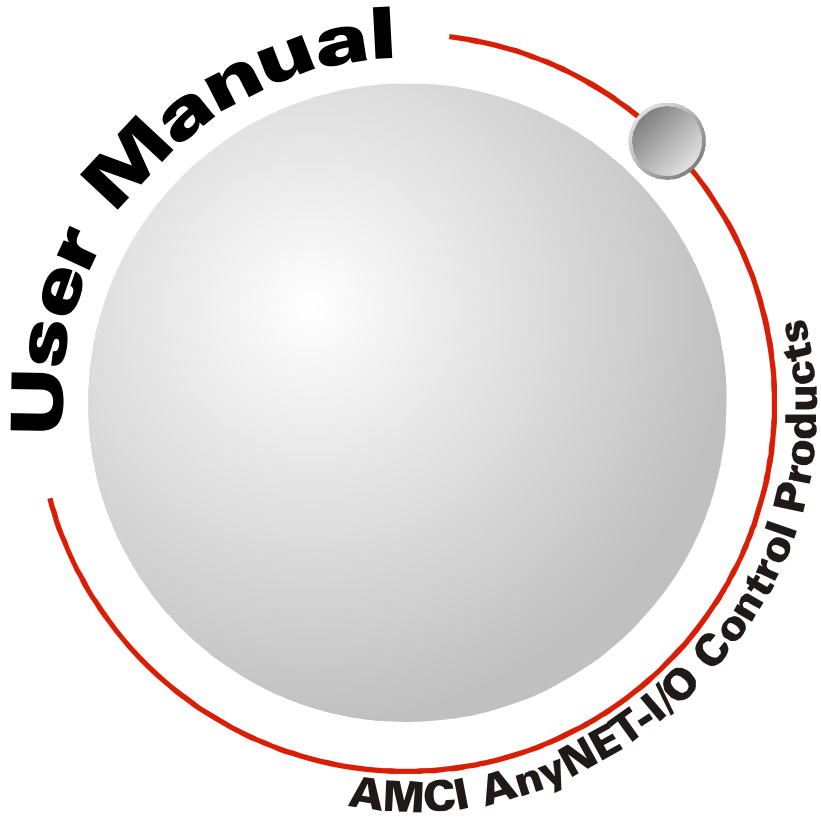
ADVANCED MICRO CONTROLS INC.

Manual #: 940-0A082

ANA2

AnyNET-I/O Resolver Interface Module



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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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 audiences.

Audience

This manual explains the set-up, installation, and operation of AMCI's ANA2 AnyNET-I/O Resolver Interface 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 ANA2 modules, including those that have an integral network connection. If your ANA2 module has a network interface, such as the ANA2E, ANA2P, or ANA2M, 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.

Trademark Notices

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Revision Record

This manual, 940-0A082, is the third release of this manual. It was released September 24th, 2013. This revision corrects slave mode wiring.

Revision History

940-0A081 6/21/2013 Release. It added slave mode and additional error code messages.

940-0A080 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. You will also find ***red text that are hyperlinks*** to various pages on the www.amci.com website. Clicking on the text will open your web browser and attempt to connect you with our website. Adobe Acrobat products may ask for confirmation before linking to the World Wide Web.

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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.
HTML Link	When viewing the PDF version of the manual, clicking on the link will connect you with the www.amci.com website.

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 ANA2***	Anyone new to the ANA2. 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 ANA2***	Anyone that must install an ANA2 on a machine. Includes information on mounting, grounding, and wiring specific to the units.
4	***AMCI Net Configurator Software***	Screen captures of the AMCI NET Configurator software that you can use to test the ANA2 and become familiar with its programming.
5	***Module & Channel Status Data***	Anyone interested in the format of the data you can read from the ANA2. The data format for all of the modes is included in this chapter.
6	***Configuration Mode Data Format***	Anyone that needs information on the commands you must write to the ANA2 to set its configuration.
7	***Setup Mode Data Format***	Anyone that needs information on the commands you must write to the ANA2 to setup the ANA2 for your type of transducer.
8	***Alignment Mode Data Format***	Anyone that needs information on the commands you must write to the ANA2 to align a sensor before measurements can be made from it.
9	***Measurement Mode Data Format***	Anyone that needs information on the commands you must write to the ANA2 to gather position and velocity data from a sensor.
A	***The Resolver***	Anyone who needs to learn more about resolvers in general.

CHAPTER 1

INTRODUCTION TO THE ANA2

This manual is designed to get you quickly up and running with the ANA2 Resolver Interface Module. It is possible to purchase an ANA2 with or without a network interface. This manual only covers the functionality unique to the ANA2. 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 ANA2 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 ANA2

The ANA2 is a two channel resolver interface module that accepts 24 Vdc as its power source. What makes the ANA2 unique is its advanced digital technology that allows the ANA2 to interface with virtually any resolver transmitter, regardless of the manufacturer. This is accomplished by having the transformation ratio, reference voltage, and reference frequency completely programmable from the host controller.

NOTE

1) The ANA2 is factory configured for AMCI transducers and the R11X-J family of resolvers. Programming the ANA2 is simplified by using AMCI product.

2) This manual assumes that you are familiar with resolvers and their electrical characteristics. If you are not familiar with resolvers, please refer to Appendix A, ***The Resolver*** starting on page 63.

The ANA2 (continued)

The ANA2 can be programmed to accept two types of resolver based transducers:

- **Single Resolver Transducers -** This type of transducer has a single resolver in the transducer package. This type includes transducers that yield an absolute position over a single turn, such as our HT-20, HT-400, H25, and R11 product lines, and transducers that include an integral gear train between the input shaft and the resolver so they can yield an absolute position value over multiple turns. An example of this type of transducer is any member of the HT-20-(x) line from AMCI.
- **Dual Resolver Transducers -** This type of transducer has two resolvers in the transducer package that are geared in such a way that the transducer yields a high resolution absolute position over multiple turns. As shown in figure 1.2 to the right, there are two types of dual resolver multi-turn transducers. One type uses a vernier gearing, where the two gears differ by one tooth. Examples of this type of transducer are the HTT-20-100, HTT-20-180, HTT-20-1000 and HTT-20-1800 transducers from AMCI. The second type uses a gear reduction between the fine and coarse gear so that the coarse gear completes one rotation for multiple turns of the fine resolver.

NOTE A third type of transducer is the redundant dual resolver transducer, such as the HTT-20-1 and HTT-400-1 from AMCI. This type of transducer has two resolvers that are geared 1:1 with the input shaft. They are typically used in systems that require redundant controls for safety or high availability. To the ANA2, these transducers appear as two single resolver transducers so this transducer type is treated as such in this manual.

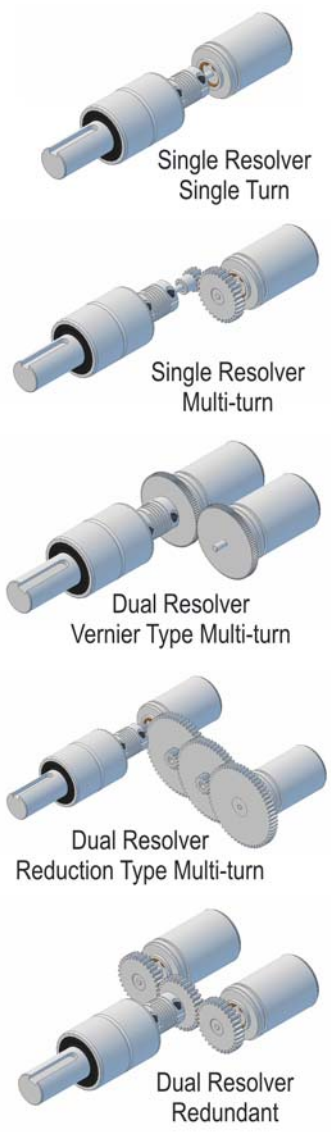


Figure 1.2 Resolver Transducer Types

The ANA2 accepts programming information and reports position, velocity, and error information over the network connection to the AnyNET-I/O stack. This connection means that you do not have to be physically near the ANA2 while configuring it. All configuration and setup data is sent from your host system over the network connection. This allows you to:

- Configure the ANA2 from anywhere
- Store multiple setups on your machine
- Copy setup data from one machine to another
- Design custom HMI interfaces for configuration and setup that can simplify machine training, startup, and repair.

Master/Slave Module

Some applications require position feedback to two different controllers. One example of this is feeding a resolver into an ANA2 as well as a servo drive controller. Previously, many of these applications required the use of a redundant dual resolver transducer, but the programmable parameters of the ANA2 will now allow you to use a single resolver in most applications. This is accomplished by configuring the ANA2 as a Slave module.

All ANA2 modules ship as Master modules and generate their own reference voltages. You change an ANA2 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 resolver master to the ANA2 slave module. The ANA2 reads the reference voltage from the resolver master and uses this data to properly decode the resolver position. Note that the ANA2 can interface with one or two resolvers while acting as a Slave module. The only restriction is that the reference voltage and frequency must be the same for both resolvers.

The ANA2 (continued)

Master/Slave Reference Voltage Mode (continued)

Master Device Compatibility

Not all potential resolver master devices will be able to use the ANA2 as a slave device. Compatibility will depend on how the reference is generated and how the return signals are measured. The ANA2 uses single ended inputs to measure the reference voltage and return signals. If your master device is not compatible with this measurement method, it will not be compatible with the ANA2 module.

NOTE AMCI iPLC and iPCE controllers are not compatible with the ANA2 due to the way they measure the return signals.

Electrically, the reference voltage will appear as one of the following three output types:

- **Transformer Isolated -** Both sides of the reference are electrically isolated from the master device.
- **Single Ended -** One side of the reference is tied to the signal common of the master device and the other side supplies the reference voltage to the resolver.
- **Non-Isolated Differential -** The R1 and R2 pins of the master device both carry a voltage with respect to the device's common.

All AMCI devices use either a transformer isolated reference or a single ended reference with R2 tied to device signal common. In all cases, R2 of the master device can be tied to the signal common connection of the ANA2 without affecting the operation of the master device. R1 must be connected to the SyncIn input of the ANA2.

When using a non-AMCI master device, use a ohmmeter to determine if one of the resolver's R1/R2 connections is tied to the signal common of the master device. If it is, this pin must be tied to the signal common connection of the ANA2 and the other reference pin tied to its SyncIn input.

CAUTION Tying the wrong pin of your master device to the csignal ommon connection of the ANA2 will effectively short the reference output to ground, which may damage the master device or the ANA2.

If neither of the R1/R2 pins is attached to the common of your master device, contact your device's manufacturer to determine if the output is transformer isolated or non-isolated differential.

- Transformer isolated outputs can have either side attached to the common connection on the ANA2. The other side must be connected to the SyncIn input of the ANA2.
- Non-isolated differential outputs must be connected in a very different way. A wire must be run from the common connection of the master device to the common pin on the ANA2. A second wire is run from either of the R1/R2 connections of the master device to the SyncIn input pin on the ANA2. The ANA2 will see 1/2 of the total reference voltage supplied by the master device. To compensate for this, the programmed TR of the resolver must be twice the resolver's actual value and the programmed Reference Voltage parameter value must be 1/2 of the actual reference voltage generated by the master device. For example, if the transformation ratio of the resolver is 0.45, the value programmed into the ANA2 for the TR parameter must be 0.90. To continue the example, if the reference voltage of the master device is 3.6 Vac, the value programmed into the ANA2 for the Reference Voltage parameter must be 1.8 Vac.

