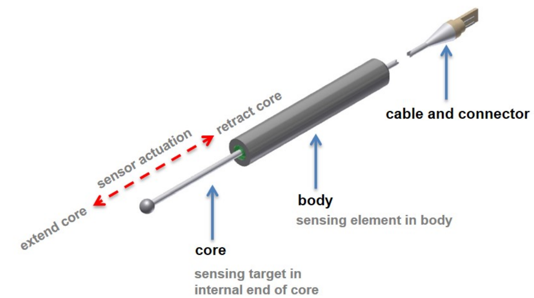


Figure 4 - Contact-type Sensor Actuation

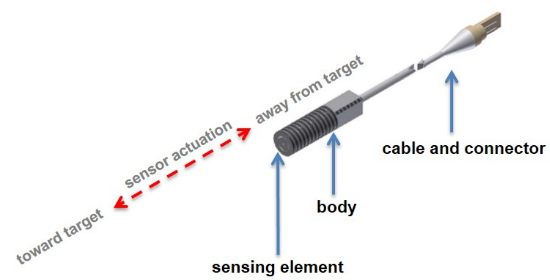


Figure 5 - Non-Contact Sensor Actuation

Once the signal conditioner is plugged in, the system is operating. The analog measurement device will display the current output voltage based on the position of the sensor core within the sensor body (for contact-type sensors) or proximity to the sensing target (non-contact sensors) and will change as the sensing element is actuated.

Actuate the sensor and verify the analog output voltage changes.

- ***Contact-type sensors*** - As the core is actuated, the output will go from a mid-range voltage, through one of the voltage range endpoints (either minimum or maximum depending on the type of sensor), and then back to the mid-range voltage.

- ***Non-contact sensors*** - The output voltage will increase or decrease from one end of the output range to the other as the sensor is moved toward the target.

NOTE

The sensing element in contact-type sensors is located in the end of the core and must be installed in the correct orientation. If no voltage output is observed after the core has been removed and re-inserted, change the orientation of the core in the sensor body and re-check for an output.

3. Determine the Sensor Position Range for Installation

Contact-type sensors

Observe the output voltage as the sensor is actuated. Start with the core fully extended and slowly retract. Once the first endpoint voltage is reached, the sensing target has entered the calibrated range of the sensor. Nominally that would be maximum or minimum voltage output (0 or 10 V dc in the standard 0 to 10 V dc system). Continue to retract until the mid-range output voltage is reached (5 V dc in the standard 0 to 10 V dc system). This is the nominal mid-range of the position range. Retract all the way. This is the second endpoint of the position range.

Install the sensor body and core so that the position range is maximized within the calibration range but not directly on the endpoints. The calibration sheet for each system shows the actual endpoint voltages, which will vary from the nominal.

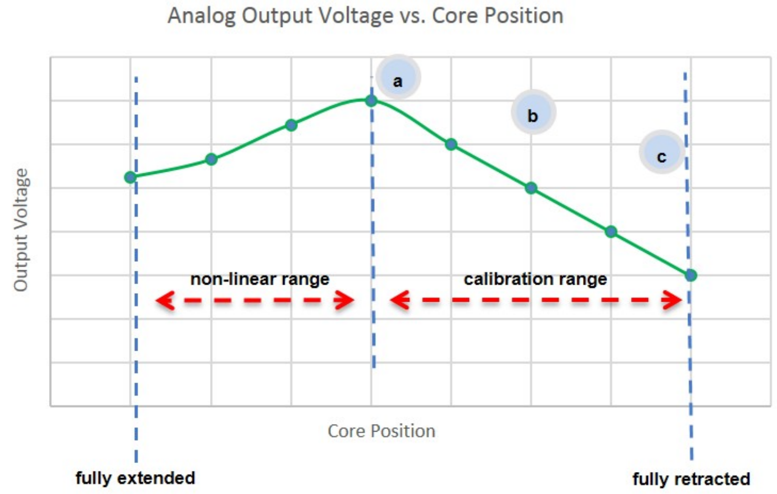


Figure 6 - Example Contact-type Sensor Range and Home Position

The home position is the reference starting position of the sensing target from which position changes will be sensed.

a. For applications in which the core will only be extending from the home position, the core and body should be mounted so the core home position is near the retracted endpoint of the calibration range.

b. For applications in which the core will be retracting and extending from the home position, the core and body should be mounted so the core home position is in the middle of the calibration range.

c. For applications in which the core will only be retracting from the home position, the core and body should be mounted so the core home position is near the extended endpoint of the calibration range.

