ADVANCED MICRO CONTROLS INC.

Manual #: 940-0A032

ANR2

AnyNET-I/O LVDT/RVDT Signal Conditioner Module

User Manual

AMCI AnyNET-I/O Control Products

GENERAL INFORMATION

Important User Information

The products and application data described in this manual are useful in a wide variety of different applications. Therefore, the user and others responsible for applying these products described herein are responsible for determining the acceptability for each application. While efforts have been made to provide accurate information within this manual, AMCI assumes no responsibility for the application or the completeness of the information contained herein.

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We Want Your Feedback

Manuals at AMCI are constantly evolving entities. Your questions and comments on this manual are both welcomed and necessary if this manual is to be improved. Please direct all comments to: Technical Documentation, AMCI, 20 Gear Drive, Terryville CT 06786, or fax us at (860) 584-1973. You can also e-mail your questions and comments to *techsupport@amci.com*

Table of Contents

About this Manual

Read this chapter to learn how to navigate through this manual and familiarize yourself with the conventions used in it. The last section of this chapter highlights the manual's remaining chapters and their target audience.

Audience

This manual explains the set-up, installation, and operation of AMCI's ANR2 AnyNET-I/O LVDT/RVDT Signal Conditioner Module. It is written for the engineer responsible for incorporating these modules into a design, as well as the engineer or technician responsible for their actual installation.

Applicable Units

This manual applies to all ANR2 modules, including those that have an integral network connection. This includes the ANR2E which has an integral Ethernet port. This port allows the ANR2E to connect itself, and up to five other modules, to an EtherNet/IP or Modbus/TCP network.

If you have an ANR2 module with a network interface, you will have to refer to the appropriate AnyNET-I/O Network Interface manual for information on connecting the module to your network. These manuals can be found in the PDF document section of our website at ***www.amci.com/documents.asp***

NOTE The AnyNET-I/O product line is constantly evolving. Check our website, ***www.amci.com*** for the latest information on available modules and network interfaces in the AnyNET-I/O line.

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Revision Record

This manual, 940-0A031, is the second release. Released on June 25th, 2013 this edition updates parameter ranges, adds differential wiring diagrams for 5- and 6- wire sensors, and adds screen captures from the AMCI Net Configurator software.

Revision History

940-0A030 Initial Release.

Navigating this Manual

This manual is designed to be used in both printed and on-line formats. Its on-line form is a PDF document, which requires Adobe Acrobat Reader version 7.0+ to open it. The manual is laid out with an even number of pages in each chapter. This makes it easier to print a chapter to a duplex (double sided) printer.

Bookmarks of all the chapter names, section headings, and sub-headings were created in the PDF file to help navigate it. The bookmarks should have appeared when you opened the file. If they didn't, press the F5 key on Windows platforms to bring them up.

Throughout this manual you will also find ***blue text that functions as a hyperlink*** in HTML documents. Clicking on the text will immediately jump you to the referenced section of the manual. If you are reading a printed manual, most links include page numbers.

The PDF file is password protected to prevent changes to the document. You are allowed to select and copy sections for use in other documents and, if you own Adobe Acrobat version 7.0 or later, you are allowed to add notes and annotations.

Manual Conventions

Three icons are used to highlight important information in the manual:

NOTE — **NOTES** highlight important concepts, decisions you must make, or the implications of those decisions.

CAUTION — **CAUTIONS** tell you when equipment may be damaged if the procedure is not followed properly.

WARNING — **WARNINGS** tell you when people may be hurt or equipment may be damaged if the procedure is not followed properly.

The following table shows the text formatting conventions:

Format	Description
Normal Font	Font used throughout this manual.
Emphasis Font	Font used the first time a new term is introduced.
Cross Reference	When viewing the PDF version of the manual, clicking on the cross reference text jumps you to referenced section.

Where To Go From Here

This manual contains information that is of interest to everyone from engineers to operators. The table below gives a brief description of each chapter's contents to help you find the information you need to do your job.

CHP Num.	Chapter Title	Intended Audience
1	***Introduction to the ANR2***	Anyone new to the ANR2. This chapter gives a basic overview of the features available on the unit, typical applications, and specifications.
2	***Operating Modes***	Anyone that needs detailed information on how the module operates.
3	***Installing the ANR2***	Anyone that must install an ANR2 on a machine. Includes information on mounting, grounding, and wiring specific to the units.
4	***Network Input Data Format***	Anyone interested in the format of the data you can read from the ANR2. The data format for all of the modes is included in this chapter.
5	***Configuration Mode Data Format***	Anyone that needs information on the commands you must write to the ANR2 to set its configuration.
6	***Alignment Mode Data Format***	Anyone that needs information on the commands you must write to the ANR2 to align a sensor before measurements can be made from it.
7	***Measurement Mode Data Format***	Anyone that needs information on the commands you must write to the ANR2 to gather position and velocity data from a sensor.
A		Anyone that needs to learn more about LVDT/RVDT's in general.

CHAPTER 1

INTRODUCTION TO THE ANR2

This manual is designed to get you quickly up and running with the ANR2 LVDT/RVDT Signal Conditioner Module. It is possible to purchase an ANR2 with or without a network interface. This manual only covers the functionality unique to the ANR2. Information on connecting to the network interface is available in the appropriate AnyNET-I/O Network Interface manual available on the AMCI website.

AnyNET-I/O

The ANR2 is an expansion to the AnyNET-I/O product line from AMCI. The concept of this product line is simple: specialty and/or high speed I/O that can be attached to any popular industrial network; hence the name *AnyNET-I/O*.

AnyNET-I/O is designed for a broad range of applications, from small machines with a single control enclosure, to large machines that use distributed I/O extensively to minimize wiring costs.

What makes the AnyNET-I/O line different is that all of the modules are available with or without a network interface. Eliminating the need for a separate networking module lowers the total cost of ownership for all applications, but especially for the cost sensitive small machines that only require one or two sophisticated functions.

Like many modern controllers, AnyNET-I/O modules are designed to be DIN rail mounted. Up to six AnyNET-I/O modules can be stacked together and accessed over a single network interface. "Stacking" is accomplished through a small backplane connector that snaps into the DIN rail before the AnyNET-I/O modules are installed. These connectors allow the AnyNET-I/O modules to communicate with each other. To the network, the stack of modules appear as one continuous block of I/O words.

Figure 1.1 AnyNET-I/O Module Stack

The ANR2

The ANR2 is a two channel LVDT/RVDT signal conditioner module that accepts 24 Vdc as its power source. What makes the ANR2 unique is its advanced digital technology that completely eliminates all potentiometer adjustments and all but one jumper. This technology allows the ANR2 to interface with half bridge sensors, as well as 3-, 4-, 5-, and 6-wire AC LVDT/RVDT sensors from any manufacturer with methods that eliminate many of the errors associated with changes in environmental temperatures. The ANR2 offers 14 bit (16,386 count) position resolution.

The elimination of jumpers and potentiometers means that you do not have to be physically near the ANR2 while configuring and aligning it. All configuration and alignment data is sent from your host system over the network connection of the AnyNET-I/O stack. This allows you to:

- Configure the ANR2 from anywhere
- Store multiple setups on your machine, one for each type of sensor you use
- Copy setup data from one machine to another
- Design custom HMI interfaces for configuration and alignment that can simplify machine training, startup, and repair.

NOTE This manual assumes that you are familiar with LVDT/RVDT's and their electrical characteristics. If you are not familiar with these sensors, please refer to Appendix A, ***The LVDT and RVDT*** starting on page 60.

The ANR2 (continued)

LVDT Interface

The ANR2 incorporates a DSP controlled sine wave oscillator and power amplifier to generate the excitation voltage for the LVDT. Fully programmable over a wide range of frequencies and amplitudes, the ANR2 can be configured to run at the optimum frequency of your LVDT or RVDT sensor.

Many of signal conditioners on the market today use the *differential measurement* method, where the secondary windings are put in series opposition and the voltage across the two windings is measured. This conditioning method is the simplest, compatible with all 4-, 5-, and 6-wire LVDT's, and offers acceptable performance for most applications. However, the accuracy of differential measurements can suffer from the following:

- Changes in excitation voltage and frequency caused by ambient temperature changes
- Changes in sensor sensitivity caused by ambient temperature changes at the sensor
- Electrical noise injected into the cabling from external sources.

A simple method used by the ANR2 eliminates measurement errors caused by changes in the ambient temperature around the module. By feeding the excitation voltage (V_e) back into the ANR2, the module can calculate the ratio: $\{(V_A - V_B) / (V_e)\}$. Dividing the differential measurement by the excitation voltage eliminates changes in the excitation voltage as a source of error. However, this method does not eliminate errors caused by changes in ambient temperature around the sensor.

Many LVDT/RVDT applications expose the sensor to large variations in temperature, and these applications often require the most accurate measurements possible over the entire temperature range. For these demanding applications, the ANR2 supports the *ratiometric measurement* method. This method requires a five or six wire sensor that is specifically manufactured to support ratiometric measurements. This method measures the two secondary voltages separately and calculates the LVDT position as: $\{(V_A - V_B) / (V_A + V_B)\}$. By considering the ratio of the outputs, any error caused by an increase or decrease in the absolute values of these voltages is eliminated. This method also eliminates any common mode electrical noise that can be induced into the sensor wiring from external sources.

Master/Slave Excitation Mode

Up to six ANR2 modules can be placed in a single AnyNET-I/O stack. When using multiple sensors in close proximity, it is sometimes beneficial to synchronize the excitation voltages when the sensors use the same excitation frequency. Synchronizing the excitation voltages avoids a phenomenon known as *heterodyning*, which is commonly called *beating*.

In LVDT/RVDT applications, heterodyning can be considered a form of cross talk. If a small variance in excitation frequency is coupled from one sensor into another, the result will be a dynamic change in output signal that will affect the accuracy of the measurement. These effects are also compensated for in the ANR2 when using the ratiometric measurement method, but these effects can still be seen in differential measurements.

All ANR2 modules ship as Master modules and generate their own excitation voltages. You change an ANR2 to a slave module by changing a jumper on the front of the unit and programming a parameter in the network data. External wiring is then used to connect the master module to the slaves. Any module in the stack can be the master, but wiring will be easier if the module on the far left of the stack is the master.

ANR2 Programmable Parameters

Module Parameters

Module Type: In addition to setting the Master/Slave jumper, you must also program this parameter to configure the ANR2 as a master or slave module. The unit ships as a master module.

Excitation Voltage: The excitation voltage of an ANR2 can be set to any value between 0.800 Vrms and 12.000 Vrms.

Excitation Frequency: The excitation frequency can be set to any value between 400 and 10,000 Hz.

Sensor Parameters

Sensor Type: The ANR2 has to know what type of sensor (Differential, Ratiometric, or 3-wire/half bridge) is wired to the channel. Note that 5- and 6-wire ratiometric sensors can be wired to the channel as differential sensors. In these cases, the Sensor Type must be set to "Differential".

Sensor Sensitivity: This parameter specifies the change in output as the sensor's core moves. The value this parameter should be set to is given with the sensor. The units for this parameter are 0.1mVoutput/Vexcitation/displacement, where displacement can be in units of millimeters, 0.001 inches (mills), or 0.01°. This parameter is programmed with 0.1 millivolt resolution, with a range of 1 to 50,000. You will probably have to convert between units before entering the values into the ANR2. For example, if the sensitivity of your LVDT is 6.5 mV/V/mm, you would multiply this value by 10 to convert it to the units of 0.1mV/V/mm and enter this value of 65 into the ANR2.

Sensor Displacement: This is the expected travel for your sensor. The ANR2 uses this information to verify that the analog inputs will not become saturated during normal operation. The units for this parameter are 0.01mm, mil (0.001"), or 0.01° and should be the same as the displacement unit used for Sensor Sensitivity. Your displacement can exceed this value during operation, but accuracy may suffer. The valid range of this parameter is 5 to 10,000.

Null Value: The desired value when the sensor is at its null position. This is a signed thirty-two bit value, with the range of ±2,147,483,647.

Minimum Value: The desired value when the sensor is at one of its end of travel positions. This is a signed thirty-two bit value, with the range of ±2,147,483,647. The maximum difference between the Minimum and Null Values is 65,535 counts.

Maximum Value: The desired value when the sensor is at the other of its end positions. This is a signed thirty-two bit value, with the range of ±2,147,483,647. The maximum difference between the Maximum and Null Values is 65,535 counts.

Disable Channel LED: Allows you to turn off the front panel Status LED if you have an unused channel.

Position Output

Your position output is defined at up to three points, the minimum, maximum, and null points. The values at these points are defined when you align the sensor.

There are four different ways to define these points:

- Two Sided Alignment: You define all three values at the null, minimum and maximum travel points.
- Two Sided Symmetrical Alignment: You define the Null Value and the value at one of the end points. The other endpoint is calculated as (Null Value – End Value).
- One Sided Alignment: You define the Null Value and the value at one of the end points. This form of alignment is identical to Two Sided Symmetrical Alignment, but was included for users that only measure from the null point to one of the end points. The un-used end point is still defined as (Null Value – End value).
- Two Point Linear Alignment: You define the minimum and maximum points of travel.

Position Output (continued)

Figure 1.2 shows three forms of the position output graphs that are available when using the Two Sided Alignment method. When using this method:

- The points do not have to be colinear.
- The Minimum and Maximum values can be equal.
- The Null value cannot be equal to either the Minimum or Maximum values.
- The maximum difference between the Null value and the end values is 65,535 counts.

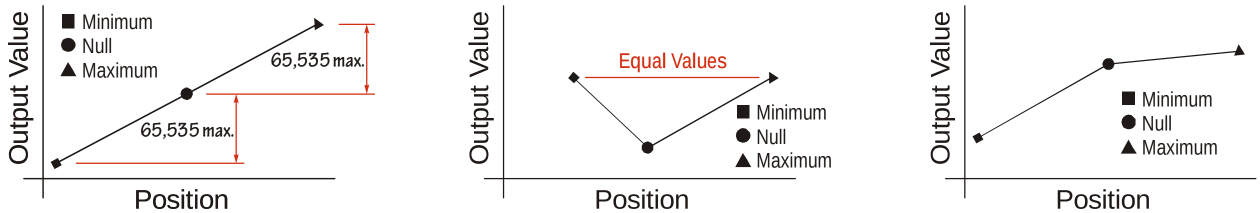


Figure 1.2 Position Output Example Graphs

The linear output graph is the only form available when using the Two Sided Symmetrical Alignment and One Sided Alignment methods. The Two Point Linear Alignment method also results in a linear graph, but the maximum difference between the minimum and maximum values is 65,535 counts.

The ANR2 has a maximum position resolution of fourteen bits. This resolution is available over the full range of motion, from minimum to maximum positions. If your range of motion is less than this, your resolution will also be less. For example, if your range of motion is from the null point to one extreme, your resolution will be thirteen bits.

Power Connector

Figure 1.3 shows the location of the Power Connector. The mate to this connector is included with the ANR2. Spares are available from AMCI under the part number MS-4M. They are also available from Phoenix Contact under their part number 187 80 37.

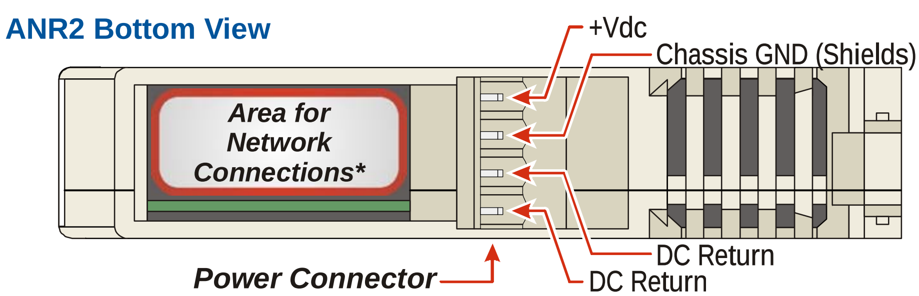


Figure 1.3 Power Connector

Figure 1.3 also shows the area of the AnyNET-I/O modules that is reserved for network connections. If your ANR2 has a network connection, such as the ANR2E for Ethernet networks, connection to the network will be made here. Refer to the appropriate AnyNET-I/O Network Interface manual for additional information.

I/O Connector

As shown in figure 1.4, the I/O Connector is located on the top of the module. All sensor connections are made at this connector. Power connections for the ANR2 are made through the MS-4M connector on the bottom of the module.

The mate for this connector is included with the ANR2. Spares are available from AMCI under the part number MS-2X11. They are also available from Phoenix Contact under their part number 173 88 98.