ANA2 Programmable Parameters

Programmable parameters on the ANA2 are broken down into sets. Each set is programmed with a single block of programming data from your host controller. The sets are:

Calibration Parameters

These parameters are used to make fine adjustments to the reference voltage circuitry and allows the ANA2 to accurately control the reference voltage. After successful calibration, the resolution of the reference voltage setting is one millivolt.

NOTE Every ANA2 is calibrated at the factory. You should never need to enter this mode. If an ANA2 reports that the module needs to be calibrated, contact AMCI Technical Support for assistance. Calibrations can be made in the field, but an accurate true RMS meter is required.

Configuration Parameters

These parameters configure the ANA2 for the electrical characteristics of your resolvers. The ANA2 is factory configured for AMCI's R11X-J style resolvers that are used in all AMCI resolver transducer products. These factory defaults can easily be restored with our configurator software utility.

- **Reference Voltage -** Allows you to set the reference voltage from 0.800 to 12.000 VRMS. Programmed in millivolt increments for convenience, the resolution is 0.05 Vrms with an accuracy of 0.1%. Factory default is 3.25 VRMS.
- **Reference Frequency -** Programmable over a range of 400 to 10,000Hz with a resolution of 1Hz and an accuracy of 0.01%, this parameter allows you to match the frequency of the reference voltage to the operating specification of your resolver. Factory default setting is 2500 Hz.
- **Channel 1 Transformation Ratio -** Programmable of a range of 0.10 to 3.00 with a resolution of 0.01, this parameter allows you to match the gain of the input amplifiers to the transformation ratio of your resolver. Factory default setting is 95, (0.95 TR).
- **Channel 2 Transformation Ratio -** Programmable of a range of 0.10 to 3.00 with a resolution of 0.01, this parameter allows you to match the gain of the input amplifiers to the transformation ratio of your resolver. Factory default setting is 95, (0.95 TR).
- **Slave Mode -** Allows you to define the ANA2 as a master module or a slave module. Master modules generate their own reference voltage signal, while slave modules accept the reference voltage signal from another source.

Setup Parameters

These parameters configure the ANA2 for the type of transducer you are using as well as scale and offset the position data reported back to your host controller.

Single Resolver Transducers

When the ANA2 is programmed for single resolver transducers, each transducer channel has the following parameters:

- **Transducer Fault Latch -** Gives you programmable control over whether or not transducer faults are self clearing or latched and must be cleared by the host. The factory default setting is for self clearing faults.
- **Count Direction -** Gives you programmable control over the direction of rotation needed to produce increasing counts. When you use AMCI transducers that are wired as shown in this manual, the factory default setting is for clockwise increasing counts.
- **Full Scale Count -** This parameter allows you to set the number of counts reported by the ANA2 for a full rotation of the resolver. This parameter has a range of 2 to 65,536, with a factory default of 1,024.
- **Preset Value -** The transducer position can be set to any value within the range of 0 to (Full Scale Count – 1). This parameter sets the value that the transducer position will be set to when the host controller issues the Apply Preset command. It has a factory default value of zero.

ANA2 Programmable Parameters (continued)

Setup Parameters (continued)

AMCI Dual Resolver Transducers

When the ANA2 is programmed for AMCI dual resolver transducer, the unit has the following setup parameters:

- **Transducer Fault Latch -** Gives you programmable control over whether or not transducer faults are self clearing or latched and must be cleared by the host. The factory default setting is for self clearing faults.
- **Count Direction -** Gives you programmable control over the direction of rotation needed to produce increasing counts. When you use AMCI transducers that are wired as shown in this manual, the factory default setting is for clockwise increasing counts.
- **Transducer Type -** This parameter defines the type of AMCI dual resolver transducer attached to the ANA2. This parameter has four values: 100, 180, 1000, and 1800.
- **Number of Turns -** This parameter defines the number of turns the transducer shaft must complete before the position value returns to zero. The acceptable values are dependant on the value of the Transducer Type parameter.

Transducer Type Parameter Setting	Number of Turns Acceptable Values
100	1, 2, 4, 5, 10, 20, 25, 50, 100
180	1, 2, 3, 4, 5, 6, 9, 10, 12, 15,18, 20, 30, 36, 45, 60, 90, 180
1000	10, 20, 40, 50, 100, 200, 250, 500, 1000
1800	10, 20, 30, 40, 50, 60, 90, 100, 120, 150,180, 200, 300, 360, 450, 600, 900, 1800

Table 1.1 Number of Turns Parameter Settings

- **Full Scale Count -** This parameter allows you to set the number of counts reported by the ANA2 over the programmed Number of Turns. This parameter has a range of 2 to (65,536 * Number of Turns) for 100 and 180 turn transducers and 2 to (65,53.6 * Number of Turns) for 1000 and 1800 turn transducers. As an example, assume an HTT-20-180 transducer and you have programmed the Number of Turns to 36. The range of the Full Scale Count Parameter is 2 to 2,359,296. (65,536*36)
- **Preset Value -** The transducer position can be set to any value within the range of 0 to (Full Scale Count – 1). This parameter sets the value that the transducer position will be set to when the host controller issues the Apply Preset command.

ANA2 Programmable Parameters (continued)

Setup Parameters (continued)

Foreign Dual Resolver Transducers

When the ANA2 is programmed for a foreign dual resolver transducer, that is, one not manufactured by AMCI, the ANA2 uses the following setup parameters:

- **Transducer Fault Latch -** Gives you programmable control over whether or not transducer faults are self clearing or latched and must be cleared by the host. The factory default setting is for self clearing faults.
- **Count Direction -** Gives you programmable control over the direction of rotation needed to produce increasing counts.
- **Gearing Type -** Allows you to define the type of gearing used in the transducer. The choices are *Reduction Type* or *Vernier Type*.
- **Transducer Type -** This parameter defines the maximum number of turns the transducer can encode. The range of values is any number between 2 and 128.
- **Number of Turns -** This parameter defines the number of turns the transducer shaft must complete before the position value returns to zero. The range of the Number of Turns parameter is the factors of the programmed value of the Transducer Type parameter. Examples for 64 and 128 turn transducers are given in the table below

Transducer Type Parameter Setting	Number of Turns Acceptable Values
64	1, 2, 4, 8, 16, 32, 64
128	1, 2, 4, 8, 16, 32, 64, 128

Table 1.2 Number of Turns Parameter Settings

- **Full Scale Count -** This parameter allows you to set the number of counts reported by the ANA2 over the programmed Number of Turns. This parameter has a range of 2 to (65,536 * Number of Turns). As an example, assume a 128 transducer and you have programmed the Number of Turns to 32. The range of the Full Scale Count Parameter is 2 to 2,097,152. (65,536*32)
- **Preset Value -** The transducer position can be set to any value within the range of 0 to (Full Scale Count – 1). This parameter sets the value that the transducer position will be set to when the host controller issues the Apply Preset command.

Alignment Parameters

Alignment is only required when using a foreign dual resolver transducer to assure that the fine and coarse resolvers are properly aligned. The Alignment Offset is an internal parameter that adjusts the Coarse Resolver position to align the two resolvers. The value of the Coarse Resolver Offset is not available to the host controller. The host only issues a command to the ANA2 to calculate this offset.

Measurement Parameters

An internal Position Offset is the only parameter that is set with the measurement block of data. Like the Coarse Resolver Offset alignment parameter, the Position Offset is not available to the host controller. The Position Offset is calculated when the host controller issues an Apply Preset command and it is the offset required to bring the actual resolver position to the required Preset Value.

The measurement programming block is also used to control the ANA2 such as enabling and disabling channel LED's and clearing latched transducer faults.

Power Connector

Figure 1.3 shows the location of the Power Connector. The mate to this connector is included with the ANA2. 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.

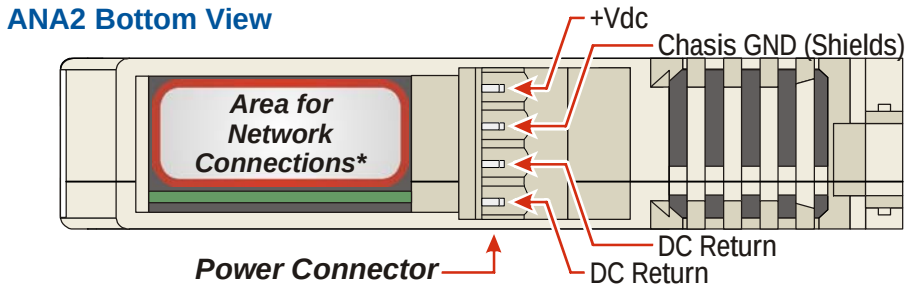


Figure 1.3 Power Connector

Figure 1.3 also shows the area of the AnyNET-I/O modules that is reserved for network connections. If your ANA2 has a network connection, such as the ANA2E 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 ANA2 are made through the MS-4M connector on the bottom of the module.

The mate for this connector is included with the ANA2. 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.

Pins 6 and 7 on the J1 and J2 connectors are internally connected together and are attached to the module's signal ground. You will not see a signal on these pins when your reference point is any of the GND pins. The ANA2 measures the signals on pins 5 and 8 of the J1 and J2 connectors to determine the resolver position.

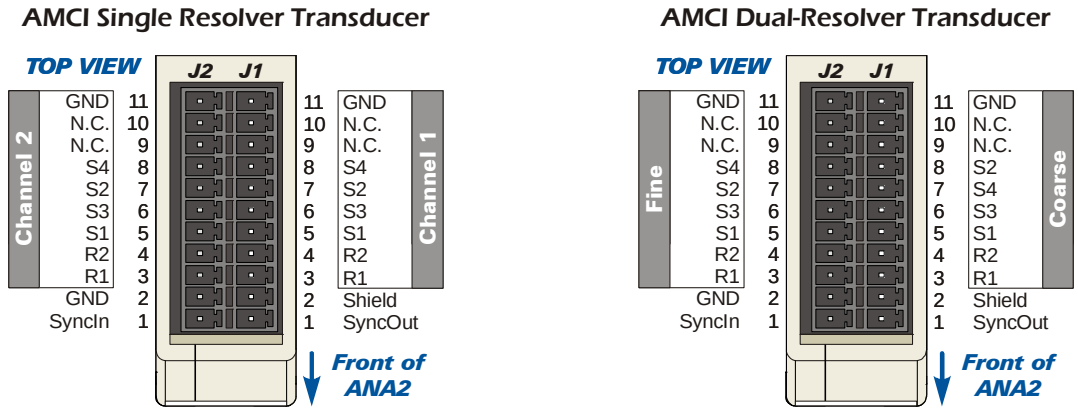


Figure 1.4 I/O Connector

Connections to foreign dual-resolver transducers depends on the number of stages in the gear train of the transducer. Information on Autotech RL210 transducers is given in the *Installing the ANA2* chapter starting on page 28.

The SyncIn and SyncOut pins are used when the ANA2 is used as a slave module. The reference voltage from the resolver master is brought in on the SyncIn pin and the SyncOut pin is used if an additional ANA2 module must be slaved to the resolver master.