Non-contact sensors

Observe the output voltage as the sensor is actuated. Start with the sensor body directly coupled to the external sensing target, and move it away slowly. Depending on the type of sensing material used, the initial voltage may be at either the minimum or maximum end of the output range. Find both ends.

Mount the sensor so the travel to the target is fully within the sensing range but not directly on the endpoints. The calibration sheet for each system shows the actual endpoint voltages, which will vary from the nominal.

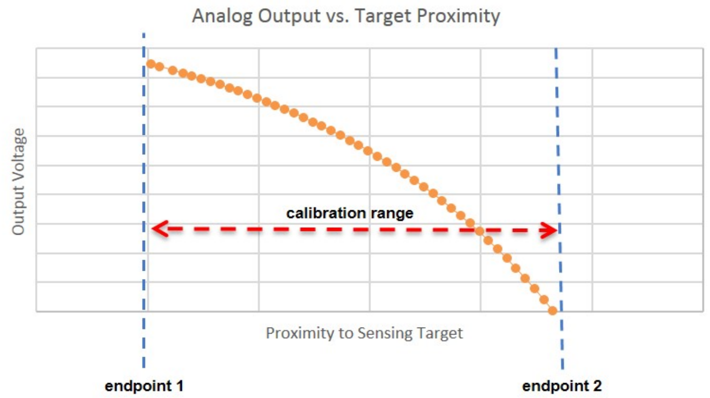


Figure 7 - Non-contact Sensor Output Range

> **NOTE**
>
> The sensing target for non-contact sensors must be metallic. For accurate measurements ensure there is not other metal, such as sensor mounting hardware, that could cause sensing interference. The target material must be known at the time of factory calibration in order to apply the appropriate model and may require a material sample in sensitive applications.

4. Record the Installation Offset

The output voltage at the home position is the installation offset voltage and must be subtracted from the final displacement value after scaling volts to position measurements. Record the home position voltage for calculations in the next step.

5. Scale Volts to Displacement

Three calibration models are provided with the calibration data for each system and are used to characterize the conversion of output voltage to displacement position in millimeters (mm). The calibration values are specific to each system and are provided in the calibration reports. Select the fit best suited for the application and apply the formula to the sensor measurements to determine displacement.

Use the selected formula to calculate the installation offset (in mm), which will then be subtracted from each measurement calculation.

- **Least squares linear fit**- assumes a linear relationship between the position and analog output voltage. It is the easiest to use but least accurate.

- **Multi-segmented linear fit**- breaks up the calibration into fixed distance segments to better characterize linearity diversions. More accurate than a least squares linear fit but requires more computation time.

- **Polynomial fit**- Uses the sum of ascending powers of the voltage value. Most accurate fit but requires the most computation time.

> **NOTE**
>
> Non-contact sensors typically do not provide a very linear output. It is highly recommended that a polynomial calibration fit model be used with non-contact sensors.

APPENDIX

1. Calibration Formulas

Displacement

$D_a = D_m - O$

Least squares linear fit

$D_m = mx + b$

Multi-segmented linear fit

$D_m = m(i)x + b(i)$

Polynomial fit

$D_m = A0 + A1x + A2x^2 + A3x^3 + A4x^4 + A5x^5 + A6x^6 + A7x^7$

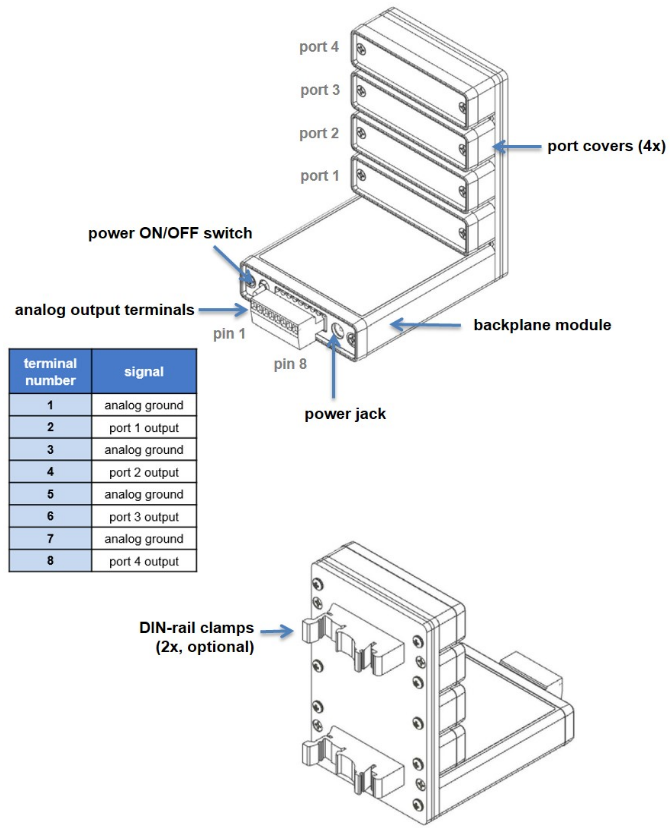
D_m = measured displacement (mm)
D_a = actual displacement (mm)
O = installation offset (mm)
x = sensor output voltage (V)
m = slope (mm/V)*
b = calibration offset*
(i) = index value*
A(i) = polynomial coefficients*