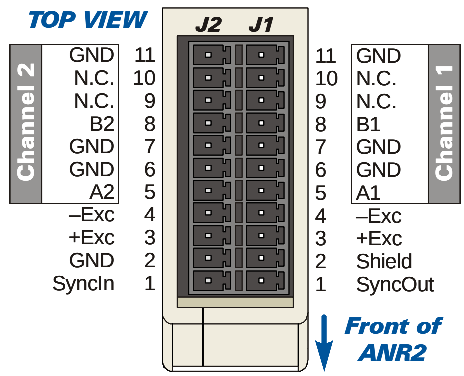


Figure 1.4 I/O Connector

Front Panel

The front panels of three ANR2 modules are shown in figure 1.5. The front cover is hinged on the bottom, and swings down to allow you to change the DIP switch address settings and the slave mode jumper. The front panel also has the Status LED's, which give you information on the state of the module and the sensors.

Address Settings

The AnyNET-I/O platform allows you to connect up to six modules to a single network connection in what we call an AnyNET-I/O Stack. The DIP switches behind the front panel cover are used to set the address of the module within the AnyNET-I/O Stack. A module with a network interface, such as the ANR2E for Ethernet networks, communicates with the host and must have an address of zero. This address is set by having all of the DIP switches in their OFF position. (If you are using a single module, then it must have an address of zero.) The remaining modules in the stack should have their addresses set to their position in the stack by setting the corresponding DIP switch to its ON position. Figure 1.5 shows the correct addressing for three modules. The module on the left is an ANR2E and has its address set to zero. The remaining modules can be ANR2 modules with or without network interfaces and their addresses are set to one and two.

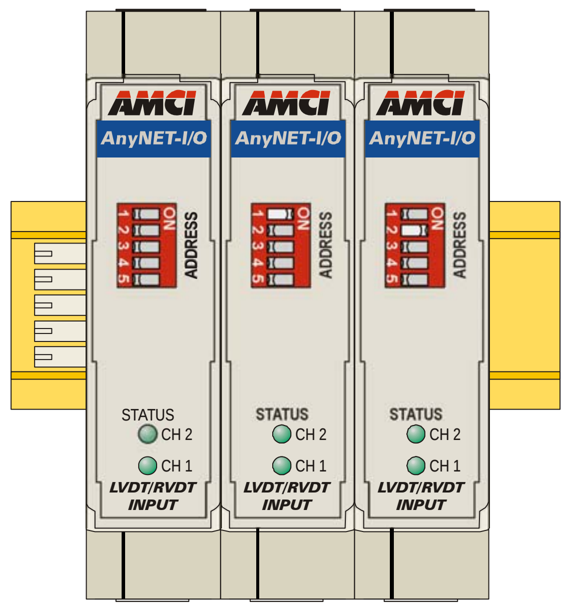


Figure 1.5 ANR2 Front Panel

NOTE If an ANR2 with a network interface has its address set to any value other than zero, its network interface is disabled. This allows you to use multiple modules with network interfaces in a single AnyNET-I/O Stack.

Front Panel (continued)

Status LED's

The Status indicators are bi-color red/green LED's shows the status of the module and sensors.

Module States

Module State	LED Blink Pattern	Description
Module Initialized	Both LED's flash green twice in one second followed by one second off.	Module has finished its power up sequence and is waiting for network command data.
Module Error	Both LED's ON Red	Error in module or communications within the AnyNET-I/O Stack. Cycle power to the module or stack to attempt to clear this problem.
Calibration Mode	Both LED's flash red at 4 Hz. (Fast blink)	The module is calibrated at the factory. If you see this pattern, cycle power. If the pattern remains, contact AMCI Tech Support for assistance.
Configuration Mode	Both LED's flashes red twice in one second (slow blink), followed by one second off.	The last network data transfer to the ANR2 placed it in Configuration Mode.

Table 1.1 Status LED's - Module Patterns

Channel States

Channel State	LED Blink Pattern	Description
Alignment Mode (Increase B voltage to reach Null Point)	Channel LED flashes green three times in 1.5 seconds (slow blink), followed by one second off.	The channel is in Alignment Mode, and is searching for the null point. Movement must occur to increase the voltage on the B channel to reach the null point.
Alignment Mode (Decrease B voltage to reach Null Point)	Channel LED flashes red three times in 1.5 seconds (slow blink), followed by one second off.	The channel is in Alignment Mode, and is searching for the null point. Movement must occur to decrease the voltage on the B channel to reach the null point. This is the same as increasing the voltage on the A channel for 5-wire and 6-wire sensors.
Alignment Mode (At Null Point)	Channel LED alternately flashes red and green at 2 Hz. (Slow blink)	The channel is in Alignment Mode, and is at the null point.
Alignment Mode (Null Point programmed)	Channel LED alternately flashes red and green at 4 Hz. (Fast blink)	The channel is in Alignment Mode, and the null point has been programmed.
Measurement Mode (Channel not active)	Channel LED flash green at 2 Hz. (Slow blink)	Channel is fully configured and aligned and is waiting for command to begin measurements.
Measurement Mode (Channel active)	Channel LED is ON green.	Channel is reading position data from the sensor.
Sensor Error	Channel LED flash red at 2 Hz. (Slow blink)	Error reading sensor. (Improper wiring, sensor damaged, or sensor missing)
Channel Disabled	LED off	The channel is disabled.

Table 1.2 Status LED's - Channel Patterns

Front Panel (continued)

Excitation Mode Jumper

Figure 1.6 shows the location of the headers that set the excitation mode of the ANR2. You access the headers by opening the front cover of the module. All ANR2 modules ship with a jumper across the "Master" pins. To set the module to slave mode, move the jumper from the Master pins to the Slave pins.

NOTE The module will not operate correctly if the jumper is not across one of the sets of pins.

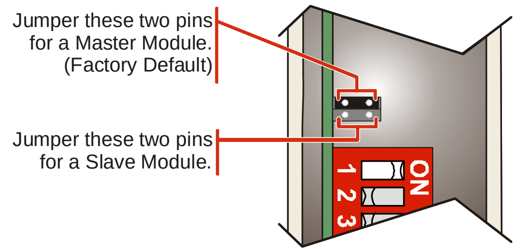


Figure 1.6 Slave Mode Jumper Location

Specifications

Sensor Type

AC. Half bridge, three, four, five, or six wire LVDT/RVDT.

Number of Input Channels

Two

Number of I/O Words (16 bits each)

10 input words and 10 output words

Physical Dimensions

Width: 0.9 inches max.

Depth: 4.5 inches max.

Height: 3.9 inches
5.0 inches min. with mating connectors

Weight

0.38 lbs. (0.17 kg.) with mating connectors

Current Draw

200 mA without sensors

375 mA with Excitation voltage shorted to GND.

Available Measurement Methods

Differential and Ratiometric. Ratiometric is only available as an option with 5- and 6- wire sensors.

Excitation Voltage

Voltage Output:
Programmable from 0.800 to 12.000 Vrms with 1 millivolt resolution

Frequency:
Programmable from 400 to 10,000 Hz with 1 Hz resolution

Output Current:
200 mA maximum

Sensor Sensitivity

Programmable from 0.1 to 5,000.0 mV/V/{mm, 0.001" (mil), 0.01°} with a resolution of 0.1 mV. The ANR2 uses Sensor Sensitivity and Sensor Displacement to set input amplifier gains.

Sensor Displacement

Programmable from 5 to 10,000. Units are 0.01mm, 0.001" (mil), or 0.01°. Distance units must match units used when programming Sensor Sensitivity. The ANR2 uses Sensor Sensitivity and Sensor Displacement to set input amplifier gains.

Position Resolution

14 bit max. (16,384 steps over entire range) Position output can be scaled to a 32 bit value

Position Update Time

250 microseconds.

Environmental Specifications

Input Power ...... 24 Vdc ±10%, surge to 30Vdc without damage to module.

Ambient Operating Temperature
.... -4° to 122°F (-20° to 50°C)

Storage Temperature
.... -40° to 185°F (-40° to 85°C)

Humidity .... 0 to 95%, non-condensing

Status LED

See ***Status LED's*** starting on page 12.

Connectors

Mating connectors are included with the ANR2 and are available separately under the following AMCI part numbers.

Connector	AMCI Part #	Wire	Strip Length	Min. Tightening Torque
I/O	MS-2X11	28 - 16 AWG	0.275 inches	Spring Cage Connector
Power	MS-4M	28 - 12 AWG	0.394 inches	4.43lb-in (0.5 Nm)
Backplane	IC-5	Not Applicable		

20 Gear Drive, Plymouth Ind. Park, Terryville, CT 06786
Tel: (860) 585-1254 Fax: (860) 584-1973 http://www.amci.com

Notes

CHAPTER 2
OPERATING MODES

The ANR2 has to be configured for your LVDT or RVDT and the range of motion defined before the unit can accurately read the position of your sensor. The ANR2 has four operating modes that allow to setup and read your sensor.

Available Modes

The order and names of the available modes are:

1) Calibration Mode
2) Configuration Mode
3) Alignment Mode
4) Measurement Mode

Commands are available that allow you to switch between modes as needed. When you exit a mode, the ANR2 will automatically select the highest available mode that can be entered and enter that mode.

Calibration Mode

NOTE Every ANR2 is calibrated at the factory. You should never need to enter this mode. If an ANR2 reports that the module needs to be calibrated, contact the AMCI Technical Support department for assistance. Calibrations can be made in the field, but an accurate true RMS meter is required.

Calibration Mode is used to make fine adjustments to the excitation voltage circuitry and allows the ANR2 to accurately control the excitation voltage. After successful calibration, the resolution of the excitation voltage setting is one millivolt.

Configuration Mode

The parameters set in Configuration Mode are shown in table 2.1. The ANR2 has only one excitation voltage, so the Excitation Voltage and Excitation Frequency parameters apply to both channels. The three sensor parameters exist separately for each channel.

Parameter	Range	Units
Excitation Type	Master / Slave	
Excitation Voltage	800 to 12,000	millivolts
Excitation Frequency	400 to 10,000	Hertz
Sensor Type	Ratiometric, Differential, or 3-wire/half bridge	
Sensor Sensitivity†	1 to 50,000	0.1 mV/V/mm 0.1 mV/V/mil (0.001") 0.1 mV/V/°
Sensor Displacement†	5 to 10,000	0.01 mm mil (0.001") 0.01°

† The unit of distance of the Sensitivity and Displacement parameters must be the same. If you do not know the value of these parameters, you can leave them un-set. If you do this, the only alignment method available to you is the Two Point Linear method.

Table 2.1 Configuration Parameters

Available Modes (continued)

Alignment Mode

After the module is configured, Alignment Mode is used to set the Minimum, Maximum, and Null Values. Note that each channel is programmed separately

Parameter	Range	Units
Null Value†	±2,147,483,647	Counts
Minimum Value	Null Position ± 65,535 ±2,147,483,647 max.	Counts
Maximum Value	Null Position ± 65,535 ±2,147,483,647 max.	Counts

† The Null Value is not set when using the Two Point Linear method. When using this method, the maximum distance between the Minimum Value and Maximum Value is 65,535 counts. Both values must be in the range of ±2,147,483,647.

Table 2.2 Alignment Parameters

Measurement Mode

After the sensor is aligned, use Measurement Mode to read back the position and velocity values from your sensor. If the ANR2 automatically enters Measurement Mode after you exit a different mode, you must issue a command to the unit to tell it which channels to read.

Status Bits

The ANR2 has five module status bits so you can determine the state of the module. It also has four status bits per channel to tell you what valid data exists for the channel and if the ANR2 is actively measuring the position of the sensor.

Module Status Bits

Module Initialized: This bit is set on power up or after a hardware reset. The ANR2 is only transmitting status information. Position data is set to zero. The module is waiting for the first command from the host controller.

In Calibration Mode: If this bit is set along with the Module Initialized bit on power up, the ANR2 requires calibration. If it is set when the Module Initialized bit is reset, the unit is in Calibration Mode.

In Configuration Mode: If this bit is set along with the Module Initialized bit on power up, the ANR2 does not have valid configuration data for either channel. If it is set when the Module Initialized bit is reset, the unit is in Configuration Mode. Use the Channel Status bits to determine which channels require configuration.

In Alignment Mode: If this bit is set along with the Module Initialized bit on power up, the ANR2 does not have valid alignment data for either channel. If it is set when the Module Initialized bit is reset, the unit is in Alignment Mode. Use the Channel Status bits to determine which channels require alignment.

In Measurement Mode: If this bit is set along with the Module Initialized bit on power up, the ANR2 is ready to measure position on at least one of the channels. If it is set when the Module Initialized bit is reset, the unit is in Measurement Mode. Use the Channel Status bits to determine which channels the ANR2 is actively measuring.

Channel Status Bits

Channel Calibrated: Valid calibration data exists for the channel.

Channel Configured: Valid configuration data exists for the channel.

Channel Aligned: Valid alignment data exists for the channel.

Channel Measuring: The ANR2 is actively measuring the position of the sensor.

Power Up Behavior

When power is applied to the ANR2, it runs self checks and determines which modes have been successfully completed by validating the data stored in its EEPROM. It sets status bits for each channel and then status bits for the module. Its final act is to set the *Module Initialized* bit.

NOTE The Module Initialized Bit is only set when the ANR2 completes its power up sequence, and is reset when the module accepts its first command. If this bit is set during normal operation, then the module has experienced a hardware reset. This behavior can be caused by a temporary drop in input voltage or a surge of electrical noise that was induced into the module.

After power up, the ANR2 waits for the first command from the host controller before entering one of the available modes. While waiting, the ANR2 only transmits status information. The words used to transmit position data are set to zero.

NOTE For normal operation, you must issue a command to switch to Measurement Mode after every power up. The ANR2 will not transmit position data to the host until this command is issued.

Switching Modes During Normal Operation

Figure 2.1 is a graphical representation of how the ANR2 allows you to switch between modes during normal operation. You can jump from any mode to any *previous* mode, but, if parameter changes are saved while in the new mode, you can only progress forward in the correct order after that.

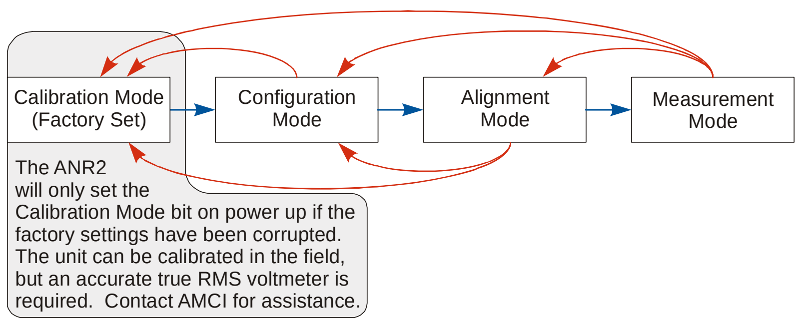


Figure 2.1 Switching Between Modes

Notes

CHAPTER 3

INSTALLING THE ANR2

The ANR2 module must be installed as part of an AnyNET-I/O stack. The instructions in this manual explain how to install the ANR2 as part of the stack and how to set its address. Complete installation instructions for the AnyNET-I/O stack, or individual networked modules, is included in the manual for installing the network interface module.

Safe Handling Guidelines

Prevent Electrostatic Damage

CAUTION Electrostatic discharge can damage the ANR2 if you touch the rear bus connector pins. Follow these guidelines when handling the module.

1) Touch a grounded object to discharge static potential before handling the module.
2) Work in a static-safe environment whenever possible.
3) Wear an approved wrist-strap grounding device.
4) Do not touch the pins of the bus connector or I/O connector.
5) Do not disassemble the module
6) Store the module in its anti-static bag and shipping box when it is not in use.

Prevent Debris From Entering the Module

WARNING During DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, tapping liquids, etc.) is prevented from falling into the module. Debris may cause damage to the module or unintended machine operation with possible personal injury. The DIN rail for the modules should be securely installed and grounded before the modules are mounted on it.

Remove Power Before Servicing in a Hazardous Environment

WARNING The AnyNET-I/O InterConnect bus is hot-swappable, but remove power before removing or installing any modules in a hazardous environment.

Mounting

Dimensions

Figure 3.1 shows the dimensions of an AnyNET-I/O module. The ANR2 module is a low power module that does not require any additional spacing when mounting the unit. Refer to the installation instructions of the appropriate AnyNET-I/O network interface module for complete information on spacing needed to install the module.

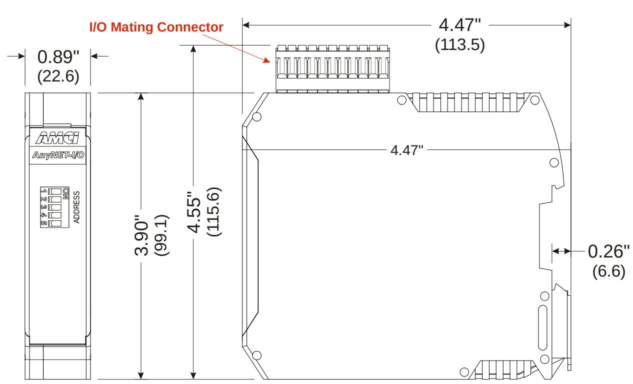


Figure 3.1 AnyNET-I/O Outline

NOTE You will need to ground the LVDT/RVDT cable shields at the module. There is a single pin on the ANR2 to ground a shield, but if you have multiple shields, it may be better to ground them to the DIN rail. If you decide to do this, make sure your DIN rail is long enough to mount the AnyNET-I/O modules and ground the cable shields.