Front Panel

The front panels of three ANA2 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.

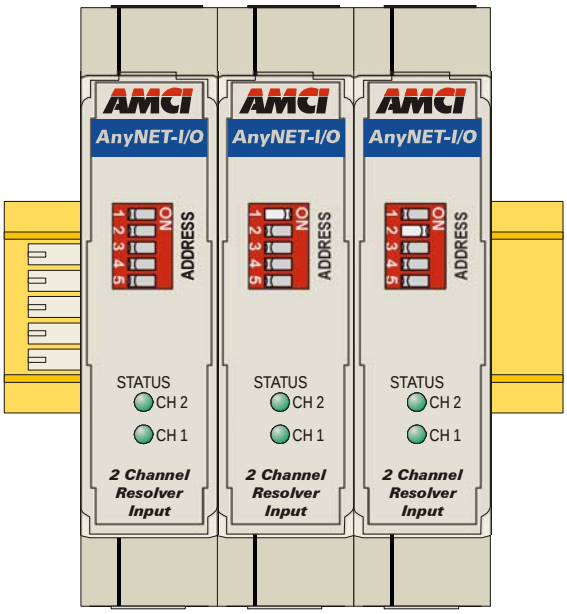


Figure 1.5 ANA2 Front Panel

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 ANA2E 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 ANA2E and has its address set to zero. The remaining modules can be ANA2 modules with or without network interfaces and their addresses are set to one and two.

NOTE If an ANA2 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. (Slow blink)	Module has finished its power up sequence and is waiting for network command data.
Module Error	Both LED's ON Red	1) Error in module 2) Communications error within the AnyNET-I/O Stack. Cycle power to the module or stack to attempt to clear these problems. 3) Reference Voltage missing while in Slave Mode. The reference voltage must be brought into the *SyncIn* pin, J2-1.
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 ANA2 placed it in Configuration Mode.
Alignment Mode	Both LED's alternately flashes red and green at 2 Hz. (Slow blink)	The last network data transfer to the ANA2 placed it in Alignment Mode, but the Align command has not been issued.
Alignment Mode	Both LED's alternately flashes red and green at 4 Hz. (Fast blink)	The channel is in Alignment Mode, and the resolvers have been successfully aligned.

Table 1.3 Status LED's - Module Patterns

Channel States

Channel State	LED Blink Pattern	Description
Setup Mode	Channel LED flashes red three times in 1.5 seconds (slow blink), followed by 1.5 seconds off.	The last network data transfer to the ANA2 placed the channel in Setup Mode.
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) On Dual resolver transducers only the resolver with the error will blink. This pattern will only occur when the channel is enabled.
Channel LED Disabled	LED off	The LED for the channel has been disabled.

Table 1.4 Status LED's - Channel Patterns

Front Panel (continued)

Master/Slave Reference Voltage Jumper

Figure 1.6 shows the location of the headers that set the reference voltage mode of the ANA2. You access the headers by opening the front cover of the module. All ANA2 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.

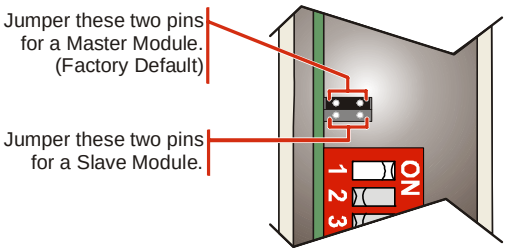


Figure 1.6 Master/Slave Mode Jumper Location

Specifications

Sensor Type

Resolver Transmitters and similar sensors with sine/cosine stator outputs such as variable reluctance transducers.

Number of Input Channels

Two. ANA2 can interface with two independent single resolver transducers or one dual resolver transducer.

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 reference voltage shorted to GND.

Measurement Method

Ratiometric. Compensates for and eliminates most sources of error, including phase shift, voltage drift, electrical noise, and temperature changes.

Reference Voltage

Programmable from 0.800 to 12.000 Vac with 1 millivolt resolution Default of 3.25 Vac

Reference Frequency

Programmable from 400 to 10,000 Hz with 1 Hz resolution Default of 2,500 Hz

Sensor Transformation Ratio

Programmable from 0.10 to 3.00 with a resolution of 0.01 Default of 0.95

Position Resolution

16 bit maximum per turn. (65,536 steps over a single turn)

Velocity Update Time

Fixed at 100 milliseconds

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 15.

Connectors

Mating connectors are included with the ANA2 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		

CHAPTER 2
OPERATING MODES

The ANA2 is factory configured to support two AMCI single resolver transducers with a resolution of 1,024 counts per turn and can have their position values preset to zero. If you are using a different type of transducer, the ANA2 has to be reconfigured before the unit can accurately read the position of your sensor. The ANA2 has five 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) Setup Mode
4) Alignment Mode
5) Measurement Mode

Commands are available that allow you to switch between modes as needed. When you exit a mode, the ANA2 will automatically enter the highest available mode that can be entered.

Calibration Mode

NOTE Every ANA2 is calibrated at the factory. You should never need to enter this mode. If an ANA2 reports that the module needs to be calibrated, contact AMCI Technical Support 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 reference voltage circuitry and allows the ANA2 to accurately control the reference voltage. After successful calibration, the resolution of the reference voltage setting is one millivolt.

Configuration Mode

Configuration Mode is used to configure the ANA2 for the resolvers you are attaching to it. This involves setting the reference voltage and frequency and specifying the Transformation Ratios of the resolvers to adjust the gains of the input amplifiers. All ANA2 modules are factory configured for AMCI R11X-J style resolvers, which are also used in all AMCI standard transducer products as well. Factory configuration is easily restored using the AMCI NET Configurator software available from AMCI as a free download from our website. The ***Configuration Parameters*** section on page 10 lists the parameters set in Configuration Mode.

Setup Mode

Setup Mode is used to configure your resolver based transducer to your system. As explained in chapter 1, the ANA2 can interface with three different types of resolver transducers; single resolver transducers, AMCI dual resolver transducers, and foreign dual resolver transducers. Therefore, three different programming blocks are available to configure your transducer. Parameters set while in this mode are defined in the ***Setup Parameters*** section of chapter 1, starting on page 10.

Alignment Mode

Required only when using a foreign multi-turn transducer, Alignment Mode is used to verify the alignment of the zero points of the two resolvers. The ANA2 will automatically calculate an offset to compensate for any mis-alignments between the two resolvers.

NOTE AMCI multi-turn transducers are mechanically aligned at the factory as part of the test procedure. With 100% of all AMCI transducers tested before they leave the factory, field alignment is unnecessary.

Available Modes (continued)

Measurement Mode

After your transducer is setup, use Measurement Mode to read back its position and velocity values. If the ANA2 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 ANA2 has six module status bits that allow you to determine the state of the module. It also has five status bits per transducer to tell you what valid data exists for the transducer and if the ANA2 is actively measuring the position and velocity data from your transducer.

Module Status Bits

Module Initialized: This bit is set on power up or after a hardware reset. The ANA2 is only transmitting status information. Position and velocity data are set to zero. The module is waiting for the first command from the host controller.

NOTE The Module Initialized Bit is only set when the ANA2 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.

In Calibration Mode: If this bit is set along with the Module Initialized bit on power up, the ANA2 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 ANA2 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 Setup Mode: If this bit is set along with the Module Initialized bit on power up, the ANA2 does not have valid setup data for either channel. If it is set when the Module Initialized bit is reset, the unit is in Setup Mode.

In Alignment Mode: If this bit is set along with the Module Initialized bit on power up, the ANA2 does not have valid alignment data for the foreign dual resolver transducer. If it is set when the Module Initialized bit is reset, the unit is in Alignment Mode.

In Measurement Mode: If this bit is set along with the Module Initialized bit on power up, the ANA2 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 ANA2 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 Setup: Valid setup data exists for the channel.

Channel Aligned: Valid alignment data exists for the channel.

Channel Measuring: The ANA2 is actively measuring the position of the transducer.

Power Up Behavior

When power is applied to the ANA2, it runs self checks and determines which modes have been successfully completed by validating the data stored in its Flash memory. It sets status bits for each transducer and then status bits for the module. Its final act is to set the *Module Initialized* bit.

After power up, the ANA2 waits for the first command from the host controller before entering one of the available modes. While waiting, the ANA2 only transmits status information. The words used to transmit position and velocity data are set to zero.

NOTE For normal operation, you must issue a command to switch to Measurement Mode after every power up. The ANA2 will not transmit position or velocity data to the host until this command is issued.

Switching Modes During Normal Operation

Changing parameters in any mode will reset all parameters in all high modes to factory defaults.

- Changing Configuration Mode parameters resets Setup, Alignment, and Measurement Mode parameters to factory defaults. This configures the ANA2 to interface with two single resolver transducers with a Full Scale Count of 1,024 counts per turn. The Position Offsets, which are set in Measurement Mode when a position value is preset, are reset to zero.
- Changing Setup Mode parameters resets Alignment and Measurement Mode parameters to factory defaults. The Position Offsets, which are set in Measurement Mode when a position value is preset, are reset to zero. If you program the Setup Mode parameters to configure the ANA2 for a foreign dual resolver transducer, the Alignment Offset, which is set in Alignment Mode, is reset to zero. You will have to enter Alignment Mode and re-align the transducer before you will be able to enter Measurement Mode.

Notes

CHAPTER 3
INSTALLING THE ANA2

The ANA2 module must be installed as part of an AnyNET-I/O stack. The instructions in this manual explain how to install the ANA2 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 ANA2 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 Remove power before removing or installing any modules in a hazardous environment. The InterConnect bus is not power limited.

Mounting

Dimensions

Figure 3.1 shows the dimensions of an AnyNET-I/O module. The ANA2 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.

NOTE You will need to ground the resolver cable shields at the module. There is a single pin on the ANA2 to ground a shield, but if you have multiple shields, it will 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.

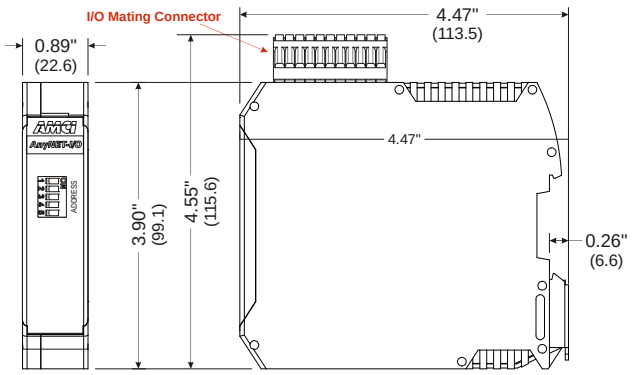


Figure 3.1 AnyNET-I/O Outline

Mounting (continued)

Installing IC-5 Connectors

If you are using your ANA2 as part of an AnyNet-I/O stack, you need to install the included IC-5 connector on the DIN rail to allow the ANA2 to communicate with the stack. Figure 3.2 shows how to install the IC-5 connectors in the DIN rail.