* values from the calibration report

Figure 8 - Calibration Formulas

2. Using the Backplane

The backplane is used to stack four DEMOD - DVRT® -2 modules together for power and signal distribution and installation efficiency. The backplane has a removable terminal block for the analog voltage outputs, an input power jack, and an optional DIN-rail mounting clamp.



terminal number	signal
1	analog ground
2	port 1 output
3	analog ground
4	port 2 output
5	analog ground
6	port 3 output
7	analog ground
8	port 4 output

Figure 9 - Backplace Interface

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To install a DEMOD - DVRT -2 module in the backplane, remove the backplane port cover and the back end-plate and bezel on the DEMOD - DVRT -2. Insert the DEMOD - DVRT -2 into the port and fasten with the port cover screws.

Up to four can be installed. Each DVRT® sensor is still connected to the signal conditioner it was calibrated with, and the analog output on the signal condition can still be used instead of the backplane terminal block.

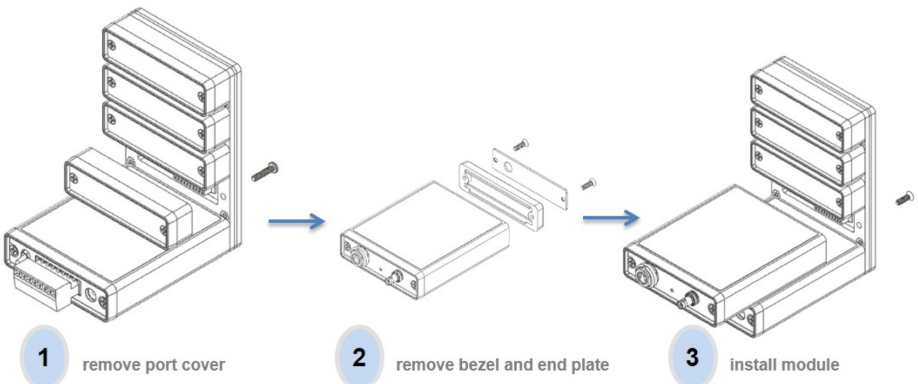

Figure 10 - DEMOD - DVRT® -2 Installation on Backplane

3. System Customization

Factory configuration options are available to optimize the DEMOD - DVRT -2 for particular applications.

- **Output filtering** - The signal conditioner filter is designed to maximize resolution and bandwidth while minimizing signal-to-noise ratio. This filter can be factory-adjusted to maximize performance for a particular application. Contact LORD MicroStrain® Technical or Sales Support for more information.
- **Output voltage range** - The signal conditioner output can be factory configured for a 0 to 5 V dc voltage range if needed for the application, however, this will reduce the system resolution.

4. Sensors

There are many sensor options available in various stroke lengths, actuator, and sensing types. All sensors use inductive-type sensing. For additional details and the most current options, refer to the sensor datasheet.

Sensing options:

- ***Contact*** - The sensing element is in the senor body and the sensing target is in the core. The core slides within the sensor body and is attached to the moving part for which displacement is being measured
- ***Non-contact*** - the sensing element is within the sensor body and senses proximity to an external metallic target. The target is mounted to the moving object.

Contact sensor core options:

- ***Gauging*** - spring retained core
- ***Non-gauging*** - slide actuator, non-retained core

Sensor product line	Actuator type	Sensing type	Stroke lengths
M- DVRT	non-gauging	contact	3, 6, 9 mm (std.) 1.5 mm (hi-res)
MG - DVRT	gauging	contact	
S - DVRT	non-gauging	contact	4, 8, 24, 38 mm (std.) 6 mm (hi-res) 500 µm or less (nano)
SG - DVRT	gauging	contact	
NC - DVRT	--	non-contact	1 mm, 2.5 mm

Table 2 - Sensor Options

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