Mounting (continued)

Installing IC-5 Connectors

You need to install an IC-5 connector on the DIN rail to allow the ANR2 to communicate with the stack. Figure 3.2 shows how to install the IC-5 connectors in the DIN rail.

NOTE Note the orientation of the IC-5 connectors when installing them. The module key goes towards the bottom of the DIN rail.

If you are using a single ANR2 with a network interface, then you do not need the IC-5 connector. The connector is only used for communications within the stack.

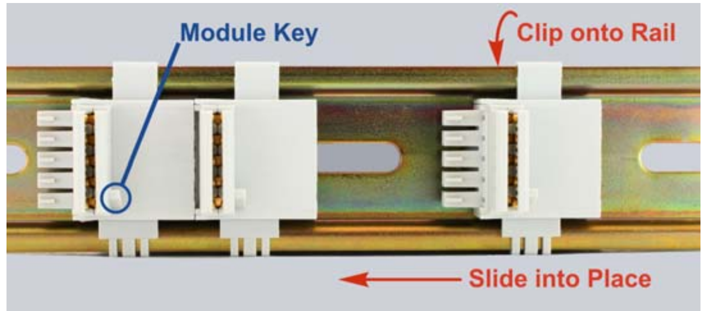


Figure 3.2 IC-5 Connector Installation

Mounting the ANR2 Module

Mounting an AnyNET-I/O module is a very simple process thanks to the design of the enclosure.

1) Partially engage the connector into the enclosure.
2) Engage the top clip in the enclosure with the top of the DIN rail and rotate the module down until the metal bracket snaps on to the DIN Rail.

Once all of your modules are installed, it is strongly suggested to use the end caps from Phoenix Contact with the part number of 271 37 80 to secure the modules on the DIN Rail. These end caps prevent the module from sliding along the DIN rail if it is subjected to shock or vibration during machine operation.

Addressing

Each module needs to be given an address before the system will operate correctly. The address is set with the five position DIP switch on the front of the module.

NOTE
1) Only a single switch should be in the "ON" position when setting the address.
2) The module that has an address of zero must have a network interface and it is the only module in the stack that can have a direct connection to the network.
3) If a module with a network interface has a non-zero address, then its network interface is disabled.

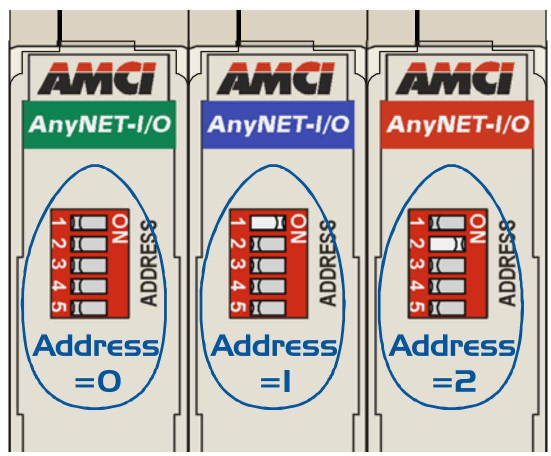


Figure 3.3 Addressing Example

Figure 3.3 is a close up of three modules in an AnyNET-I/O Stack. The module on the left has a network interface and has an address of zero (All DIP switches off.) This module has the active network interface and connects the stack to the network. Reading left to right, the remaining modules have addresses of one and two respectively. If either of these module have a network interface, it is disabled.

Power Connector

The ANR2 accepts 24 Vdc as its input power. As shown in the figure below, the power connector is located on the bottom of the module. Th e mating connector is included with the ANR2. Spares are available from AMCI under the part number MS-4M. They are also available from Phoenix Contact under their part number 187 80 37.

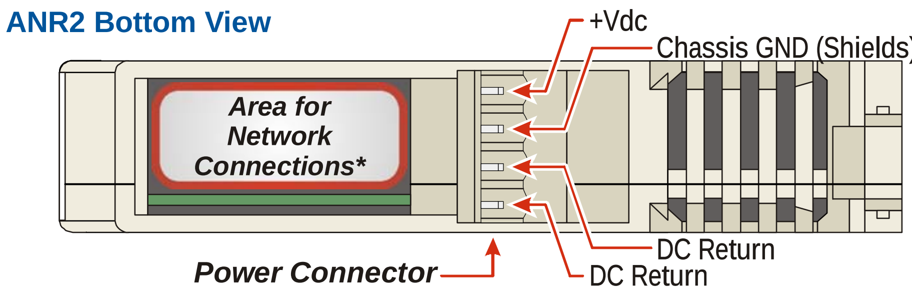


Figure 3.4 Power Connector Location

Power connections should be tight, as loose connections may lead to arcing which will heat the connector. Phoenix Contact specifies a tightening torque of 4.4 to 5.4 lb-in (0.5 to 0.6 Nm).

The power supply is connected to the pins marked “+Vdc In” and “DC Return”. The “Chassis GND” pin is used to attach the ANR2 to earth ground.

NOTE

1) AnyNET-I/O modules are electrically isolated from the DIN rail by their mounting, but the Chassis GND connection is common to all of the modules in the stack through a pin in the IC-5 connector. At least one module in the AnyNET-I/O Stack must be attached to earth ground through a heavy gauge stranded wire to ensure reliable operation of the stack.

2) Each ANR2 module must have its own power connection.

I/O Connector Pin Out

The I/O Connector is located on the top of the module. The mate for this connector is included with the ANR2. Spares are available from AMCI under the part number MS-2X11 and are also available from Phoenix Contact under their part number 173 88 98. Figure 3.5 shows the pin out for the I/O connector.

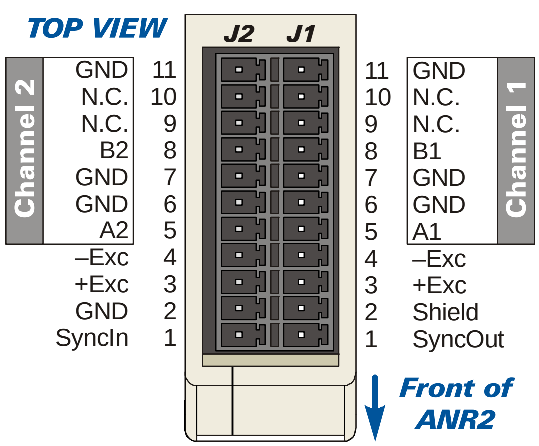


Figure 3.5 I/O Connector

Sensor Wiring

The ANR2 supports 3-, 4-, 5-, and 6-wire LVDT's and RVDT's as well as half bridge sensors. The following diagrams show how to wire these sensors to channel 1 of the ANR2. Wiring to channel 2 is identical except for the shield connection. Shield connections on the MS-2X11 can only be made on the J1-2 pin.

CAUTION "GND" in the following diagrams reference *signal ground*, not *chassis ground*. Connecting shield wires to these pins may result in electrical noise being injected into the transducer circuit that may cause faulting readings with the potential for improper machine operation.

Half Bridge

There is only one way to wire a half bridge sensor to an ANR2.

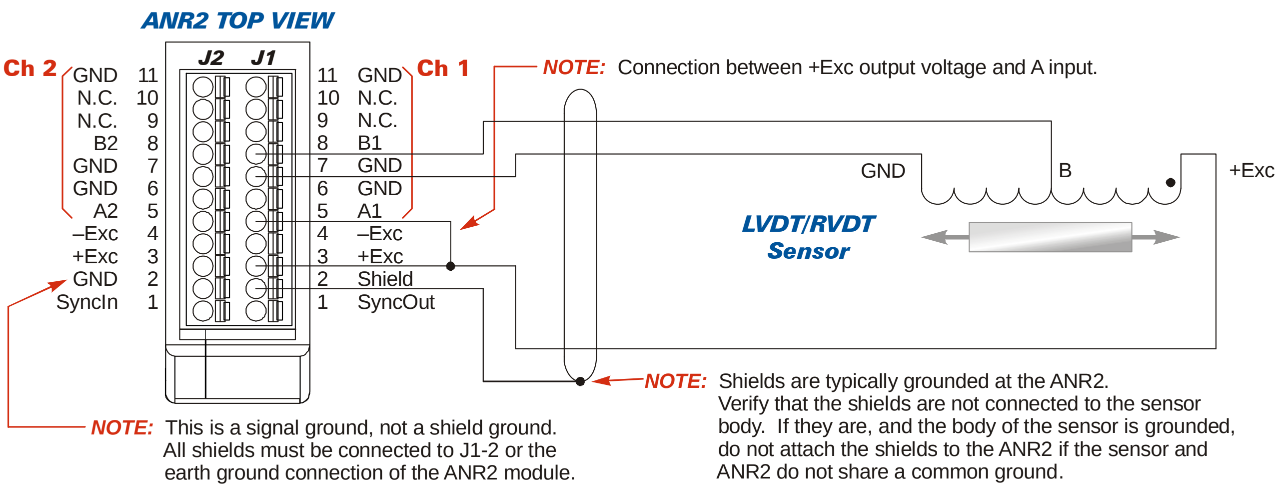


Figure 3.6 Half Bridge LVDT/RVDT Wiring

3-Wire Sensor

There is only one way to wire a 3-wire sensor to an ANR2.

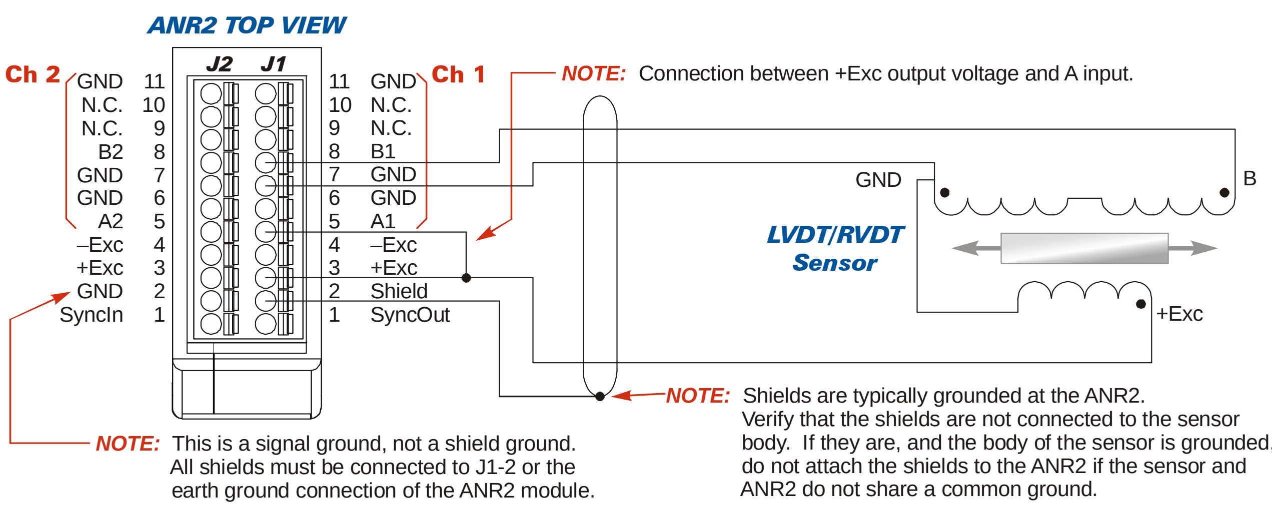


Figure 3.7 3-Wire LVDT/RVDT Wiring

Sensor Wiring (continued)

4-Wire Sensor

There is only one way to wire a 4-wire sensor to an ANR2.

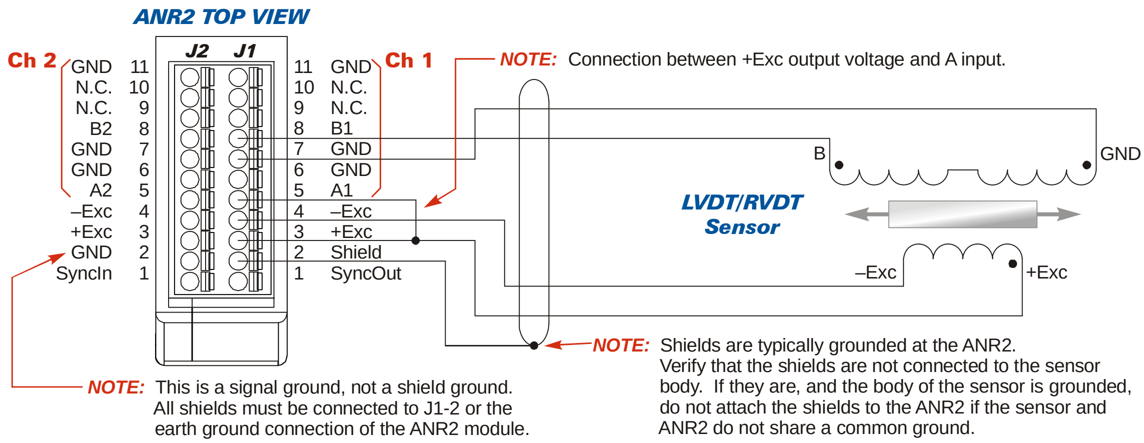


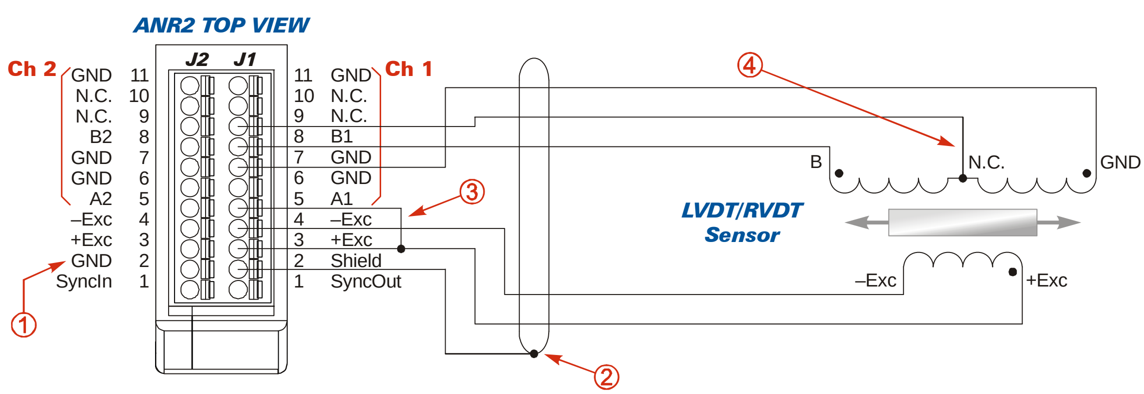
Figure 3.8 4-Wire LVDT/RVDT Wiring

5-Wire Sensor

Five wire sensors can be wired as either differential sensors or ratiometric sensors. Ratiometric wiring is less sensitive to temperature variations, but the sensor must be manufactured for use as a ratiometric sensor. Contact your sensor's manufacturer if you are not sure which type of sensor you have.

Differential Wiring

Five wire sensors can be used as 4-wire sensors by leaving the centertap wire unconnected and electrically isolated. As shown in the diagram below, you have the option of landing the centertap wire on one of the N.C. pins of the ANR2 connector.



① This is a signal ground, not a shield ground. All shields must be connected to J1-2 or the earth ground connection of the ANR2 module.

② Shields are typically grounded at the ANR2. Verify that the shields are not connected to the sensor body. If they are, and the body of the sensor is grounded, do not attach the shields to the ANR2 if the sensor and ANR2 do not share a common ground.

③ Connection between +Exc output voltage and A input must be made.

④ The sensor's output centertap wire is not used and must remain electrically isolated. The wire can be left unconnected or landed on pins J1-9 or J1-10.