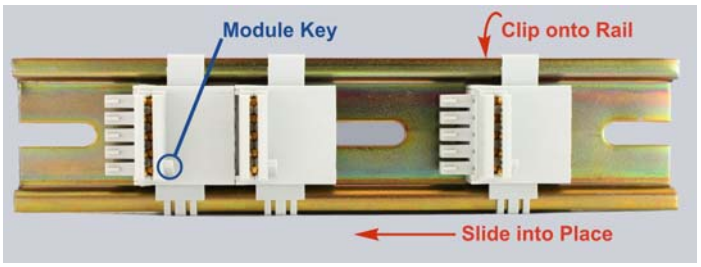


Figure 3.2 IC-5 Connector Installation

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 ANA2 with a network interface, then you do not need the IC-5 connector. The connector is only used for communications within the stack. IC-5 connectors are also available from Phoenix Contact under their part number 2713722.

Mounting the ANA2 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.

Stack Addressing

Each module needs to be given an address within the stack before the system will operate correctly. The stack 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.

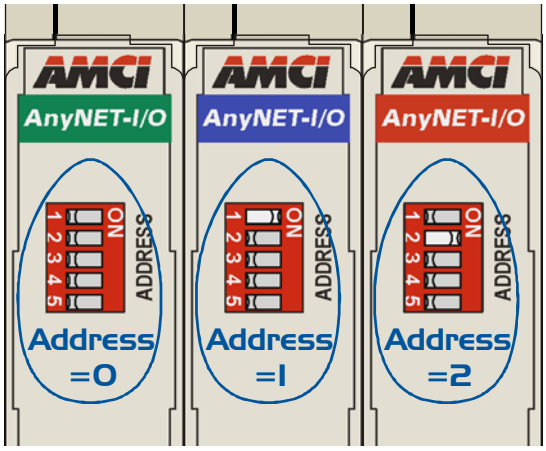


Figure 3.3 Addressing Example

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 ANA2 accepts 24 Vdc as its input power. As shown in the figure below, the power connector is located on the bottom of the module. The mating connector is included with the ANA2. Spares are available from AMCI under the part number MS-4N. They are also available from Phoenix Contact under their part number 187 80 37.

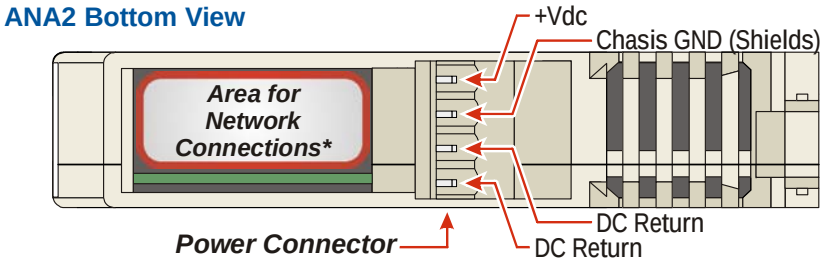


Figure 3.4 Power Connector Location

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 ANA2 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 ANA2 module must have its own power connection.
3) AnyNET-I/O modules will not be damaged if it is plugged into the InterConnect bus while power is applied, but the stack will not reconfigure itself to accept the new module.

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 ANA2. 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.

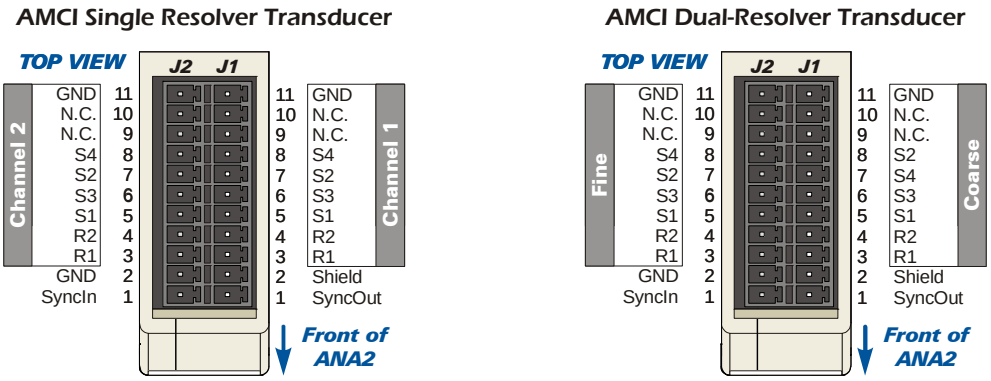


Figure 3.5 I/O Connector

NOTE

1) When using the ANA2 with a dual resolver multi-turn transducer, the coarse resolver must be wired to channel 1 and the fine resolver must be wired to channel 2.
2) Pins 6 and 7 of the J1 and J2 connectors are internally connected together and attached to the module's signal ground. You will not see a signal on these pins when your reference point is any GND pin. The ANA2 measures the signals on pins 5 and 8 of the J1 and J2 connectors to determine the resolver position.

AMCI Transducers

Transducer Outline Drawings

The ANA2 is compatible with all R11X and R15X resolvers and all single and dual resolver transducers manufactured by AMCI. Outline drawings and specification sheets are available on our website, ***www.amci.com/resolvers.asp***.

Mounting

All AMCI resolver transducers are designed for industrial environments and therefore require little attention. The resolver is electrically isolated from the body of the transducer to eliminate the potential for ground loops and ground shifts in the system. The main guideline to follow when mounting the transducers is to limit bearing loads when coupling the transducer to your machine. This includes using flexible couplers when directly coupling shafts to eliminate shaft misalignments.

The following bearing load ratings are known as "L_{10} ratings" in the bearing trade associations. L_{10} is a statical rating meaning that 90% of the bearings will survive the specified number of revolutions. AMCI specifies our rated number of revolutions as $2X10^9$, or 2 billion, which is a number commonly used in the industry. By specifying the maximum load and statical life, AMCI gives you data you need to choose the right transducer for your application.

Note that these load ratings are maximums, and you should always strive to keep shaft loading to a minimum. The inverse relationship between shaft loading and bearing life is not linear, it's exponential.

$$\left[\frac{1}{x}\right]^3 \text{ where } x = \frac{\text{new shaft load}}{\text{old shaft load}} \Rightarrow \left[\frac{\text{old shaft load}}{\text{new shaft load}}\right]^3$$

This means that decreasing the shaft loading by half will, statically, increase the bearing life by a factor of eight. For example, decreasing a shaft load from 100 lbs. to 50 lbs. yields: $[100/50]^3 = 8$ times increase in statistical bearing life.

At the loads specified below, bearing life is a minimum of $2x10^9$ revolutions. Note that the R11 series and HT-6 transducers always require a flexible coupler to your machine because of their shaft size.

Shaft Dia.	Maximum Radial Load	Maximum Axial Load
R11 Series		
0.120"	2.0 lbs. (8.9N)	1.0 lb. (4.4N)
0.188"	6.0 lbs. (26.7N)	3.0 lbs. (13.3N)
HT-6		
0.188"	6.0 lbs. (26.7N)	3.0 lbs. (13.3N)
H25 Series		
0.250"	40 lbs. (178N)	20 lbs. (89N)
10 mm	40 lbs. (178N)	20 lbs. (89N)
0.375"	40 lbs. (178N)	20 lbs. (89N)
0.625"	100 lbs. (445N)	50 lbs. (222N)
HT Series		
0.375"	100 lbs. (445N)	50 lbs. (222N)
0.625"	100 lbs. (445N)	50 lbs. (222N)
HTT Series		
0.375"	100 lbs. (445N)	50 lbs. (222N)
0.625"	100 lbs. (445N)	50 lbs. (222N)

Table 3.1 Shaft Load Specifications

Foreign Transducers

The wide range of programmable parameters in the ANA2 makes it compatible with resolver transmitters and other sine/cosine output sensors such as variable reluctance transducers. You will have to obtain specifications for these units from their manufacturer, including mounting, wiring, and electrical characteristics.

NOTE Regardless of the type of cable suggested by the transducer manufacturer, AMCI strongly recommends Belden 9873, 9730, and 9731 or exact equivalents as cables for your transducer. With tens of thousands of installations worldwide, AMCI is confident in the quality of these cables. If you wish to use a different cable, contact AMCI to verify your cable type.

Transducer Wiring

NOTE In the United States, the National Electrical Code cable type used for the transducer cable is CM (Communications, General Purpose cable). Therefore the installation of the cable falls under Article 800 of the National Electrical Code unless your local code or company policy is more restrictive.

Single Resolver Transducers

The following diagram shows how to wire a standard AMCI single resolver transducer to channel 1 of the ANA2. 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.

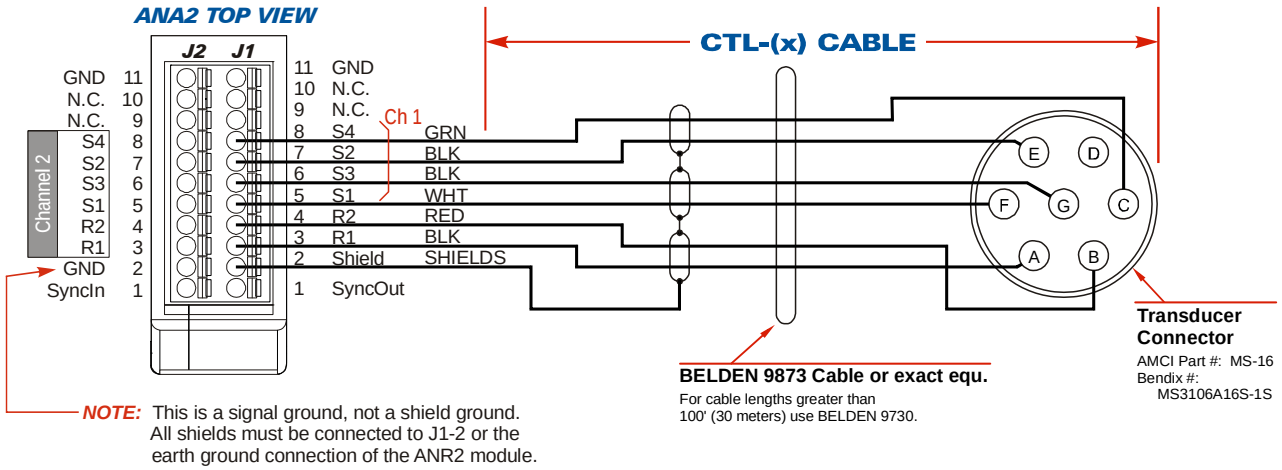


Figure 3.6 AMCI CTL Cable Wiring

NOTE

1) There are two ways to reverse the count direction when using single resolver transducers. One method is to set the Count Direction parameter when programming the ANA2. The other method is to reverse the connections on one of the stator pairs. AMCI standard method is to reverse the S2-S4 pair, which is the green/black pair of the CTL cables.

2) When using a foreign single resolver transducer, note how the signals are paired in the cable and use this pairing when generating your wiring diagrams.

3) The cable shields must be isolated from earth ground at the transducer to prevent ground loops and ground shifts. When using a foreign transducer, do not attach the shields to a transducer pin, even if this follows the standard of your transducer's manufacturer.

Transducer Wiring (continued)

Single Resolvers

Figure 3.7 shows the connections required to attach a resolver with industry standard wire colors to a Belden 9873 or 9730 cable. If these connections are followed, you can refer to figure 3.6 on page 25 for connections from the Belden cable to the ANA2.