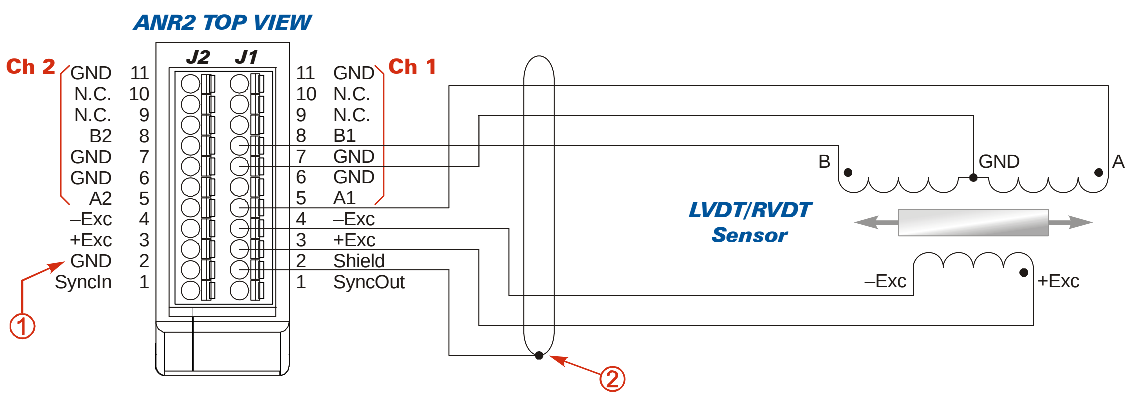
Figure 3.9 5-Wire LVDT/RVDT Differential Wiring

Sensor Wiring (continued)

5-Wire Sensor (continued)

Ratiometric Wiring

There is only one way to wire a 5-wire sensor to an ANR2 when using ratiometric wiring. Note that the sensor as to be designed for ratiometric measurements. If you are unsure about your sensor, contact the manufacturer of your sensor.



① This is a signal ground, not a shield ground. All shields must be connected to J1-2 or the earth ground connection of the ANR2 module.

② Shields are typically grounded at the ANR2. Verify that the shields are not connected to the sensor body. If they are, and the body of the sensor is grounded, do not attach the shields to the ANR2 if the sensor and ANR2 do not share a common ground.

Figure 3.10 5-Wire LVDT/RVDT Ratiometric Wiring

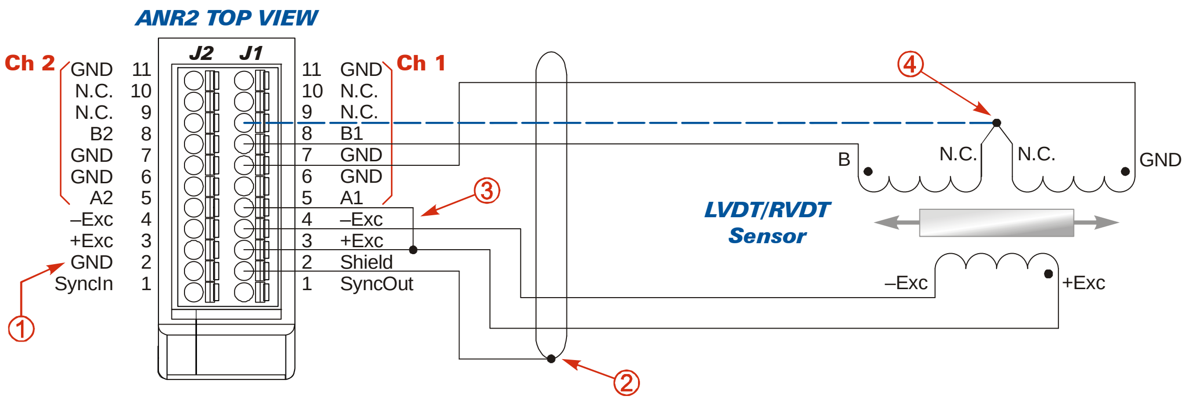
Sensor Wiring (continued)

6-Wire Sensor

Six wire sensors can be wired as either differential sensors or ratiometric sensors. Ratiometric wiring is less sensitive to temperature variations, but the sensor must be manufactured for use as a ratiometric sensor. Contact your sensor's manufacturer if you are not sure which type of sensor you have.

Differential Wiring

Six wire sensors can be used as 4-wire sensors by connecting the secondary windings in series opposition at the sensor and electrically isolating this connection. As shown in the diagram below, if the connection cannot be made at the sensor, the two wires can be landed on one of the N.C. pins of the ANR2 connector.



① This is a signal ground, not a shield ground. All shields must be connected to J1-2 or the earth ground connection of the ANR2 module.

② Shields are typically grounded at the ANR2. Verify that the shields are not connected to the sensor body. If they are, and the body of the sensor is grounded, do not attach the shields to the ANR2 if the sensor and ANR2 do not share a common ground.

③ Connection between +Exc output voltage and A input must be made.

④ The sensor's output windings must be connected in series opposition at the sensor and electrically isolated. If the connection cannot be made at the sensor, the two wires can be brought back to the ANA2 and landed on either J1-9 or J1-10.

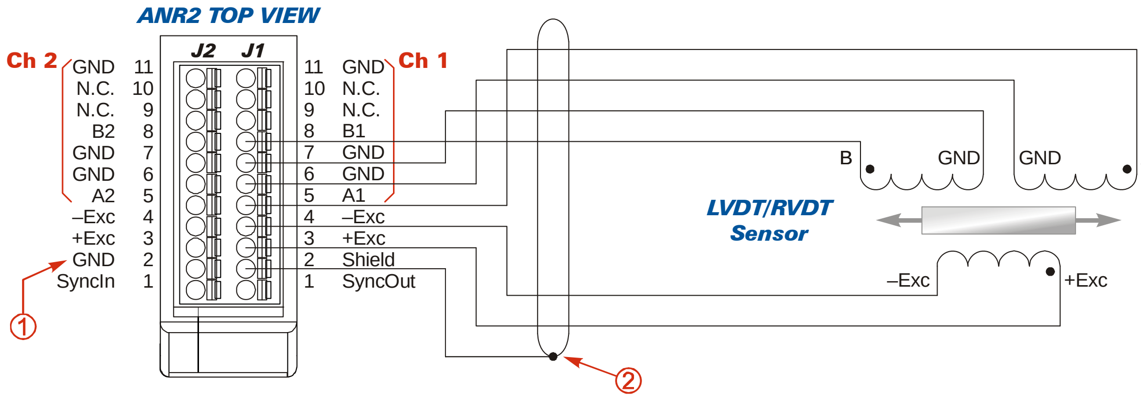
Figure 3.11 6-Wire LVDT/RVDT Differential Wiring

Sensor Wiring (continued)

6-Wire Sensor (continued)

Ratiometric Wiring

There is only one way to wire a 6-wire sensor to an ANR2 when using ratiometric wiring. Note that the sensor as to be designed for ratiometric measurements. If you are unsure about your LVDT/RVDT's suitability, contact your sensor's manufacturer.



① This is a signal ground, not a shield ground. All shields must be connected to J1-2 or the earth ground connection of the ANR2 module.

② Shields are typically grounded at the ANR2. Verify that the shields are not connected to the sensor body. If they are, and the body of the sensor is grounded, do not attach the shields to the ANR2 if the sensor and ANR2 do not share a common ground.

Figure 3.12 6-Wire LVDT/RVDT Ratiometric Wiring

NOTE It is important to note the sense of the secondary windings and wire them appropriately. One of the secondary windings must be in phase with the primary and one must be in anti-phase. The sensor will not work if one of the secondary windings is reversed. The sensor will count in the opposite direction if both of the phases are reversed.

Extending the Transducer Cable

Your sensor manufacturer should have a suggested cable if you need to extend the cable from your LVDT/RVDT. AMCI suggests Belden 9729 for half bridge, 3-wire, and 4-wire sensors as well as 5-wire and 6-wire sensors that are wired as differential sensors. Belden 9730 is suggested for 5-wire and 6-wire sensors that are wired as ratiometric sensors. Both of these cables are low capacitance, individually shielded, twisted pair cable. These cables will work for a minimum distance of one hundred feet. The actual usable length is dependent on operating frequency and sensor impedance. Feel free to contact AMCI for additional assistance if you need to extend the transducer cable more than one hundred feet.

Half Bridge Sensor

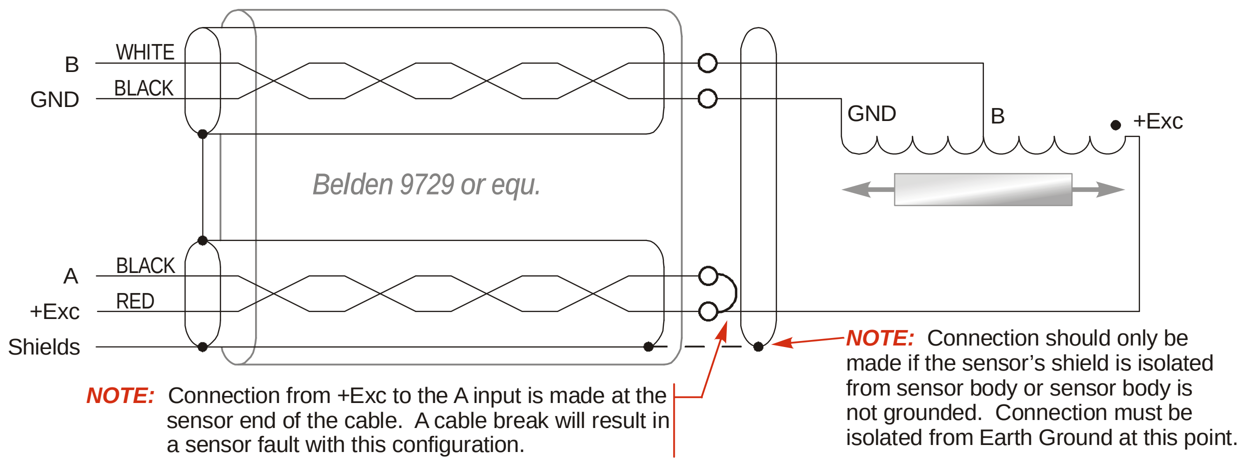


Figure 3.13 Extending a Half Bridge Sensor Cable

3-Wire Sensor

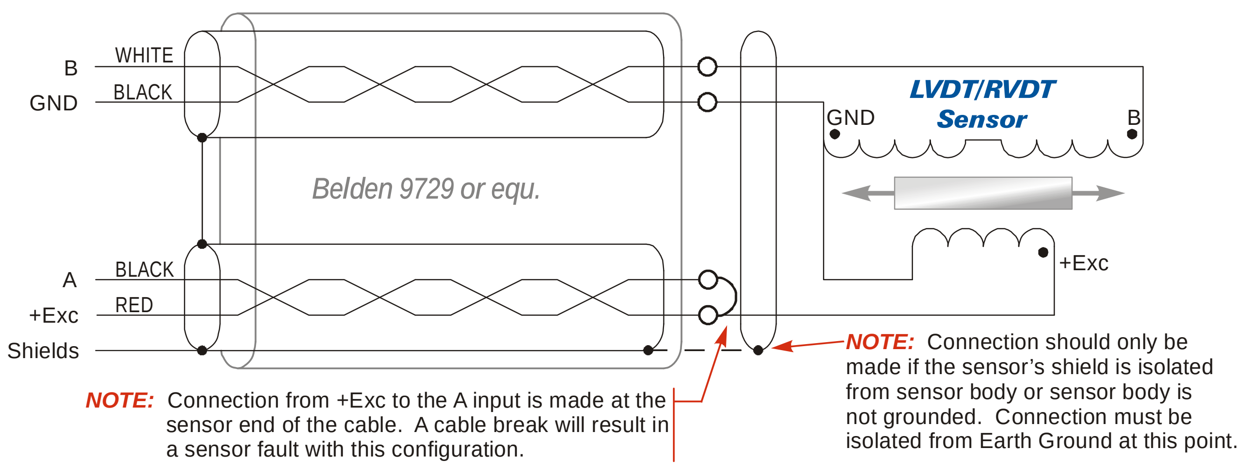


Figure 3.14 Extending a 3-Wire Sensor Cable

Extending the Transducer Cable (continued)

4-Wire Sensor

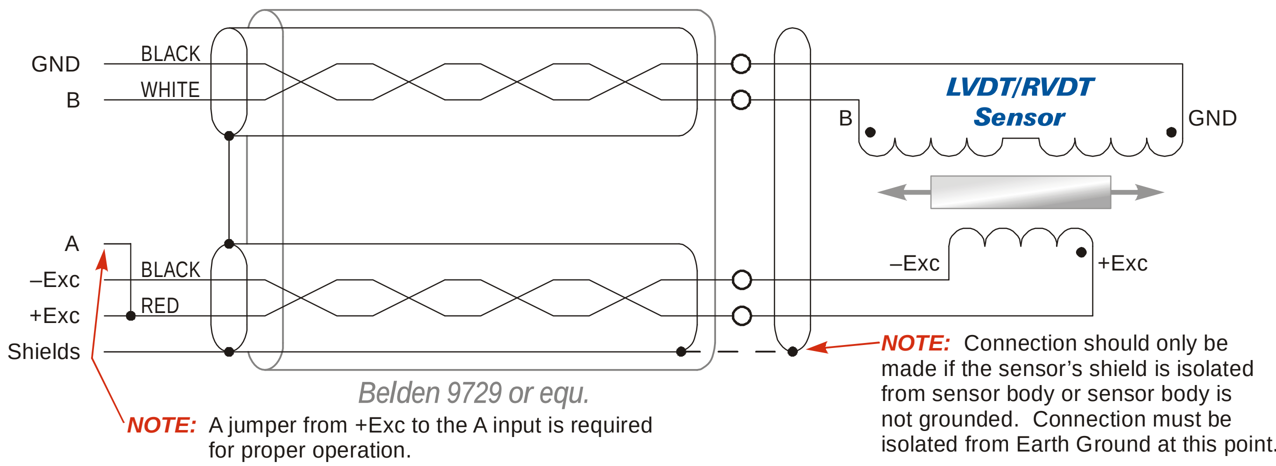


Figure 3.15 Extending a 4-Wire Sensor Cable

5-Wire Differential

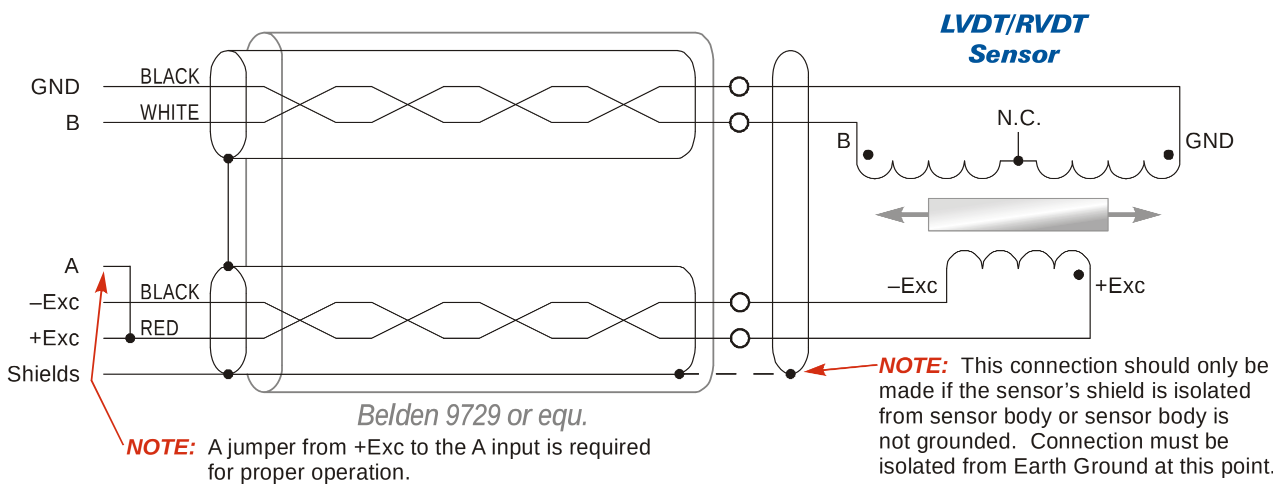


Figure 3.16 Extending a 5-Wire Differential Sensor Cable

NOTE The secondary's centertap wire is left unconnected and electrically isolated.

Extending the Transducer Cable (continued)

5-Wire Ratiometric

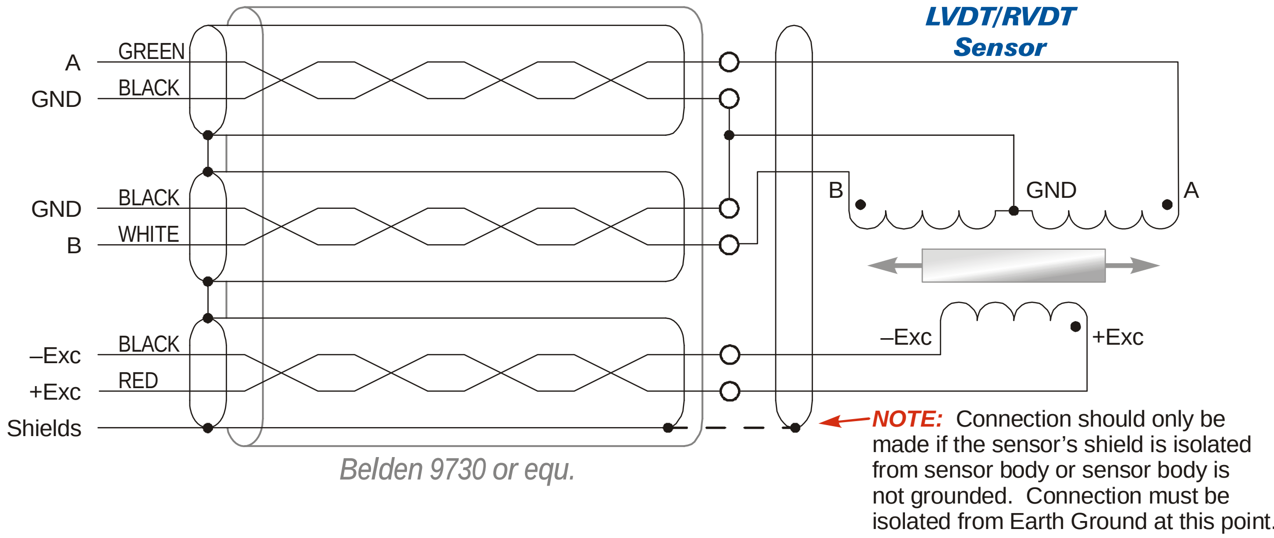


Figure 3.17 Extending a 5-Wire Ratiometric Sensor Cable

NOTE The center tap of the secondary windings is connected to two wires in the Belden 9730 cable. This is to insure that the signals remain balanced in the Belden cable. For this type of installation, a five wire sensor should be wired to the ANR2 as a six wire sensor.