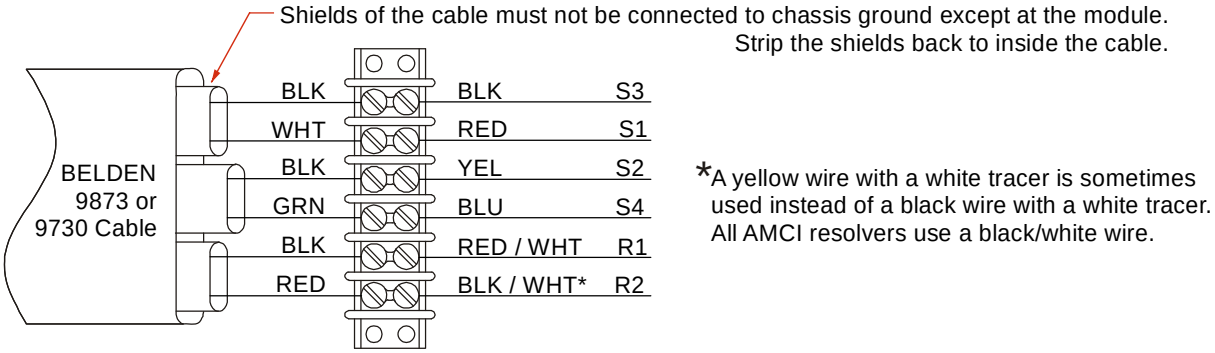


Figure 3.7 Resolver to Cable Connections

Transducer Wiring (continued)

AMCI Dual Resolver Multi-turn Transducers

The following diagram shows how to wire a standard AMCI dual resolver transducer to the ANA2. Note that 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.

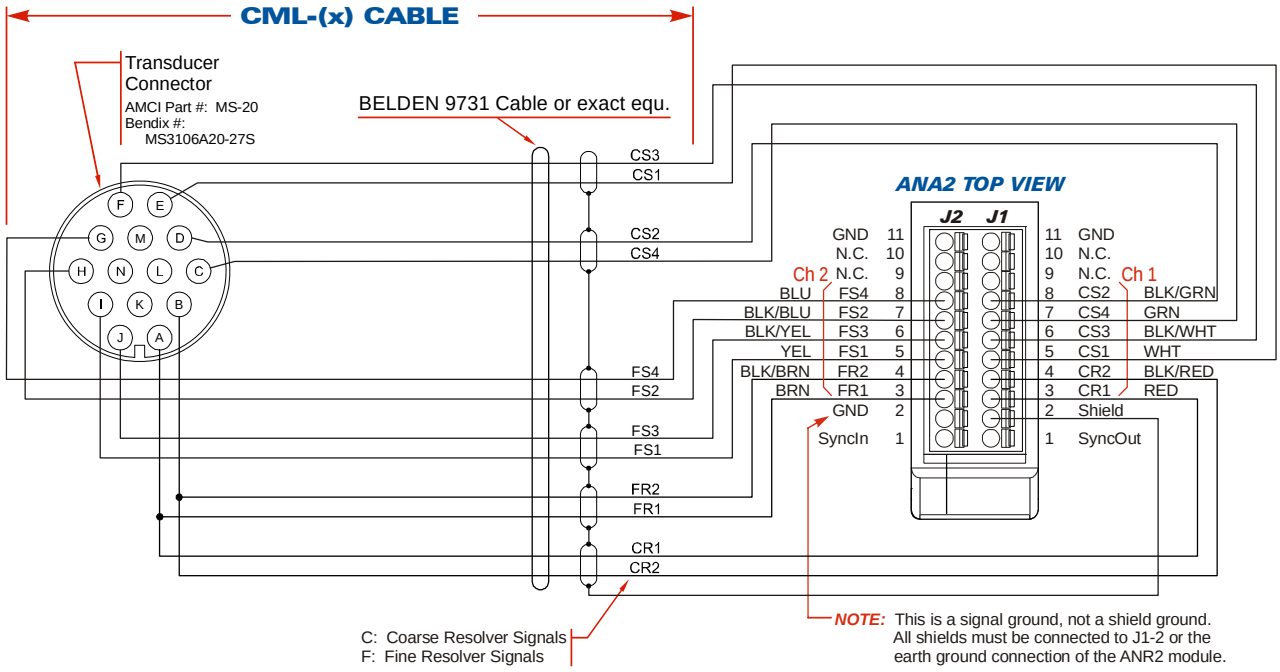


Figure 3.8 AMCI CML Cable Wiring

NOTE

1) There are two ways to reverse the count direction when using a dual resolver transducer. One method is to set the Count Direction parameter when programming the ANA2. The other method is to reverse connections on two of the stator pairs. These two pairs are the CS2-CS4 pair, which is the green/black pair, and the FS2-FS4 pair, which is the blue/black pair. The green CS4 wire goes into the CS2 terminal of the ANA2 while the black CS2 wire goes into the CS4 terminal. The blue FS4 wire goes into the FS2 terminal of the ANA2 while the black FS2 wire goes into the FS4 terminal.

2) The cable shields must be isolated from earth ground at the transducer to prevent ground loops and ground shifts. When using a foreign transducer, do not attach the shields to a transducer pin, even if this follows the standard of your transducer's manufacturer.

Transducer Wiring (continued)

Foreign Dual Resolver Transducers

Trial and error may be involved when connecting a foreign dual resolver transducer to an ANA2 module for the first time. This is because the resolvers must appear to be rotating in the same direction before the ANA2 can decode the multi-turn position correctly. The direction of rotation of the coarse resolver depends on the number of gear train stages between this resolver and the input shaft. Because of this, part of the alignment procedure when using a foreign dual resolver transducer is to verify the direction of rotation of both resolvers and changing wire connections as needed.

In order to ease the installation of Autotech RL210 transducers, the following table can be used to wire one of theses transducers to an ANA2.

Function	RL210 Connections		ANA2 Pin
	Terminal	MS Connector	
Coarse/Fine R1	1	A	J1-3
Coarse/Fine R2	2	B	J1-4
Coarse S1	3	C	J1-5
Coarse S3	5	E	J1-6
Coarse S2	4	D	J1-7
Coarse S4	6	F	J1-8
Fine S1	7	H	J2-5
Fine S3	9	L	J2-6
Fine S2	8	K	J2-7
Fine S4	10	M	J2-8
Shields	Do not connect at transducer to avoid ground loops and shifts		J1-2

Table 3.2 RL210 Connections to ANA2

Avoiding Ground Loops and Ground Shifts When Extending the Transducer Cable

A ground loop or ground shift can occur when the shields of a cable are attached to earth ground in two places. A ground loop occurs when the shield can act as a second return path for power currents. A ground shift occurs when the two places the shield is grounded at are at two different voltage potentials. (The likelihood of a ground shift increases as the cable length increases.) In either case, the shield acts as a low impedance path between the two points which results in a constant current flowing through the shield. To avoid these problems, the cable shields must not be grounded in two places.

- If the shields of the transducer cable are isolated from the body of the transducer, which is the AMCI standard practice, connect the shields of the transducer cable to the shields of the extension cable and ground the shields at the ANA2. Treat the shields of the transducer cable as a signal carrying conductors at all junctions and do not connect them to earth ground at any other point. This is the proper method to wire all transducers attached to the ANA2.
- If the shields of the transducer cable are connected to the body of the transducer through an integral cable but the body of the transducer is isolated from chassis ground by its mounting, connect the shields of the transducer cable to the shields of the extension cable and ground the shields at the ANA2. Treat the shields of the transducer cable as a signal carrying conductors and do not connect them to earth ground at any other point.

Transducer Wiring (continued)

Avoiding Ground Loops and Ground Shifts When Extending the Transducer Cable (continued)

- If the shields of the transducer cable are connected to the body of the transducer through an integral cable and the body of the transducer is connected to earth ground by its mounting, ***Do Not*** connect the shields of the transducer cable to the shields of the extension cable. The shields of the transducer cable are grounded by the transducer body. Connect the shields of the extension cable to earth ground at the ANA2. The splice between the transducer and extension cables must be made in a grounded junction box. You are strongly advised to strip back the cable shields only as far a necessary to make the splice and keep the wires as short as possible to minimize the possibility of injecting noise into the cable at the splice.

Slave Mode

Setting the ANA2 Jumper

When operating the ANA2 as a slave module, you must change the location of one jumper before applying power to the ANA2. The jumper is located behind the front cover of the module. All ANA2 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.

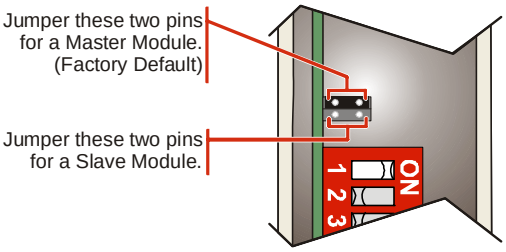


Figure 3.9 Master/Slave Mode Jumper Location

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

Wiring the Cable

Wiring between the ANA2 and the other resolver input device should be kept as short as possible and use Belden 9873, Belden 9730, or exact equivalents.

NOTE

1) The ANA2 and the other resolver input device must share a common ground.
2) If interfacing two resolvers with the ANA2 while it is acting as a Slave module, the reference voltage and frequency must be the same for both resolvers.
3) The pins 6 and 7 of the J1 and J2 connectors on the ANA2 are internally tied together and tied to the signal ground (GND) pins. If the other resolver input device has two of the stator wires tied together and going into one pin, these stator wires must be brought into pins 6 and 7 of the J1 or J2 connectors on the ANA2. The remaining two wires (either S2 or S4) and (either S1 or S3) are connected to pins 5 and 8 of the J1 or J2 connectors on the ANA2. If necessary, the Count Direction and Preset Value parameters of the ANA2 can be used to make the resolver positions between the two devices match.
4) The reference voltage from the master device must be brought into pins J2-1 and J2-2 on the ANA2. Pin J2-1 is the *SyncIn* pin and pin J2-2 is ground.

NOTE AMCI iPLC and iPCE controllers cannot be used as master devices with the ANA2 module. For all other AMCI master devices, connect the R2 signal from the master to pin J2-2 of the ANA2 and connect the R1 signal to pin J2-1 of the ANA2.

If you are using a non-AMCI product as the master device, refer to ***Master Device Compatibility*** found on page 9 for additional information on wiring the reference voltage to the ANA2.

Figure 3.10 shows an example of wiring a single resolver to an AMCI Genesis programmable limit switch and channel 1 of an ANA2. Note that the R2 connection on the Genesis controller is connected to ground at the Genesis and is therefore wired to pin J2-2 of the ANA2.

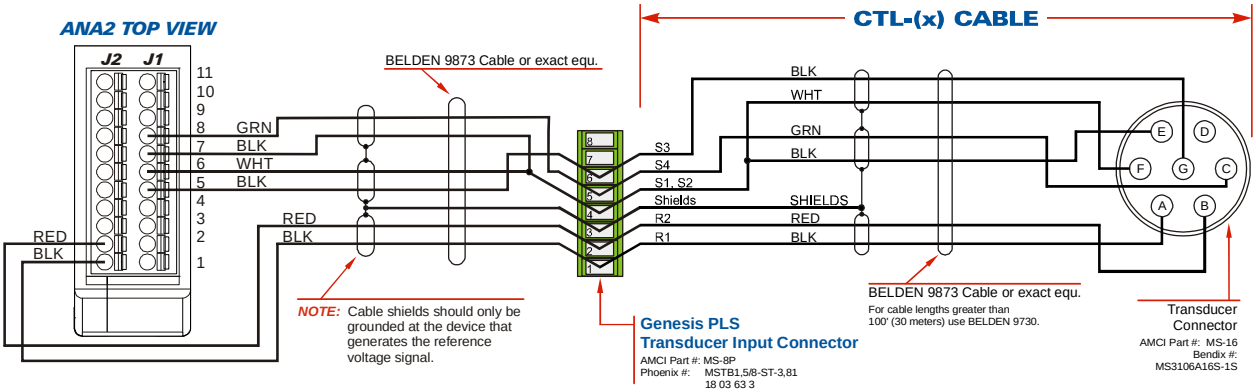


Figure 3.10 Slave Mode Wiring Example

CHAPTER 4

AMCI NET CONFIGURATOR SOFTWARE

The AMCI NET Configurator software version 4.08 and above adds screens that allow you to graphically program the parameters of an ANA2 module as well as display position and velocity data. This software is designed to assist you in gaining familiarity with the ANA2, 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 show the different screens available on the NET Configurator software for setting up an ANA2 module only. 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.

ANA2 Configuration Screen

Figure 4.1 shows the settings on the Configuration tab. This is where you set all of the Configuration Parameters that are described on page 10. The bottom half of the screen shows the module and channel status data being transmitted from the ANA2. This data is described in the ***Status Bits*** section of this manual starting on page 18.

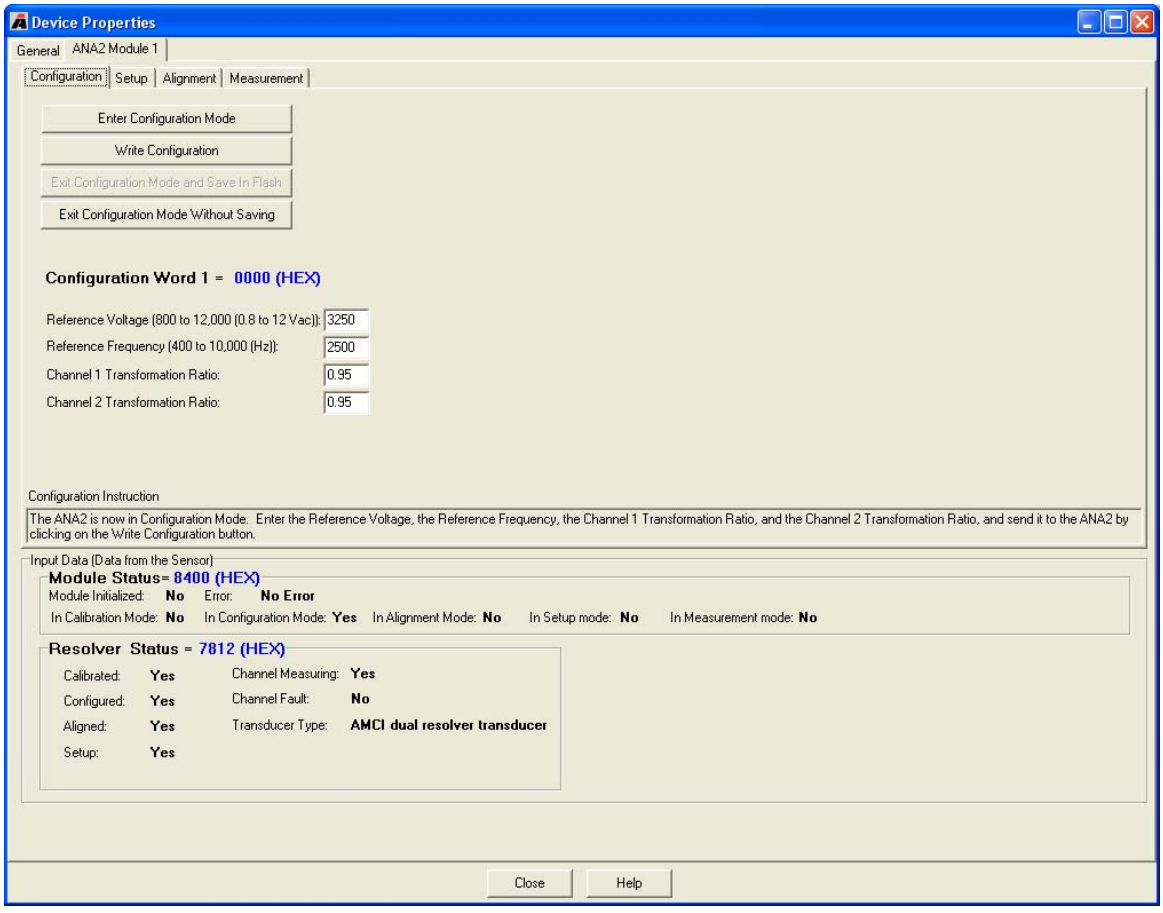


Figure 4.1 NET Configurator: Configuration Screen

ANA2 Setup Screen

Figure 4.2 shows the settings on the Setup tab for single resolver transducers. This is where you set the single resolver transducer setup parameters that are described on page 10. On this screen under "Resolver Type" you will see radio buttons that allow you to choose between Single Resolver, AMCI Dual Resolver, and Foreign Dual Resolver Transducers. Selecting any of these buttons will change the parameters available on the screen to match the parameters available for the resolver type. AMCI dual resolver transducer parameters are listed on page 11. Foreign dual resolver transducer parameters are listed on page 12.

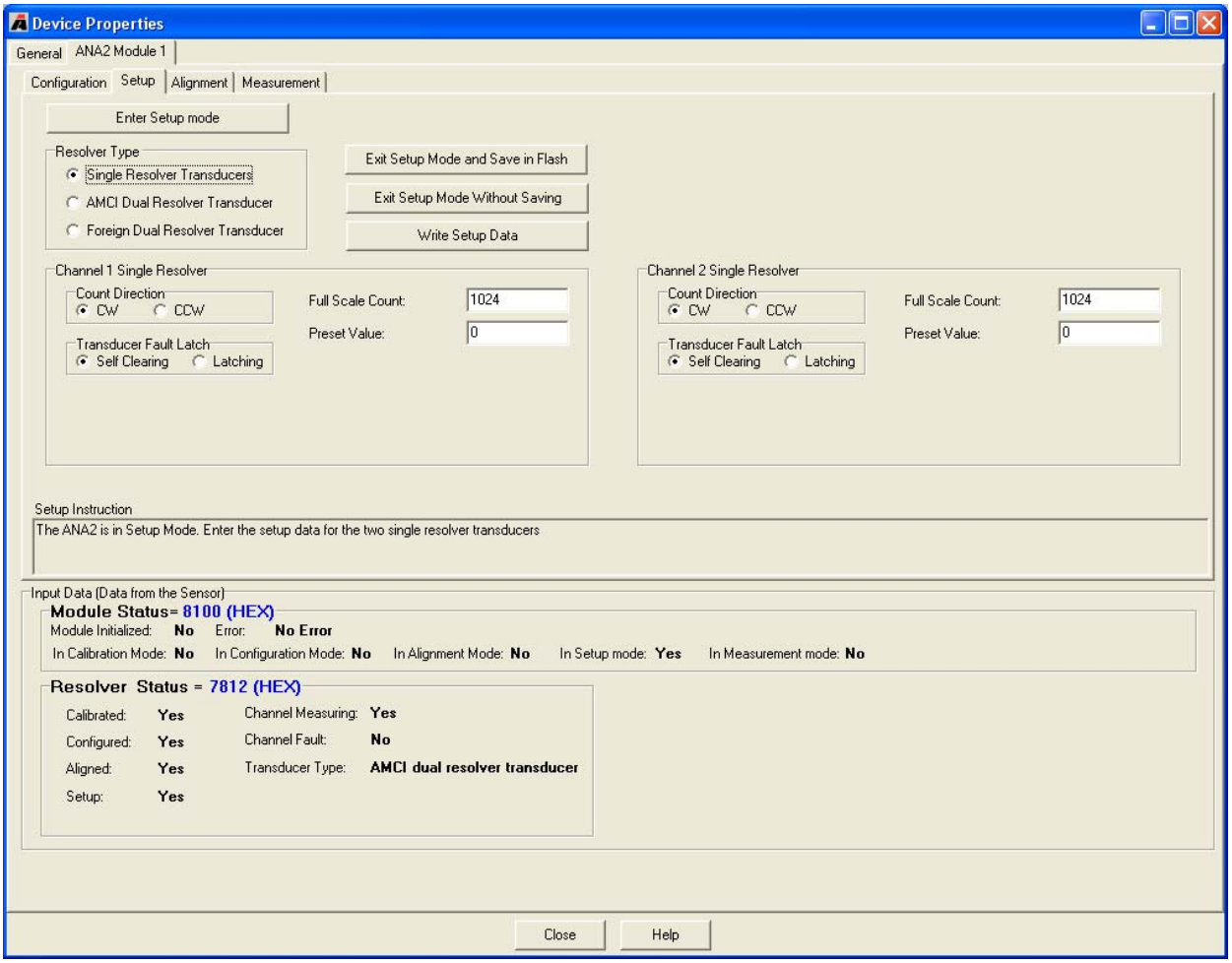


Figure 4.2 NET Configurator: Setup Screen

ANA2 Alignment Screen

Figure 4.3 shows the settings on the Alignment tab. This tab is only used when you are using a foreign dual resolver transducer with the ANA2. When you first enter the screen, it shows the positions of the fine and coarse resolvers. Pressing the [Enter Alignment Mode] button followed by the [Align Transducer] button will force the ANA2 to calculate the Coarse Resolver Offset and the screen will change to show the combined multi-turn position value.