6-Wire Differential

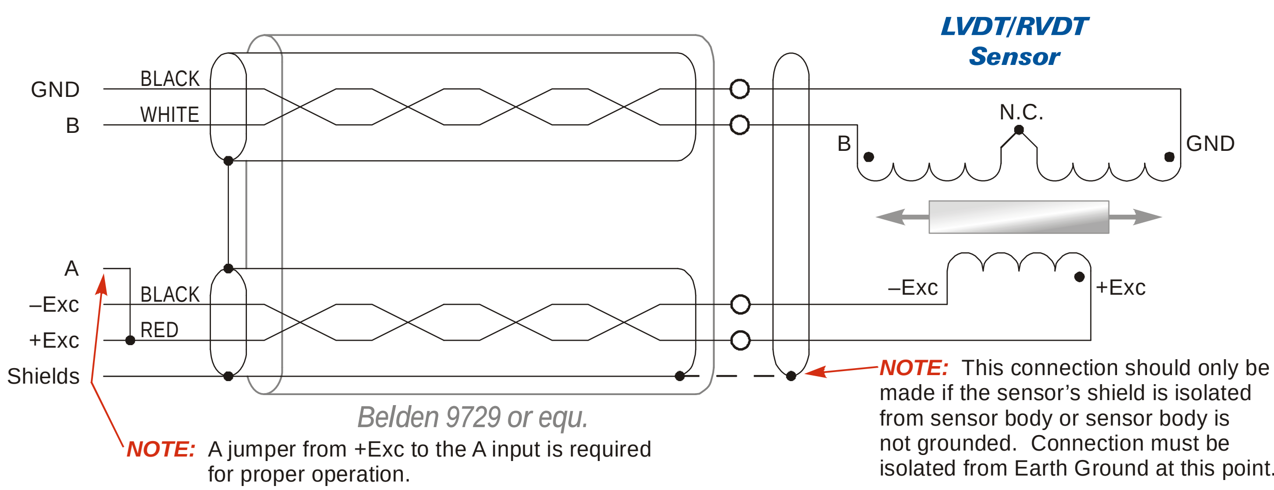


Figure 3.18 Extending a 6-Wire Differential Sensor Cable

NOTE The secondary windings must be connected in series opposition at the sensor and this connection must be electrically isolated. The sensor will not work if the secondary windings are not in series opposition.

Extending the Transducer Cable (continued)

6-Wire Ratiometric

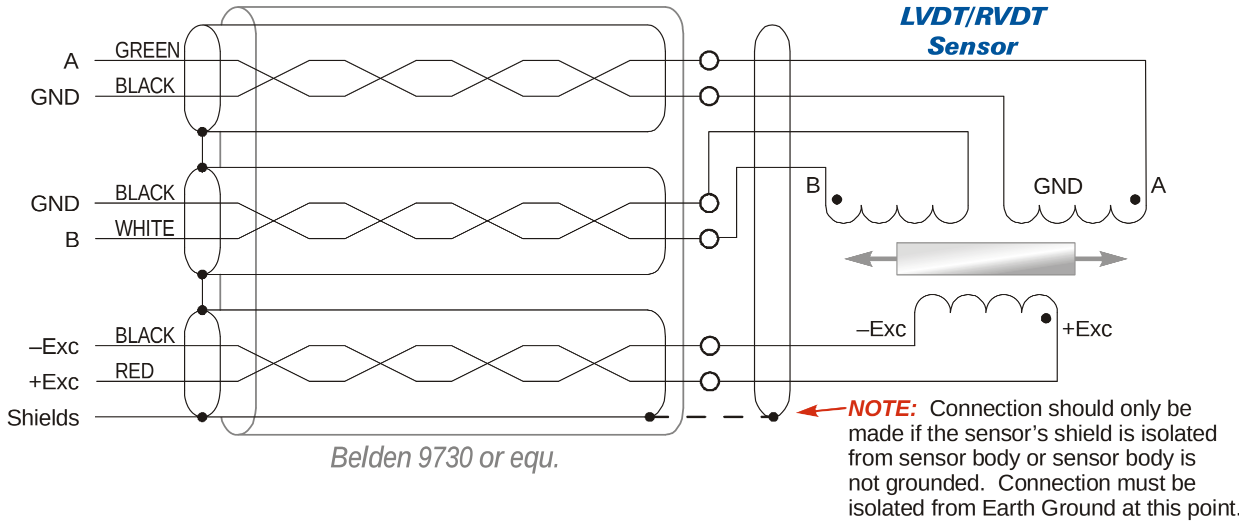


Figure 3.19 Extending a 6-Wire Ratiometric Sensor Cable

NOTE It is important to note the sense of the secondary windings and wire them appropriately. One of the secondary windings must be in phase with the primary and one must be in anti-phase. The sensor will not work if one of the secondary windings is reversed. The sensor will count in the opposite direction if both of the phases are reversed.

Avoiding Ground Loops When Extending the Sensor Cable

A ground loop occurs when the shields of a cable are attached to earth ground in two places. It is possible, and the likelihood increases as the cable length increases, for these two earth ground points to have a voltage potential between them. The shield acts as a low impedance path between the two points which results in a constant current flowing through the shield. To avoid a ground loop, the cable shields must not be grounded in two places.

- If the shield of the sensor cable is isolated from the body of the sensor, connect the shield of the sensor cable to the shields of the Belden cable and ground the shield at the ANR2. Treat the shield of the sensor cable as a signal carrying conductor and do not connect it to earth ground at any other point.
- If the shield of the sensor cable is connected to the body of the sensor but the body of the sensor is isolated from chassis ground by its mounting, connect the shield of the sensor cable to the shields of the Belden cable and ground the shield at the ANR2. Treat the shield of the sensor cable as a signal carrying conductor and do not connect it to earth ground at any other point.
- If the shield of the sensor cable is connected to the body of the sensor and the body of the sensor is connected to earth ground by its mounting, ***Do Not*** connect the shield of the sensor cable to the shields of the Belden cable. The shield of the sensor cable is grounded by the sensor body. Connect the shields of the Belden cable to earth ground at the ANR2.

Excitation Slave Mode

If your application requires more than two LVDT/RVDT sensors, then you will be using two or more ANR2 modules in the AnyNET-I/O stack. If all of these sensors operate at the same frequency, then it is strongly suggested that you use one ANR2 as a master module, which generates the excitation voltage signal, and the rest of the them as slave modules.

All ANR2 units ship as masters. You will need to change a small jumper next to the address switches to set the unit into slave mode and then wire a synchronizing signal from the master to the slaves.

Excitation Mode Jumper

Figure 3.20 shows the location of the jumpers that set the mode of the ANR2. You access the jumpers by opening the front cover of the module. All ANR2 modules ship with a jumper across the “Master” pins. To set the module to slave mode, move the jumper from the Master pins to the Slave pins.

NOTE The module will not operate correctly if the jumper is not across one of the sets of pins.

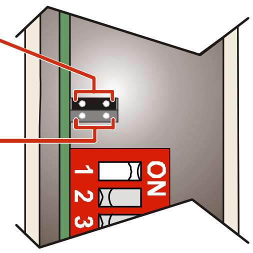


Figure 3.20 Slave Mode Jumper Location

SyncOut/SyncIn Wiring

After changing the jumper, you have to place a jumper from the SyncOut pin of the master module to the SyncIn pin of the first slave module. You will then continue to place jumpers from the SyncOut pin of one slave to the SyncIn pin of the next until all of the slaves are daisy-chained to the master module. Proper wiring is shown in figure 3.21.

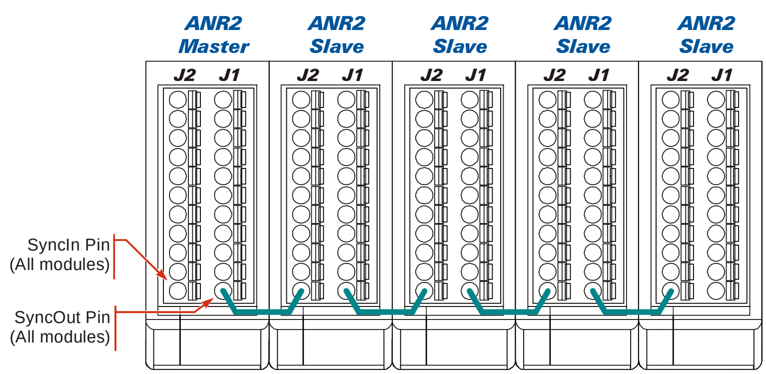


Figure 3.21 SyncOut/SyncIn Slave Mode Wiring

Notes

AMCI NET CONFIGURATOR SOFTWARE

The AMCI NET Configurator software version 4.20 and above adds screens that allow you to graphically program the parameters of an ANR2 module as well as display position and velocity data. This software is designed to assist you in gaining familiarity with the ANR2, but is not meant to replace programming your host controller.

NOTE The AMCI NET Configurator software is a simple utility program. As such, it assumes that it has exclusive access to the AnyNET-I/O Stack. Do not attempt to run this software utility while the AnyNET-I/O Stack is attached to a host controller. Doing so may result in communication contention that will prevent the Configurator software utility from communicating with the rack, may interrupt communication between the host controller and the AnyNET-I/O Stack, and may require you to cycle power to the AnyNET-I/O stack or host controller to rectify the problem.

The following images only show the different screens available on the NET Configurator software for setting up an ANR2 module. Information on installing the software and using it to configure your network interface is available in the network interface manual that is appropriate for your AnyNET-I/O Stack.

ANR2 Configuration Screen

Figure 4.1 shows the settings on the Configuration tab. This is where you set all of the ***ANR2 Programmable Parameters*** that are described on page 9. The bottom half of the screen shows the module and channel status data being transmitted from the ANR2. This data is described in the ***Status Bits*** section of this manual starting on page 16.

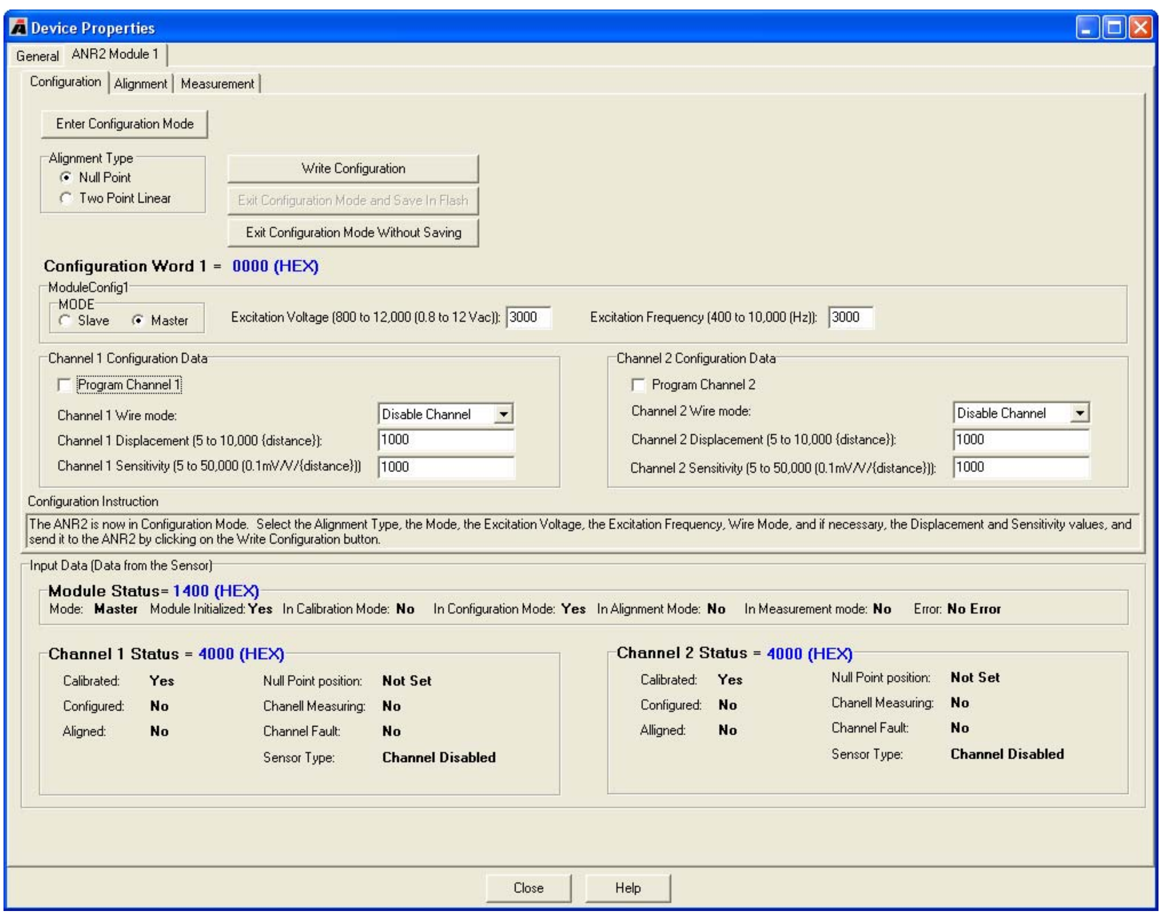


Figure 4.1 NET Configurator: Configuration Screen

ANR2 Alignment Screen

Figure 4.2 shows the settings on the Alignment tab. This tab is used to set the position values at the Null position of the sensor as well as the values at the two extremes of travel. Depending on the alignment method you choose, you may only have to define two of these three points.

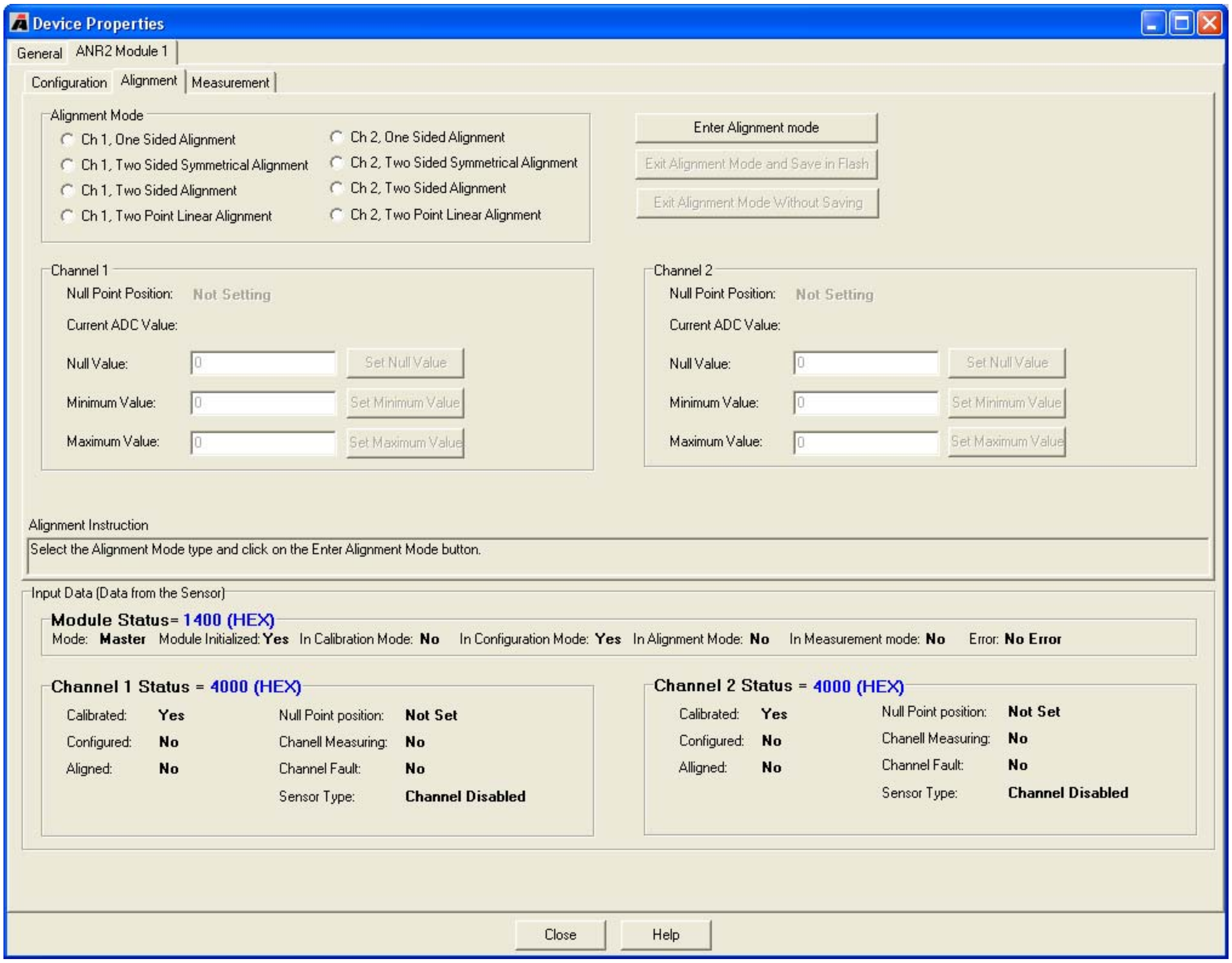


Figure 4.2 NET Configurator: Alignment Screen

ANR2 Measurement Screen

Figure 4.3 shows the settings and data available on the Measurement tab. The check boxes in the "Measurement Mode" section of the screen allow you to issue measurement commands to the ANR2. Simply select your settings and press the [Start Measurement] button to write these settings to the ANR2.

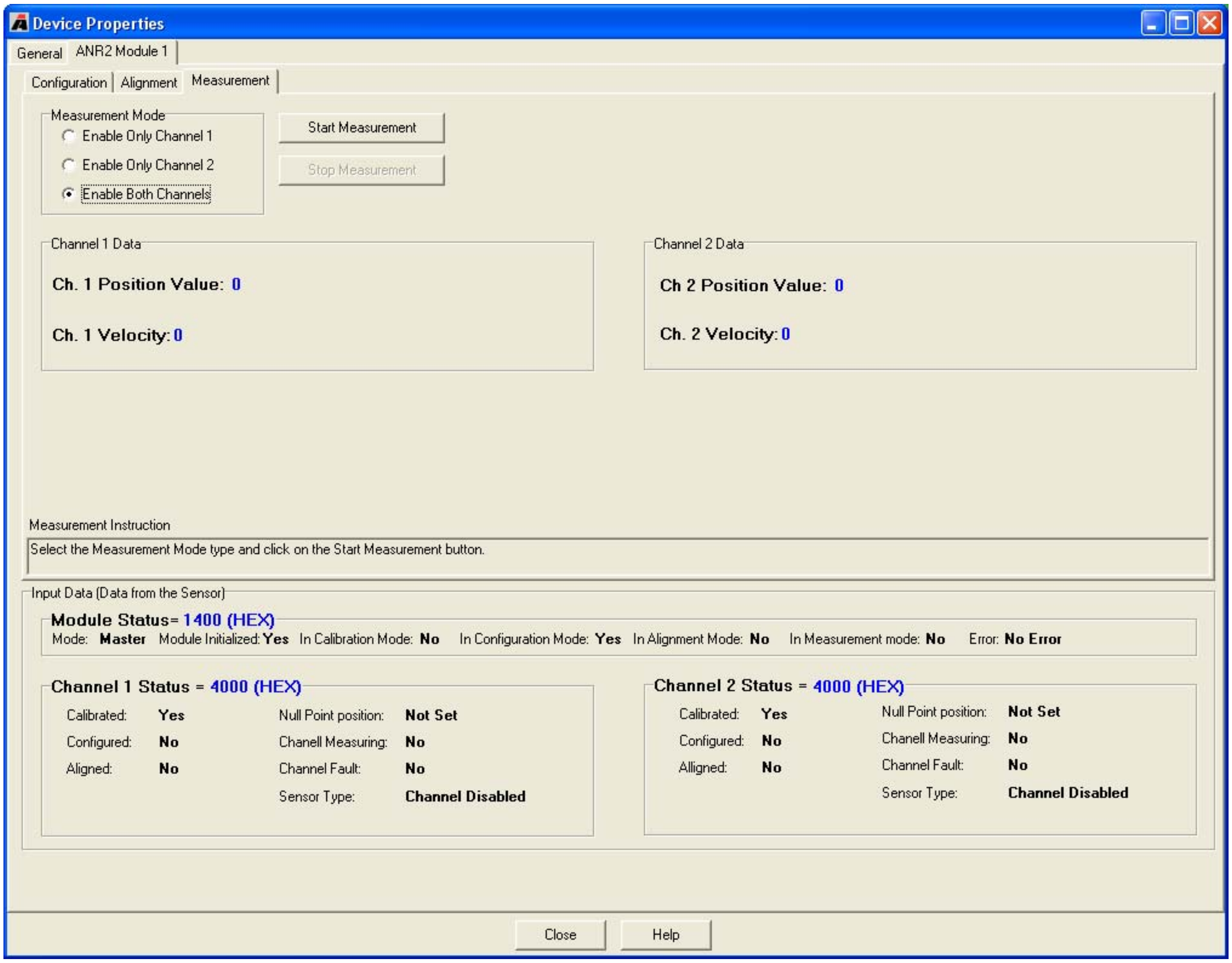


Figure 4.3 NET Configurator: Measurement Screen

Notes

NETWORK INPUT DATA FORMAT

This chapter covers the format of the Network Input Data read from the ANR2 by your network host.

Network Input Data

ANR2 Word	Power Up or Configuration Mode	Alignment Mode	Measurement Mode† (Channel Disabled)	Measurement Mode† (Channel Enabled)
0	Module Status	Module Status	Module Status	Module Status
1	Channel 1 Status	Channel 1 Status	Channel 1 Status	Channel 1 Status
2	16#0000	Ch. 1 ADC Value 32 bit Sign/Magnitude format	16#0000	Ch. 1 Position Value 32 bit Sign/Magnitude format
3	16#0000		16#0000	
4	16#0000	16#0000	16#0000	Ch. 1 Velocity 16 bit max.
5	Channel 2 Status	Channel 2 Status	Channel 2 Status	Channel 2 Status
6	16#0000	Ch. 2 ADC Value 32 bit Sign/Magnitude format	16#0000	Ch. 2 Position Value 32 bit Sign/Magnitude format
7	16#0000		16#0000	
8	16#0000	16#0000	16#0000	Ch. 2 Velocity 16 bit max.
9	Reserved	Reserved	Reserved	Reserved

† When the channel is disabled, the data words for that channel are set to zero. It is possible to have one channel disabled while the other is enabled.

Table 5.1 Network Input Data

32 Bit Sign/Magnitude Format

Position and A-D converter values are transmitted as thirty-two bit integers with sign/magnitude format. This simplifies processing in PLC's that do not support thirty-two bit signed integers. In this format, the most significant bit of the first word is the sign bit. It is "0" when the value is positive and "1" when the value is negative. The remaining bits hold the absolute value, or magnitude, of the data. Table 5.2 shows the difference between sign/magnitude and signed integer formats.

Sign/Magnitude			Signed Integer	
MSW	LSW	Decimal Value	MSW	LSW
16#0001	16#0000	65536	16#0001	16#0000
16#0000	16#FFFF	65535	16#0000	16#FFFF
16#0000	16#0001	1	16#0000	16#0001
16#0000	16#0000	0	16#0000	16#0000
16#8000	16#0001	-1	16#FFFF	16#FFFF
16#8000	16#FFFF	-65535	16#FFFF	16#0001
16#8001	16#0000	-65536	16#FFFF	16#0000

Table 5.2 Sign/Magnitude Data Format

Ladder logic examples to convert between sign-magnitude and signed integer formats are available in the sample programs available on the AMCI website. ***http://www.amci.com/sampleprograms.asp***

Module Status Word Format

The format of the Module Status word does not depend on the mode that the ANR2 is in. The format is always the same.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Acknowledge Bit	Heartbeat (10Hz)	0 = Excitation Mode Master 1 = Excitation Mode Slave	Module Initialized	In Calibration Mode	In Configuration Mode	In Alignment Mode	In Measurement Mode	0	0	0	0	Error Code 0 = No Error 1 = Command Error 2 = Save to Flash Error 3 = Excitation V Error 4 = Excitation f Error 5 = Sensitivity Error 6 = Displacement Error 7 = Null Align Error 8 = Min/Max Align Error 9-11 = Reserved 12 = Excitation Error 13-15 = Reserved			

Figure 5.1 Module Status Word Format

Bit Descriptions

Bit 15: Acknowledge Bit – Set to “1” in response to a command from the host controller. Reset to “0” when the Transmit Bit in the Command Word is reset to “0”. This bit must equal “0” before the ANR2 will accept a command.

Bit 14: Heartbeat – This bit changes state every 50 milliseconds. (50 milliseconds on, 50 milliseconds off, etc.) It can be used to verify active communications through the network interface and that the ANR2 is functioning correctly.

Bit 13: Excitation Master/Slave Mode – Reset to “0” when the ANR2 is acting as a Master Module. Set to “1” when the ANR2 is acting as a Slave module. When a Slave module, the ANR2 must be wired to a Master module before it will generate an excitation voltage.

Bit 12: Module Initialized – Set to “1” on power up to signify that the ANR2 has finished its power on self tests and the unit is ready for a command from the host controller. This bit is reset to “0” when the first command is accepted. This bit is also set to “1” whenever the module experiences a power on reset.

Bit 11: In Calibration Mode – Set to “1” when the ANR2 is in its Calibration Mode. Reset to “0” at all other times. If this bit equals “1” when the Module Initialized bit is set, the ANR2 requires calibration.

NOTE If this bit is set when the Module Initialized bit is set, the ANR2 has lost its factory calibration values. Contact AMCI for assistance with calibrating an ANR2.

Bit 10: In Configuration Mode – Set to “1” when the ANR2 is in its Configuration Mode. Reset to “0” at all other times. If this bit equals “1” when the Module Initialized bit is set, the ANR2 does not have valid configuration data for either channel and the unit must be configured.

Bit 9: In Alignment Mode – Set to “1” when the ANR2 is in its Alignment Mode. Reset to “0” at all other times. If this bit equals “1” when the Module Initialized bit is set, the ANR2 does not have valid alignment data for either channel and at least one of the channels must be aligned before measurements can be taken.

Module Status Word Format (continued)

Bit Descriptions (continued)

Bit 8: In Measurement Mode – Set to "1" when the ANR2 is in its Measurement Mode. Reset to "0" at all other times. If this bit equals "1" when the Module Initialized bit is set, the ANR2 is ready to have measurements taken on at least one of the channels. Use the Channel Status bits to determine which channels are ready to have measurements made on them. See the ***Channel Status Word Format*** section on page 41 for an explanation of these bits.

Bits 7 – 4: Reserved, These bits will always equal zero.

Bits 3 – 0: Error Codes, These bits are set when there is an error in the programming data sent from the host. Table 5.3 Lists the error codes and their meanings.

Error Code	Name	Description
0	No Error	No programming errors
1	Command Error	1) There is an error in the format of the Command Word. 2) You are attempting enter a mode that the ANR2 cannot allow at this time. For example, attempting to start measurement on a channel that is not yet aligned. 3) You attempted to enter a mode without setting the correct password in word 1. 4) You attempted to align both channels without exiting Alignment Mode and saving the first in flash. Each channel must be aligned separately. 5) Programming both the Minimum and Maximum Values when using the One Sided Alignment or Two Sided Symmetrical Alignment methods. 6) You attempted to program two setpoint values at the same physical position. The sensor must be moved before setting a different setpoint value. 7) You attempted to use the Two Point Alignment method without writing the Write Two Point Alignment Data command to the ANR2 while configuring the channel. 8) You attempted to use the Two Point Alignment method without setting both the Minimum and Maximum Values. 9)Attempting to program a position value while in Two Point Alignment mode before acquiring a signal to roughly calculate the gain.
2	Save to Flash Error	1) In Alignment Mode, you attempt to save to flash without setting all of the required parameters. 2) An error has occurred when trying to save the parameters to Flash. The module will set both of the Status LED's on red. You must cycle power to the ANR2 to clear this fault.
3	Excitation Voltage Error	The Excitation Voltage parameter is outside of its range of 800 to 12,000 millivolts.
4	Excitation Frequency Error	The Excitation Frequency parameter is outside of its range of 400 to 10,000 hertz.

(Table is continued on next page.)

Module Status Word Format (continued)

Bit Descriptions (continued)

(Continued from previous page.)

Error Code	Name	Description
5	Sensor Sensitivity Error	The Sensor Sensitivity parameter is outside of its range of 0.1 to 5,000.0 mV/V/{distance} This parameter is programmed with 0.1 millivolt resolution, with a range of 1 to 50,000.
6	Sensor Displacement Error	The Sensor Displacement parameter is outside of its range of 5 to 10,000.
7	Null Align Error	You attempted to set the Null Position value when the A-D Converter value was greater than ±255 counts away from the sensor's null position.
8	Min/Max Align Error	1) You attempted to set the Min or Max Position to a value greater than ±65,535 counts from the programmed Null Position value. 2) You attempted to set the Min. or Max. Position Value when there was less than a 100 count difference in ADC value between this position and the Null Position. 3) You attempted to set the Min. and Max. Position Value on the same side of the Null Position. 4) While using the Two Point Alignment method, you attempt to set the Minimum and Maximum Values to the same count.
9-11	Reserved	Reserved for future use.
12	Excitation Error	The ANA2 cannot measure the Excitation Voltage it is outputting on the +EXC pin.
13-15	Reserved	Reserved for future use.

Table 5.3 Module Status Error Code Bits

Channel Status Word Format

The format of the Channel Status word does not depend on the mode that the ANR2 is in. The format is always the same. There are two Channel Status words in the network data. Word 1 is for channel one and Word 5 is for channel two.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Channel Calibrated	Channel Configured	Channel Aligned	0	0	Null Point 00 = Not Setting 01 = Move to decrease B 10 = Move to increase B 11 = At Null		0	0	Channel Fault	Channel Measuring	0	0	Sensor Type See Description below	

Figure 5.2 Channel Status Word Format

Bit Descriptions

Bit 15: Reserved – Always reset to “0”.

Bit 14: Channel Calibrated – This bit is set to “1” if the channel has been properly calibrated. The ANR2 is calibrated at the factory. This bit should always be set.

Bit 13: Channel Configured – Set to “1” when the channel has valid Configuration data associated with it. Reset to “0” if the channel must be configured before it can be used.

Bit 12: Channel Aligned – Set to “1” on power up to signify that the ANR2 has finished its power on self tests and the unit is ready for a command from the host controller. This bit is reset to “0” when the first command is accepted. This bit is set whenever the module experiences a power on reset.

Bits 11 & 10: Reserved – Always reset to “0”.

Bits 9 & 8: Null Point Position – Only active while setting the null point in Alignment Mode, these bits tell you which direction you have to travel to reach the null point, and if you are there.

Bits 7 - 6: Reserved – Always reset to “0”.

Bit 5: Channel Fault – Set to “1” when there is an error reading the sensor. The state of this bit is only valid when the ANR2 is in Alignment Mode or Measurement Mode. The most common causes are that the sensor is not wired to the ANR2 correctly or the Configuration and Alignment parameters are not correct.

Bit 4: Channel Measuring – Set to “1” when the ANR2 is in Measurement Mode and actively reading the channel’s sensor. If this bit is reset to “0” while in Measurement Mode, the ANR2 will transmit a value of zero for the position and velocity values.

Bits 3 -2: Reserved – Always reset to “0”.

Channel Status Word Format (continued)

Bit Descriptions (continued)

Bits 1 & 0: Sensor Type – Bit pattern shows what type of sensor the ANR2 channel is programmed for.

	Bit Number		
Channel 1 (Word 1)	1	0	
Channel 2 (Word 5)	1	0	Description
	0	0	Channel Disabled
	0	1	Ratiometric Sensor
	1	0	Differential Sensor
	1	1	3-Wire or Half Bridge Sensor

Figure 5.3 Wire Mode Bits Description

CHAPTER 6

CONFIGURATION MODE DATA FORMAT

This chapter covers the format of the Network Output Data when the ANR2 is in Configuration Mode. You will set Excitation Voltage parameters as well as sensor sensitivity and displacement while in this mode.

Transmit Bit

The Transmit Bit is used to tell the ANR2 when a new command is being written to it. Bit 15 of the Command Word in the Network Output Data (Output Word 0, bit 15) is always the Transmit Bit.