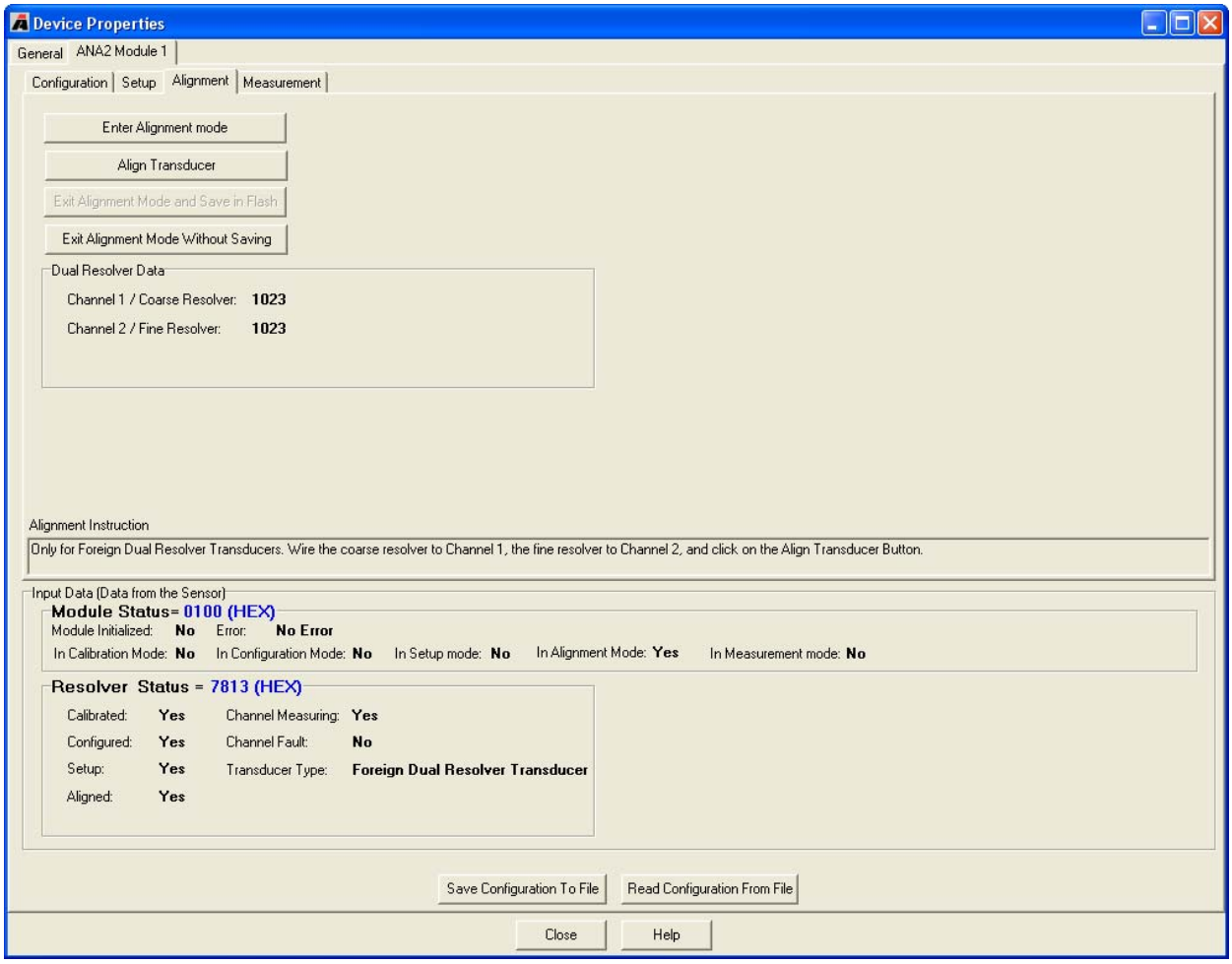


Figure 4.3 NET Configurator: Alignment Screen

ANA2 Measurement Screen

Figure 4.4 shows the settings and data available on the Measurement tab when using single resolver transducers. If the ANA2 is setup for AMCI or foreign dual resolver transducers, the screen will not show settings and data for channel 2. The check boxes in the "Measurement Command" section of the screen allow you to issue measurement commands to the ANA2. Simply select your settings and press the [Enter Measurement Mode] button to write these settings to the ANA2.

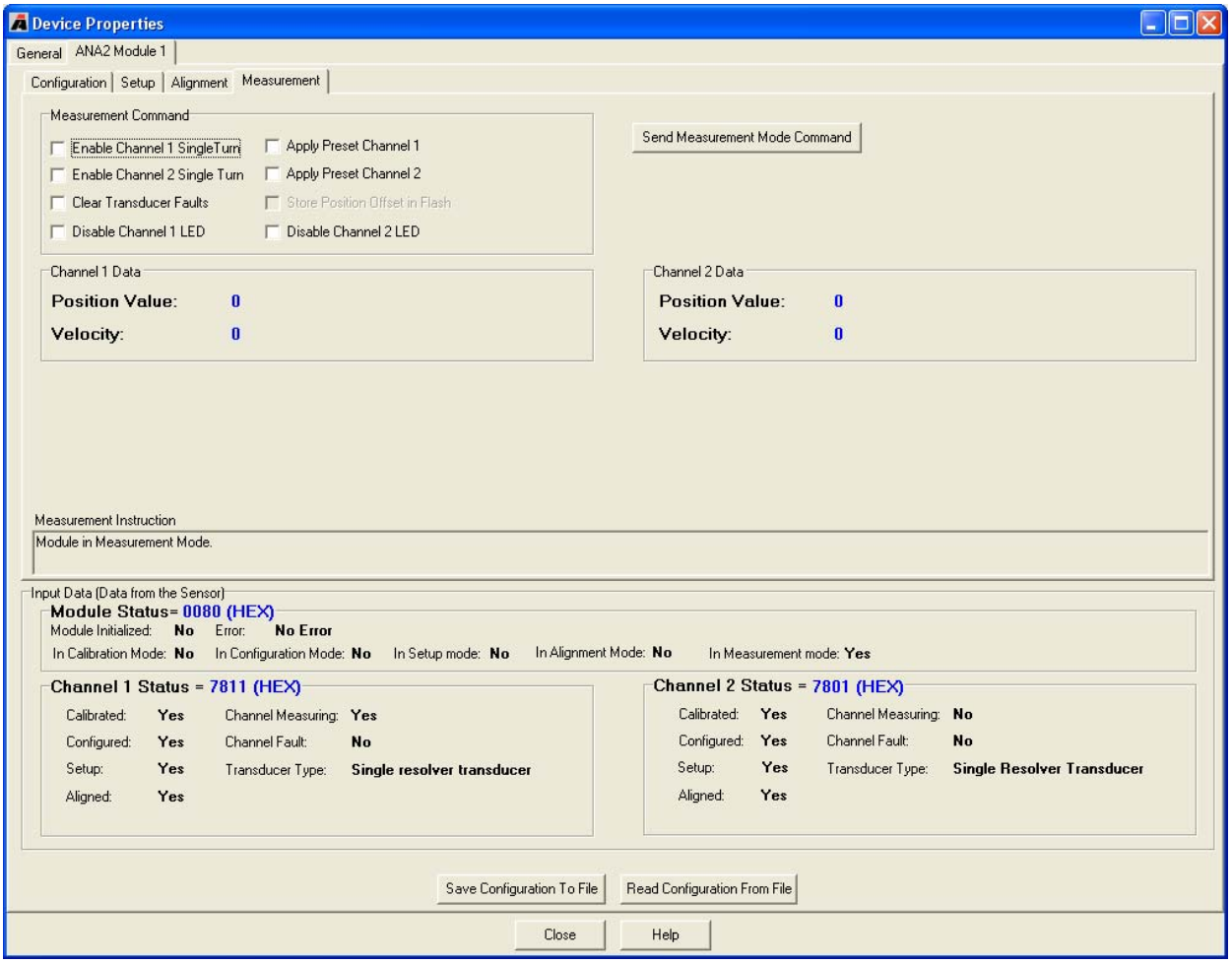


Figure 4.4 NET Configurator: Measurement Screen

CHAPTER 5
MODULE & CHANNEL STATUS DATA

This chapter covers the format of the Module and Channel Status bits read from the ANA2 by your network host.

Network Input Data

The format of the Network Data depends on the Mode the ANA2 is presently in. However, the format and position of the Module Status and Channel Status bits always remains the same.

ANA2 Word	ANA2 Network Input Data
0	Module Status
1	Channel 1 Status
2	Data Format based on the mode the ANA2 is presently in. See remaining chapters of this manual that describe the available modes.
3	
4	
5	Channel 2 Status
6	Data Format based on the mode the ANA2 is presently in. See remaining chapters of this manual that describe the available modes.
7	
8	
9	Reserved

Figure 5.1 Network Input Data

Module Status Word Format

The format of the Module Status word does not depend on the mode that the ANA2 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)	Slave Mode	Module Initialized	In Calibration Mode	In Configuration Mode	In Setup Mode	In Alignment Mode	In Measurement Mode	0	0	0	Error Code 0 = No Error 1 = Command Error 2 = Save to Flash Error 3 = Reference V Error 4 = Reference *f* Error 5 = TR Error 6 = # of Turns Error 7 = Transducer Type Error 8 = Setup Error 9 = Full Scale Count Error 10 = Preset Error 11 = Reference Error 12-15 = Reserved			

Figure 5.2 Module Status Word Format

Module Status Word Format (continued)

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 ANA2 will accept a command.

Bit 14: Heartbeat – This bit changes state every 50 milliseconds. (50 milliseconds on, 50 milliseconds off, 10Hz square wave) It can be used to verify active communications through the network interface and that the ANA2 is functioning correctly.

Bit 13: Slave Mode – This bit will equal "0" when the ANA2 is configured as a master module and "1" when it is configured as a slave module.

Bit 12: Module Initialized – Set to "1" on power up to signify that the ANA2 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" after the first valid 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 ANA2 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 ANA2 requires calibration.

NOTE If this bit is set when the Module Initialized bit is set, the ANA2 has lost its factory calibration values. Contact AMCI for assistance with calibrating the ANA2.

Bit 10: In Configuration Mode – Set to "1" when the ANA2 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 ANA2 does not have valid configuration data for either channel and the unit must be configured.

Bit 9: In Setup Mode – Set to "1" when the ANA2 is in its Setup Mode. Reset to "0" at all other times. If this bit equals "1" when the Module Initialized bit is set, the ANA2 does not have valid setup data for either channel and the unit must have transducer parameters written to it.

Bit 8: In Alignment Mode – Set to "1" when the ANA2 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 ANA2 is configured for a foreign dual resolver transducer and does not have valid alignment data for it. The resolvers must be aligned before measurements can be taken.

Bit 7: In Measurement Mode – Set to "1" when the ANA2 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 ANA2 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 39 for an explanation of these bits.

Bits 6, 5, 4: Reserved, These bits will always equal zero.

Module Status Word Format (continued)

Bit Descriptions (continued)

Bits 3 – 0: Error Codes, These bits are set when there is an error in the programming data sent from the host. Table 5.1 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 ANA2 cannot allow at this time. For example, attempting to start measurement on a channel that is not yet configured or set up. 3) You attempted to enter a mode without setting the correct password in output word 1. 4) You wrote down the same valid command to the ANA2 twice. 5) You issued a "Save to Flash" command (16#800E) while the ANA2 is reporting a command error. 6) You attempted to program a single turn setup without selecting a channel in the Command Word. 7) You attempted to apply a preset to a channel that is disabled or in transducer fault. 8) You attempted to align a dual resolver transducer while the ANA2 is configured for single resolver transducers. 9) You attempted to align a dual resolver transducer while there is a transducer fault on one or both channels. 10) You attempted to enable channel 2 or apply a preset to channel 2 while the ANA2 is configured for a dual-resolver transducer. 11) You set the "Save Offset to Flash" bit without setting the either of the "Apply Preset" bits.
2	Save to Flash Error	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 ANA2 to clear this fault.
3	Reference Voltage Error	The Reference Voltage parameter is outside of its range of 800 to 12,000 millivolts.
4	Reference Frequency Error	The Reference Frequency parameter is outside of its range of 400 to 10,000 hertz.
5	Transformation Ratio Error	The Transformation Ratio (TR) parameter is outside of its range of 0.1 to 3.0 This parameter is programmed with 0.01 resolution, with a range of 10 to 300.