The ANR2 only accepts commands when the Transmit bit makes a 0→1 transition. Therefore, this bit must be reset between commands. The easiest way to do this is to write a value of zero into the Command Word before writing the next command. Once this bit is reset, the ANR2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANR2.

This condition also applies when switching between modes.

Entering Configuration Mode

The ANR2 will allow you to enter Configuration Mode after power up as long as valid Calibration data exists. This is the normal operating condition of the module. If the ANR2 powers up with the In Calibration Mode and Module Initialized bits set to "1", then the factory set calibration data has been corrupted. If this has occurred, contact AMCI for assistance. See ***Module Status Word Format*** starting on page 38 for a full description of the In Calibration Mode and Module Initialized bits.

You can also enter Configuration Mode from Alignment Mode or Measurement Mode at any time by writing the following data to the ANR2.

ANR2 Word	Value	Description
0	16#A000	Command Word to enter Configuration Mode
1	16#1298	Password
2 – 9	16#0000	Not Used

Figure 6.1 Enter Config Mode: Network Output Data

The ANR2 responds by setting the Acknowledge bit and the In Configuration Mode bits if the command was accepted. It will respond with an error code of "0001", Command Error, if the command was not accepted. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Write Configuration Data Command

Once you are in Configuration Mode, the following command will write all of the configuration data to the ANR2. When configuring the ANR2, use this command or the ***Write Two Point Configuration Command***, which is described on page 46. Do not attempt to use both to configure the ANR2. The Write Two Point Configuration command must be used if you plan to use the Two Point Linear Alignment method to align your sensor.

Word	Configuration Data	Range
0	Command Word	16#A001
1	Configuration Word	See below
2	Excitation Voltage	800 to 12,000 (0.8 to 12 Vrms)
3	Excitation Frequency	400 to 10,000 (Hz)
4	Channel 1 Sensitivity[1]	1 to 50,000 (0.1mV/V/{distance}†)
5	Channel 1 Displacement[1]	5 to 10,000 {distance}‡
6	Channel 2 Sensitivity[1]	1 to 50,000 (0.1mV/V/{distance}†)
7	Channel 2 Displacement[1]	5 to 10,000 {distance}‡
8	Reserved for future use	0
9	Reserved for future use	0

1 These parameters are only acted upon when the appropriate bit in the Configuration Word is set.

† {distance} can be mm, mil (0.001"), or 0.01°. The unit of distance for the Sensitivity and Displacement parameters must be the same.

‡ {distance} can be 0.01 mm, mil (0.001"), or 0.01°. The unit of distance for the Sensitivity and Displacement parameters must be the same.

Figure 6.2 Command Format: Write Configuration Data

Configuration Word Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0 = Master Mode 1 = Slave Mode	Program Channel 2	0	Channel 2 Wire Mode: See description below		Program Channel 1	0	Channel 1 Wire Mode: See description below	

Figure 6.3 Configuration Word Format

Bits 15 - 9: Reserved – Always reset to “0”.

Bit 8: Module Mode – Reset this bit to “0” if the ANR2 is to generate its own excitation voltage. Set this bit to “1” if this ANR2 is slaved to another ANR2 that acts as the master module for the group. If the ANR2 is a slave module, the ***Excitation Mode Jumper*** must be changed from its factory default position. The jumper is described on page 13.

Bit 7: Program Channel 2 – Set this bit to “1” to program the configuration parameters for channel 2 of the ANR2. If this bit is reset to “0” when this command block is issued, the ANR2 will not change any of configuration parameters for channel 2.

Bits 6: Reserved – Always reset to “0”.

Write Configuration Data Command (continued)

Configuration Word Format (continued)

Bits 5 & 4: Channel 2 Wire Mode – This two bit pattern disables the channel or defines what type if sensor is attached to it. These bits are always acted upon. (The Program Channel 2 bit is not used to control when these bits are acted upon.). See ***Wire Mode Bits*** below for a full description. If the channel is disabled, its Status LED is also turned off.

Bit 3: Program Channel 1 – Set this bit to "1" to program the configuration parameters for channel 1 of the ANR2. If this bit is reset to "0" when this command block is issued, the ANR2 will not change any of configuration parameters for channel 1.

Bits 2: Reserved – Always reset to "0".

Bits 1 & 0: Channel 1 Wire Mode – This two bit pattern disables the channel or defines what type if sensor is attached to it. These bits are always acted upon. (The Program Channel 1 bit is not used to control when these bits are acted upon.). If the channel is disabled, its Status LED is also turned off. See ***Wire Mode Bits*** below for a full description.

Wire Mode Bits

These bits disable the channel or define the type of sensor attached to it. Two bit fields exist, one for channel 1 and the other for channel 2.

	Bit Number		
Channel 1	1	0	
Channel 2	5	4	Description
	0	0	Channel Disabled
	0	1	6- or 5-Wire Sensor
	1	0	4-Wire Sensor
	1	1	3-Wire or Half Bridge Sensor

Figure 6.4 Wire Mode Bits Description

ANR2 Response

The ANR2 responds to a Write Configuration Data command by setting the Acknowledge Bit in the Module Status word as well as the appropriate error code in bits 03 through 00 of that word. If the command is accepted without error, the four error bits will equal zero. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANR2, correct your data and send another Write Configuration Data command to the unit.

Write Two Point Configuration Command

In applications where the sensor is already mounted in an existing machine, you may not have access to sensitivity and displacement information. In these cases, use the following command to set the Excitation Voltage and Excitation Frequency parameters only. When configuring the ANR2, use this command or the ***Write Configuration Data Command***, which is described on page 44. Do not attempt to use both to configure the ANR2.

NOTE If you use this command, you must use the Two Point Linear method while in Alignment Mode. By using this method, the ANR2 will calculate the required input amplifier gains to work with your sensor.

Word	Configuration Data	Range
0	Command Word	16#A002
1	Configuration Word	See page 44
2	Excitation Voltage	800 to 12,000 (0.8 to 12 Vrms)
3	Excitation Frequency	400 to 10,000 (Hz)
4-9	Not Used	Set to 16#0000

Figure 6.5 Command Format: Write Two Point Configuration

ANR2 Response

The ANR2 responds to a Write Two Point Configuration command by setting the Acknowledge Bit in the Module Status word as well as the appropriate error code in bits 03 through 00 of that word. If the command is accepted without error, the four error bits will equal zero. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANR2, correct your data and send another Write Configuration Data command to the unit.

Save to Flash and Exit Command

Configuration parameter changes are not accepted until you exit Configuration Mode. They are lost if you do not store the parameters in flash memory when you exit the mode. If the ANR2 experiences a hardware reset or power loss while in Configuration Mode, the parameter changes are also lost. If you wish to store the configuration data you just wrote to the ANR2, then you must exit Configuration Mode with this command.

ANR2 Word	Value	Description
0	16#800E	Command Word to exit Configuration Mode and save parameters to flash memory.
1 – 9	16#0000	Not Used

Figure 6.6 Save and Exit Command: Network Output Data

Save to Flash and Exit Command (continued)

The ANR2 will set the Acknowledge Bit and exit Configuration Mode. The unit will enter the highest level mode that it can. This will be Alignment Mode if neither of the channels are aligned, or Measurement Mode if one of the channels is aligned.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Exit Mode Command

Changes to configuration parameters are lost if you do not store the parameters in flash memory when you exit Configuration Mode. If you are in Configuration Mode and the ANR2 experiences a hardware reset or power loss, the parameters are also lost. If you want to save the parameters to flash and use them, then you must exit Configuration Mode with the ***Save to Flash and Exit Command*** as described on page 46.

NOTE If you entered Configuration Mode accidently or you just want to abandon your edits, exit Configuration Mode with the following command.

ANR2 Word	Value	Description
0	16#800F	Command Word to exit Configuration Mode
1 – 9	16#0000	Not Used

Figure 6.7 Save and Exit Command: Network Output Data

The ANR2 will set the Acknowledge Bit and exit Configuration Mode. The unit will enter the highest level mode that it can. This will be Configuration Mode if neither of the channels are presently configured, Alignment Mode if neither of the channels are aligned, or Measurement Mode if one of the channels is aligned.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Notes

CHAPTER 7
ALIGNMENT MODE DATA FORMAT

This chapter covers the format of the Network Output Data when the ANR2 is in Alignment Mode. In this mode, you will set position values at the null, minimum, and maximum points of travel.

Alignment Types

The ANR2 supports four types of alignments.

- One Sided Alignment: You set the null point value and either the minimum or maximum value. This alignment type is for applications that only use one half of the total travel of the sensor.
- Two Sided Symmetrical Alignment: You will set the null point and either the minimum or maximum value. The value at the other extreme of travel will be symmetrically reflected from the null point. As an example, setting a Null value of 0 and a maximum value of 10,000 at 1.000 inches of travel, will result in a value of -10,000 after 1 inch of travel from the null point in the opposite direction.
- Two Sided Alignment: You will specify the count value for all three points. As explained in the section ***Position Output*** of chapter 1 starting on page 9, the points do not have to be colinear.
- Two Point Linear Alignment: Use this method if you only want to define the two extreme points within the sensor's travel. The ANR2 will automatically adjust the gain of the input amplifiers to read the sensor correctly.

NOTE Two Point Linear Alignment must be used if you have chosen to program only the Excitation Voltage and Frequency while in Configuration Mode.

32 Bit Data Values

While in Alignment Mode, A-D converter values are transmitted in the position registers as thirty-two bit integers with sign/magnitude format. In this format, the most significant bit of the first word is the sign bit. It is "0" when the value is positive and "1" when the value is negative. The remaining bits hold the absolute value, or magnitude, of the data. Table 5.2 shows the difference between sign/magnitude and signed integer formats.

Sign/Magnitude			Signed Integer	
MSW	LSW	Decimal Value	MSW	LSW
16#0001	16#0000	65536	16#0001	16#0000
16#0000	16#FFFF	65535	16#0000	16#FFFF
16#0000	16#0001	1	16#0000	16#0001
16#0000	16#0000	0	16#0000	16#0000
16#8000	16#0001	-1	16#FFFF	16#FFFF
16#8000	16#FFFF	-65535	16#FFFF	16#0001
16#8001	16#0000	-65536	16#FFFF	16#0000

Table 7.1 Sign/Magnitude Data Format

Ladder logic examples to convert between sign-magnitude and signed integer formats are available in the sample programs available on the AMCI website. ***http://www.amci.com/sampleprograms.asp***

Notes on Using Two Point Linear Alignment

The ANR2 will adjust the gain of the input amplifiers when using this method. In order for this method to work correctly, you must be aware of the A-D converter values at both points before you use the Set Minimum Value and Set Maximum Value commands to program these positions.

Before issuing commands, drive the sensor to both extreme positions and note the A-D converter values at both positions. The first position that you program must be the position where the magnitude of the A-D converter value is the greatest.

When you initially drive to either of your extreme operating points, it is possible that the A-D converter will reach its maximum value before you reach your operating point. This simply means that the gain of the input amplifiers is set too high. When you issue your Set Minimum Value or Set Maximum Value command, the ANR2 will automatically lower the gain of the system so that the ANR2 can read the position correctly.

Transmit Bit

The Transmit Bit is used to tell the ANR2 when a new command is being written to it. Bit 15 of the Command Word in the Network Output Data (Output Word 0, bit 15) is always the Transmit Bit.

The ANR2 only accepts commands when the Transmit bit makes a 0→1 transition. Therefore, this bit must be reset between commands. The easiest way to do this is to write a value of zero into the Command Word before writing the next command. Once this bit is reset, the ANR2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANR2. This condition also applies when switching between modes.

Entering Alignment Mode

The ANR2 will allow you to enter Alignment Mode after power up as long as valid Configuration data exists. If the ANR2 powers up with the In Alignment Mode and Module Initialized bits set to “1”, then you can enter Alignment Mode. See *Module Status Word Format* starting on page 38 for a full description of the In Alignment Mode and Module Initialized bits.

You can also enter Alignment Mode from Measurement Mode at any time. You enter Alignment Mode by writing the following data to the ANR2.

ANR2 Word	Value	Description
0	16#90YX	Command Word to enter Alignment Mode Y: Channel Number. “0” = Channel 1 “1” = Channel 2 X: Alignment Type “0” = One Sided Alignment “1” = Two Sided Symmetrical Alignment “2” = Two Sided Alignment “3” = Two Point Linear Alignment†
1	16#1298	Password
2 – 9	16#0000	Not Used

† This method is only available if you used the *Write Two Point Configuration Command* while in Configuration Mode as described on page 46.

Figure 7.1 Enter Alignment Mode: Network Output Data

Entering Alignment Mode (continued)

NOTE Channels must be aligned individually. Bit 4 of the Command word determines which channel is being aligned. Valid Command Word values are:

- 16#9000: Channel 1, One Sided Alignment
- 16#9001: Channel 1, Two Sided Symmetrical Alignment
- 16#9002: Channel 1, Two Sided Alignment
- 16#9003: Channel 1, Two Point Linear Alignment
- 16#9010: Channel 2, One Sided Alignment
- 16#9011: Channel 2, Two Sided Symmetrical Alignment
- 16#9012: Channel 2, Two Sided Alignment
- 16#9013: Channel 2, Two Point Linear Alignment

ANR2 Response

The ANR2 responds by setting the Acknowledge Bit and the In Alignment Mode bit if the command was accepted. It will respond with an error code of "0001", Command Error, if the command was not accepted. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Coarse Gain Adjustment for Two Point Linear Alignment

Before you can set positions using the Two Point Linear Alignment method, the ANR2 must receive a sufficiently large reading from the sensor to coarsely set the gain. The ANR2 will flash the front panel LED's using the *At Null Point* pattern as shown in table 7.2 below. If the unit is alternately flashing the channel LED red/green, then the ANR2 has received a sufficiently large reading from the sensor and you can proceed to set your Minimum Value and Maximum Value points. If the channel LED is only flashing one color, you have to drive the sensor until a proper reading can be taken. You can also use the Network Input Data to determine when a proper reading has been taken. Bits 8 and 9 of the Channel Status Word will both be on when a proper reading has been taken. The ***Channel Status Word Format*** is explained on page 41.

Setting the Null Value

All of the alignment methods except for the Two Point Linear method require you to set the position value at the null point. Setting the value at the null point should be the first step in aligning the ANR2 for all other methods. Before you can write the command down to the ANR2, you must physically drive the sensor to its null point. There are three ways to determine if you are at the null point or which direction you must travel in to reach it.

Status LED

The Status LED for the channel has three distinctive blink patterns when searching for the null point.

Channel State	LED Blink Pattern	Description
Alignment Mode (Move out to reach Null Point)	Channel LED flashes green three times in 1.5 seconds (slow blink), followed by one second off.	The channel is in Alignment Mode, and is searching for the null point. Movement must occur to increase the voltage on the B channel to reach the null point.
Alignment Mode (Move in to reach Null Point)	Channel LED flashes red three times in 1.5 seconds (slow blink), followed by one second off.	The channel is in Alignment Mode, and is searching for the null point. Movement must occur to increase the voltage on the A channel to reach the null point.
Alignment Mode (At Null Point)	Channel LED alternately flashes red and green at 2 Hz. (Slow blink)	The channel is in Alignment Mode, and is at the null point.

Table 7.2 Status LED - Setting Null Point

Setting the Null Value (continued)

Channel Status Bits

Bits 8 and 9 in the Channel Status register can be used to determine if you are at the null point or the direction of travel needed to reach it.

Bit 9	Bit 8	Description
0	0	Not setting Null position for the channel
0	1	The channel is searching for the null point. Movement must occur to increase the voltage on the B channel to reach the null point.
1	0	The channel is searching for the null point. Movement must occur to increase the voltage on the A channel to reach the null point.
1	1	The channel is at its null point.

Table 7.3 Channel Status Bits - Setting Null Point

The Channel Status bits for channel 1 are in word 1 of the Network Input Data. The Channel Status bits for channel 2 are in word 5 of the Network Input Data. A complete description of the ***Channel Status Word Format*** can be found on page 41.

Channel Position Value

The final way of determining the null point is to read the position value while aligning the sensor. The channel's position value holds the raw ADC value in 32 bit sign-magnitude format. You can set the Null value when the position reads within the range of ±255 counts. The position value for channel 1 is in words 2 and 3 of the Network Input Data. The position value for channel 2 is in words 6 and 7. A description of the ***Network Input Data*** format is started on page 37.

Set Null Value Command

Once you are at the null point of the sensor, write the following command to the ANR2 to set the position value at this point.

Word	Configuration Data	Range
0	Command Word	16#9008
1	Null Value MSW	32 bit sign-magnitude position value. Valid range of ±2,147,483,647.
2	Null Value LSW	
3	Not Used	16#0000
4	Not Used	16#0000
5	Not Used	16#0000
6	Not Used	16#0000
7	Not Used	16#0000
8	Not Used	16#0000
9	Not Used	16#0000

Figure 7.2 Command Format: Set Null Value

ANR2 Response

The ANR2 response to a Set Null Value command by setting the Acknowledge Bit in the Module Status word as well as the appropriate error code in bits 03 through 00 of that word. If the command is accepted without error, the four error bits will equal zero. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

Setting the Null Value (continued)

ANR2 Response (continued)

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANR2, correct your data and send another Set Null Value command to the unit.

Setting the Minimum Value

Before you can set the Minimum Value, you must physically drive the sensor to the position where you want to define the point.

NOTE

1) When using One-Sided or Two-sided Symmetrical Alignments, you define the null value and the value at one of your position extremes. You can use either the Set Minimum Value or Set Maximum Value commands to set your outer position. You will not use both.
2) The programmed Minimum Value can be greater than the programmed Null Value. The only restrictions on programming the Minimum Value is that it must be in the range of Null Value ± 65,535 counts, with a maximum of ±2,147,483,647.
3) When using the Two Point Linear Alignment method, you must know the value of the A-D converter readings before issuing the Set Minimum Value or Set Maximum Value commands. Issue the Set Minimum Value command first only if the magnitude of your low reading is greater than the magnitude of your high reading. This occurs when your negative reading has a greater magnitude than your positive reading.

Channel Position Value

While setting the Minimum Value, the channel's position registers holds the raw A-D converter value in 32 bit sign-magnitude format. The A-D converter value for channel 1 is in words 2 and 3 of the Network Input Data. The A-D converter value for channel 2 is in words 6 and 7. A description of the ***Network Input Data*** format starts on page 37.

NOTE

1) The ANR2 will not allow you to set the Minimum Value until the A-D converter value is at least 100 counts different from its value at all other positions.
2) The maximum ADC value is ±8,191 counts. If the A-D converter reaches this value before you reach the outer limit of your travel, then your Sensor Sensitivity parameter is set too high or your Sensor Displacement parameter is set too low. If you are not using the Two Point Linear Alignment method, you will have to enter Configuration Mode to adjust one or both of these parameters. See chapter 6. ***Configuration Mode Data Format***, starting on page 43 for more information on Configuration Mode programming.

Setting the Minimum Value (continued)

Set Minimum Value Command

Once you are at the minimum travel point of the sensor, write the following command to the ANR2 to set the position value at this point.

Word	Configuration Data	Range
0	Command Word	16#9009
1	Minimum Value MSW	32 bit sign-magnitude position value. Valid range is ±2,147,483,647.†
2	Minimum Value LSW	
3	Not Used	16#0000
4	Not Used	16#0000
5	Not Used	16#0000
6	Not Used	16#0000
7	Not Used	16#0000
8	Not Used	16#0000
9	Not Used	16#0000

† If the Null Value is set, the maximum value is (Null Value ± 65,535). If using the Two Point Linear Alignment method and the Maximum Value is already set, the maximum value for this parameter is (Maximum Value ± 65,535).

Figure 7.3 Command Format: Set Minimum Value

ANR2 Response

The ANR2 response to a Set Minimum Value command by setting the Acknowledge Bit in the Module Status word as well as the appropriate error code in bits 03 through 00 of that word. If the command is accepted without error, the four error bits will equal zero. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANR2, correct your data and send another Set Minimum Value command to the unit. If your data appears to be correct, verify that you have moved the minimum required distance from all other points, which is ±100 A-D converter counts.

Setting the Maximum Value

The next step in aligning the ANR2 is to set the Maximum Value. Before you can write the command down to the ANR2, you must physically drive the sensor to the position where you define the point.

NOTE

1) When using One-Sided or Two-sided Symmetrical Alignments, you define the null value and the value at one of your position extremes. You can use either the Set Minimum Value or Set Maximum Value commands to set your outer position. You will not use both.
2) The programmed Maximum Value can be less than the programmed Null Value. The only restrictions on programming the Maximum Value is that it must be in the range of Null Value ± 65,535 counts with a maximum of ±2,147,483,647, and, for two sided alignment, on the other side of the null point from the programmed Minimum Value.
3) When using the Two Point Linear Alignment method, you must know the value of the A-D converter readings before issuing the Set Minimum Value or Set Maximum Value commands. Issue the Set Maximum Value command first only if the magnitude of your high reading is greater than the magnitude of your low reading. This occurs when your positive reading has a greater magnitude than your negative reading.
4) When not using the Two Point Linear Alignment method, the points where you set the Minimum and Maximum Values must be on the opposite sides of the null point.

Channel Position Value

While setting the Maximum Value, the channel's position registers holds the raw A-D converter value in 32 bit sign-magnitude format. The A-D converter value for channel 1 is in words 2 and 3 of the Network Input Data. The A-D converter value for channel 2 is in words 6 and 7. A description of the ***Network Input Data*** format is started on page 37.

NOTE

1) The ANR2 will not allow you to set the Maximum Value until the A-D converter value is at least 100 counts different from all other programmed positions.
2) The maximum ADC value is ±8,191 counts. If the A-D converter reaches this value before you reach the outer limit of your travel, then your Sensor Sensitivity parameter is set too high or your Sensor Displacement parameter is set too low. If you are not using the Two Point Linear Alignment method, you will have to enter Configuration Mode to adjust one or both of these parameters. See chapter 6. ***Configuration Mode Data Format***, starting on page 43 for more information on Configuration Mode programming.

Setting the Maximum Value (continued)

Set Maximum Value Command

Once you are at the maximum travel point of the sensor, write the following command to the ANR2 to set the position value at this point.

Word	Configuration Data	Range
0	Command Word	16#900A
1	Maximum Value MSW	32 bit sign-magnitude position value. Valid range ±2,147,483,647†
2	Maximum Value LSW	
3	Not Used	16#0000
4	Not Used	16#0000
5	Not Used	16#0000
6	Not Used	16#0000
7	Not Used	16#0000
8	Not Used	16#0000
9	Not Used	16#0000

† If the Null Value is set, the maximum value is (Null Value ± 65,535). If using the Two Point Linear Alignment method and the Minimum Value is already set, the maximum value is (Minimum Value ± 65,535).

Figure 7.4 Command Format: Set Maximum Value

ANR2 Response

The ANR2 response to a Set Maximum Value command by setting the Acknowledge Bit in the Module Status word as well as the appropriate error code in bits 03 through 00 of that word. If the command is accepted without error, the four error bits will equal zero. See ***Module Status Word Format*** starting on page 38 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANR2, correct your data and send another Set Maximum Value command to the unit. If your data appears to be correct, verify that you have moved the minimum required distance from all other defined points, which is 100 A-D converter counts.

Save to Flash and Exit Command

Alignment parameter changes are not accepted until you exit Alignment Mode. They are lost if you do not store the parameters in flash memory when you exit the mode. If the ANR2 experiences a hardware reset or power loss while in Alignment Mode, the parameter changes are also lost. If you wish to store the alignment data you just wrote to the ANR2, then you must exit Alignment Mode with this command.

NOTE The ANR2 will not allow you to use this command until all of the mode's alignment points have been set correctly.

ANR2 Word	Value	Description
0	16#800E	Command Word to exit Alignment Mode and save parameters to flash memory
1 – 9	16#0000	Not Used

Figure 7.5 Save and Exit Command: Network Output Data

The ANR2 will set the Acknowledge Bit and exit Alignment Mode. The unit will enter the highest level mode that it can. This will be Measurement Mode for the channel you just aligned.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Exit Mode Command

Changes to alignment parameters are lost if you do not store the parameters in flash memory when you exit Alignment Mode. If you are in Alignment Mode and the ANR2 experiences a hardware reset or power loss, the parameters are also lost. If you want to save the parameters to flash and use them, then you must exit Alignment Mode with the ***Save to Flash and Exit Command*** as described on page 57.

NOTE If you entered Alignment Mode accidently or you just want to abandon your edits, exit Alignment Mode with the following command.

ANR2 Word	Value	Description
0	16#800F	Command Word to exit Alignment Mode
1 – 9	16#0000	Not Used

Figure 7.6 Save and Exit Command: Network Output Data

The ANR2 will set the Acknowledge Bit and exit Alignment Mode. The unit will enter the highest level mode that it can. This will be Alignment Mode if you used this command to abort changes and neither of the channels are presently aligned, or Measurement Mode if one of the channels is aligned.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANR2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANR2 will respond by resetting the Acknowledge Bit.

Notes

CHAPTER 8
Measurement Mode Data Format

This chapter covers the format of the Network Output Data needed to place the ANR2 into its Measurement Mode. The ANR2 sends position, velocity, and status information while in this mode.

Power Up Behavior

The ANR2 can be switched to Measurement Mode after power up if one or both of the channels are calibrated, configured, and aligned. On power up, if bits 12 (Module Initialized), and 8 (In Measurement Mode), in the Module Status Word are both “1”, then at least one of the channels is ready for measurements. The ***Module Status Word Format*** section on page 38 describes the complete format of this word.

The Channel Status word is used to determine when a channel is ready for measurement. On power up, if bits 14 (Channel Calibrated), 13 (Channel Configured), and 12 (Channel Aligned), all equal “1”, the channel is ready for measurements. The ***Channel Status Word Format*** section on page 41 describes the format of this word.

Exiting Alignment Mode

When you exit Alignment Mode, the ANR2 will automatically switch to Measurement Mode if one or both of the channels is aligned. This even occurs if there is an error in aligning the channel you are programming if the other channel is correctly aligned. For example, assume you are attempting to align channel 2 and you exit Alignment Mode without setting all of the required points. This will result in a failure to align the channel. If channel 1 is aligned, the ANR2 will move to Measurement Mode. If channel 1 is not aligned, the unit will move back to Alignment Mode.

Begin Measurement Command

Once Measurement Mode is available, you have to issue a command to tell the ANR2 which channels you want to take measurements on.

ANR2 Word	Value	Description
0	16#880X	Command Word to enter Measurement Mode X: Channel Enable “0” = Disable both Channels “1” = Enable only Channel 1 “2” = Enable only Channel 2 “3” = Enable both Channels
1 – 9	16#0000	Not Used

Figure 8.1 Enter Measurement Mode: Network Output Data

Once in Measurement Mode, the position and velocity data is reported to your host as given in the ***Network Input Data*** section starting on page 37.

APPENDIX A

THE LVDT AND RVDT

This appendix explains how an LVDT works and the characteristics you must be aware of when configuring the ANR2 to use your sensors.

What is an LVDT?

The LVDT, or Linear Variable Differential Transformer, is an analog sensor that measures linear position with an accuracy that is limited only by the electronics attached to it. Each LVDT contains one input, or primary, coil and two output, or secondary, coils. Some LVDT's have the two secondary coils internally connected in series opposition and appear to have only one secondary coil. A cut away view of a model LVDT is shown in figure A.1 along with a schematic representation.

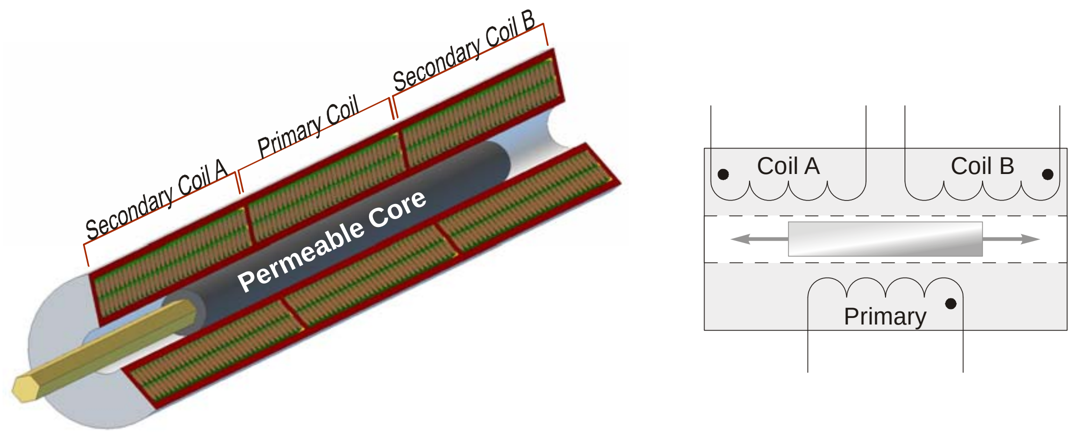


Figure A.1 LVDT Sensor

The Permeable Core is free to slide within the LVDT and is typically attached to what is being measured by a non-magnetic rod. An excitation voltage is applied to the Primary Coil. The core couples energy from the Primary Coil into the two secondary coils. When the core is centered in the LVDT, an equal amount of energy is coupled into the secondary coils and their voltage outputs are equal. This is the "Null" position. As the core moves towards Coil A, the amount of energy coupled into it increases, which appears as an increase in voltage. Simultaneously, the amount of energy coupled into Coil B decreases, and its output voltage falls. The same relationship occurs as the core moves towards Coil B. The voltage on Coil B increases while the voltage on Coil A decreases.

When considering AC voltages, phase is important. One of the secondary coils produces a voltage that is in phase with the excitation voltage and the other produces a voltage that is 180° out of phase with the excitation voltage.

The vector difference of the induced voltages ($V_A - V_B$) is linear over most of the travel of the core. This relationship is what makes the LVDT useful as an analog sensor.

What is an LVDT? (continued)

Internally, all LVDT's have six wires except for half bridge LVDT's.

"Five-wire" LVDT have the two secondary coils tied in series opposition and this connection is brought out as a centertap. The sum and difference of the two voltages can be determined with five and six wire sensors.

"Four-wire" LVDT's are made by internally tying the two secondary coils in series opposition and bringing out the other two ends. This gives a fixed secondary output of $V_A - V_B$. The sum of the two voltages cannot be determined from a four wire sensor.

"Three-wire" LVDT's are made by internally tying the two secondary coils in series opposition and tying one side of the primary to one end of the secondary coils. This gives a fixed secondary output of $V_A - V_B$. The sum of the two voltages cannot be determined from a three wire sensor.

"Half bridge" LVDT's have a single winding with a centertap connection. These devices are typically measured by using two resistors to build a bridge circuit with the LVDT as one side.

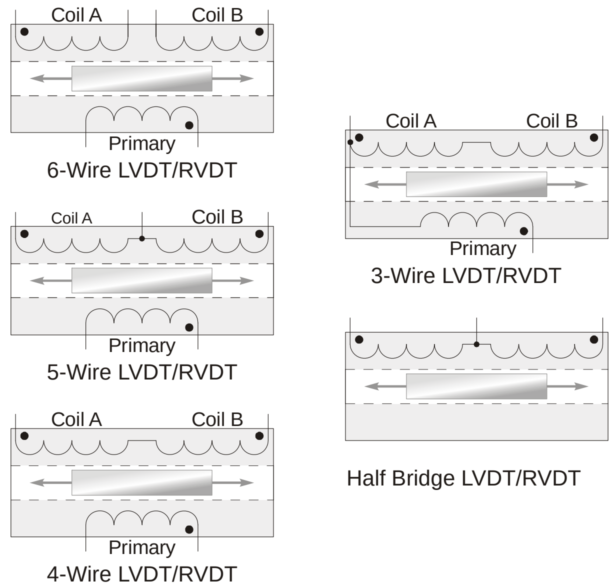


Figure A.2 LVDT/RVDT Wiring Types

All of these configurations are shown in figure A.2. The ANR2 can interface with any of these wiring types.

What is an RVDT?

An RVDT, or Rotary Variable Differential Transformer, has electrical characteristics that are functionally identical to the LVDT, but the mechanical construction is significantly different. An RVDT has the primary and secondary coils located in the body of the RVDT and the permeable core is mounted on the shaft of the sensor. As the shaft rotates, and the difference in induced voltages remains linear over a fixed range of motion, typically ±30° to ±60°.

Important Characteristics

- **Sensor Type:** This defines how the sensor is wired to the ANR2.
- **Input Voltage:** Defines the nominal operating voltage for your sensor.
- **Input Frequency:** Defines the nominal operating frequency of your sensor. This is sometimes specified as a range of acceptable values, with accuracy ratings listed at a specific frequency. Use this frequency if it is available, or choose the center value from the range given.
- **Sensitivity:** This parameter specifies the change in output that you can expect based on your Input Voltage and change in position. V_o = Sensitivity x Input Voltage x Change in position. For example, assuming a sensitivity of 6.0 mV/V/0.001" and an Input Voltage of 4 Vrms, a change in position of 0.050 inches will result in an output change of 6.0 mV x 4 V x (0.050"/0.001) = 1.2 Volts.
- **Stroke Length, or Nominal Range:** Because of present manufacturing methods, the sensitivity of an LVDT or RVDT decreases as the stroke length of the sensor increases. Therefore, the stroke length of your sensor should match your expected travel as closely as possible. With this said, when programming the ANR2, you should program in your expected travel length, especially if this length is significantly less than the total stroke length of your sensor.

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.