(Table is continued on next page.)

Module Status Word Format (continued)

Bit Descriptions (continued)

(Continued from previous page.)

Error Code	Name	Description
6	Number of Turns Error	While programming a dual resolver multi-turn transducer, the number of turns you are trying to program is not a factor of the maximum number of turns available with your transducer. In some cases, an error in the Transducer Type parameter setting may appear as this error, so verify the Transducer Type setting when you see this error. See ***Write Configuration Data Command*** starting on page 42 for information on programming this parameter.
7	Transducer Type Error	1) While programming an AMCI dual resolver transducer, you did not set the Transducer Type parameter to 100, 180, 1000, or 1800. 2) While programming a foreign multi-turn transducer, the value is outside the range of 2 to 128. See ***Foreign Dual Resolver Transducers*** on page 28 for information on programming this parameter.
8	Setup Error	One or more of the reserved bits in the Setup Word are set to '1'.
9	Full Scale Count Error	1) For single resolver transducers, the Full Scale Count parameter is outside its valid range or 2 to 65,536. 2) For AMCI 1000 and 1800 turn, dual resolver transducers, the Full Scale Count parameter is outside its valid range of 2 to (65,53.6 * Number of Turns). 3) For all other dual resolver transducers, the Full Scale Count parameter is outside its valid range of 2 to (65,536 * Number of Turns).
10	Preset Value Error	The Preset Value parameter is outside its valid range of 1 to (Full Scale Count - 1).
11	Reference Error	1) The ANA2 is configured as a master module and the reference voltage is shorted. 2) The ANA2 is configured as a slave module and the reference voltage is not being received from the master. The master device must be wired into the J2-1 and J2-2 pins of the ANA2 with the J2-2 pin being ground.
12-15	Reserved	Reserved for future use.

Table 5.1 Module Status Error Code Bits

Channel Status Word Format

The format of the Channel Status word does not depend on the mode that the ANA2 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 Setup	Channel Aligned	0	0	0	0	0	Transducer Fault	Channel Measuring	0	0	Sensor Type See Description Below	

Figure 5.3 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 ANA2 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. Valid configuration data is programmed into the ANA2 at the factory, so this bit will be set on new units.

Bit 12: Channel Setup – Set to "1"when the channel has valid Setup data associated with it. Reset to "0" if the Setup parameters must be written to the channel before it can be used. Valid setup data is programmed into the ANA2 at the factory, so this bit will be set on new units.

Bit 11: Channel Aligned – Always set to "1" when using single resolver and AMCI dual resolver transducers. When using a foreign dual resolver transducer, set to "1" when valid alignment data exists for the transducer. This bit is reset to "0" if the foreign dual resolver transducer must be aligned before use.

Bits 10 - 6: Reserved – Always reset to "0".

Bit 5: Transducer Fault – Set to "1" when there is an error reading the transducer. The state of this bit is only valid when the ANA2 is in Alignment Mode or when in Measurement Mode and the channel measuring bit is set to "1". The most common causes are that the sensor is not wired to the ANA2 correctly or the Configuration parameters do not work with the attached resolver. Position and Velocity data are set to zero when there is a transducer fault on the channel.

Bit 4: Channel Measuring – Set to "1" when the ANA2 is in Measurement Mode and actively reading the transducer. If this bit is reset to "0" while in Measurement Mode, the ANA2 will transmit a value of zero for the position and velocity values.

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

Bits 1 & 0: Sensor Type – Bit pattern shows what type of transducer the ANA2 channel is programmed for.

Bit Number		
1	0	Description
0	0	Reserved
0	1	Single resolver transducers
1	0	AMCI dual resolver transducer
1	1	Foreign dual resolver transducer

Figure 5.4 Transducer Type Bits Description

Notes

CHAPTER 6
CONFIGURATION MODE DATA FORMAT

This chapter covers the steps needed to program the ANA2 while it is in its Configuration Mode.

Transmit Bit

The Transmit Bit is used to tell the ANA2 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 ANA2 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 ANA2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANA2.

This condition also applies when switching between modes.

Entering Configuration Mode

The ANA2 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 ANA2 power 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 35 for a full description of the In Calibration Mode and Module Initialized bits.

You can also enter Configuration Mode from Alignment Mode, Setup Mode, or Measurement Mode at any time by writing the following data to the ANA2.

ANA2 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 ANA2 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 35 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Network Input Data Format

The format of the Network Data while the ANA2 is in Configuration Mode is shown below. The Module Status word contains the Acknowledge Bit and Error Code bits. Words 2 - 4 and 6 - 9 are always 16#0000 in this mode.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word *Module Status Word Format* described starting on page 35
1	Channel 1 Status Word *Channel Status Word Format* described starting on page 39
2	16#0000
3	16#0000
4	16#0000
5	Channel 2 Status Word *Channel Status Word Format* described starting on page 39
6	16#0000
7	16#0000
8	16#0000
9	Reserved, 16#0000

Figure 6.2 Network Input Data: Configuration Mode

Write Configuration Data Command

Command Data

Once you are in Configuration Mode, use the following command to configure the ANA2 with the correct resolver parameters.

Word	Configuration Data	Range	Factory Defaults
0	Command Word	16#A001	
1	Module Mode	0 = Master Mode 8,192 = Slave Mode	0
2	Reference Voltage	800 to 12,000 (0.8 to 12 Vac)	3250
3	Reference Frequency	400 to 10,000 (Hz)	2500
4	Channel 1 Transformation Ratio	10 to 300 (0.10 to 3.00)	95
5	Channel 2 Transformation Ratio	10 to 300 (0.10 to 3.00)	95
6	Reserved for future use	0	
7	Reserved for future use	0	
8	Reserved for future use	0	
9	Reserved for future use	0	

Figure 6.3 Command Format: Single Resolver Transducers Configuration

NOTE

1) The ANA2 comes factory configured for AMCI transducers. This includes the R11X-J style bare resolvers available from AMCI.

2) All of the data in words 1 through 5 must be present and valid before the command will be accepted. Missing or invalid data in any of the words will cause a command error.

Write Configuration Data Command (continued)

Slave Mode Programming

When using the ANA2 as a slave device, the Reference Voltage, Reference Frequency, and Transformation Ratio parameters must still be programmed so that the ANA2 can reliably decode the resolver position and detect transducer faults. The Reference Voltage and Reference Frequency parameters must equal the voltage and frequency supplied by the resolver's master controller and the Transformation Ratio parameters must match those of your resolvers.

ANA2 Response

The ANA2 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. The four error bits will equal zero if the command completes without error. See ***Module Status Word Format*** starting on page 35 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

If there is an error response from the ANA2, 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 ANA2 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 ANA2, then you must exit Configuration Mode with this command.

ANA2 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 6.4 Save and Exit Command: Network Output Data

The ANA2 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 you are using a foreign dual resolver transducer, or Measurement Mode with default values for Setup Parameters on the channel you just programmed.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

NOTE Saving Configuration parameters to Flash memory will reset the Setup parameters to their default values. Because the Setup parameters have default values, the ANA2 will never go directly to Setup Mode while programming the unit. See ***Default Setup Parameter Values*** on page 45 for more information.

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 ANA2 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 above.

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

ANA2 Word	Value	Description
0	16#800F	Command Word to exit Configuration Mode
1 – 9	16#0000	Not Used

Figure 6.5 Save and Exit Command: Network Output Data

The ANA2 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 the ANA2 is not presently configured, Alignment Mode if you are using a foreign dual resolver transducer, or Measurement Mode if at least one of the channels is ready for measurements.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

CHAPTER 7
SETUP MODE DATA FORMAT

This chapter covers the steps needed to program the ANA2 while it is in its Setup Mode. Setup Mode is used to program the parameters used to set the position and tachometer data that is reported by the ANA2.

Default Setup Parameter Values

The following parameters can be programmed while in Setup Mode.

Parameter	Range	Default Value
Count Direction	CW increasing, CCW increasing	CW increasing
Transducer Fault Latch	On, Off	Off
Full Scale Count	Single Resolver: 2 to 65,536	1,024
	Dual Resolver: 2 to (65,536 * Number of Turns†)	1,024 * Number of Turns
Preset Value	0 to (Full Scale Count - 1)	0

† "Number of Turns" refers to the value of the Number of Turns parameter programmed as part of the Dual Resolver Setup data.

Table 7.1 Setup Parameters

Note that these parameters have default values. Setup Parameters are set to these values when you exit Configuration Mode with the ***Save to Flash and Exit Command*** as described on page 43. Because these parameters are set to defaults, the ANA2 will never jump directly to Setup Mode. If you are using single resolver or AMCI dual resolver transducers, the ANA2 will jump directly to Measurement Mode when you exit Configuration Mode. If you are using a foreign dual resolver transducer, the ANA2 will jump directly to Measurement Mode when you exit Alignment Mode.

Transmit Bit

The Transmit Bit is used to tell the ANA2 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 ANA2 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 ANA2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANA2. This condition also applies when switching between modes.

Entering Setup Mode

The ANA2 will allow you to enter Setup Mode after power up as long as valid Configuration data exists. If the ANA2 powers up with the In Setup Mode and Module Initialized bits set to "1", then you can enter Setup Mode. See ***Module Status Word Format*** starting on page 35 for a full description of the In Setup Mode and Module Initialized bits.

You can also enter Setup Mode from Measurement Mode at any time. You enter Setup Mode by writing the following data to the ANA2.

ANA2 Word	Value	Description
0	16#B000	Command Word to enter Alignment Mode
1	16#1298	Password
2 – 9	16#0000	Not Used

Figure 7.1 Enter Alignment Mode: Network Output Data

Entering Setup Mode (continued)

ANA2 Response

The ANA2 responds by setting the Acknowledge Bit and the In Setup 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 35 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Network Input Data Format

The format of the Network Input Data when the ANA2 first enters Setup Mode is shown below. The format does not change while in Setup Mode. The Module Status word contains the Acknowledge Bit and Error Code bits.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word ***Module Status Word Format*** described starting on page 35
1	Channel 1 Status Word ***Channel Status Word Format*** described starting on page 39
2	16#0000
3	16#0000
4	16#0000
5	Channel 2 Status Word ***Channel Status Word Format*** described starting on page 39
6	16#0000
7	16#0000
8	16#0000
9	Reserved, 16#0000

Figure 7.2 Network Input Data: Setup Mode Format

Multi-Word Parameters

The Full Scale Count and Preset Value parameters, as well as values reported back to the PLC, can exceed ±32,768 counts. Therefore, they require two words of storage and they are transmitted as 32 bit values. The least significant word (LSW) contains the lower sixteen bits of the value and the most significant word (MSW) contains the remaining bits. When determining the values needed when programming the ANA2, it is easiest to convert the parameter value to hexadecimal and enter these values into your data table. (Many host platforms only show 16 bit values in 2's-compliment notation. Sixteen bit values between 32,768 and 65,535 will appear as negative numbers when viewed as decimals.)

Value (dec)	Value (hex)	MSW (hex)	MSW (dec)	LSW (hex)	LSW (dec)
50,800	16#0000:C670	16#0000	0	16#C670	-14,736
11,772,561	16#00B3:A291	16#00B3	179	16#A291	-23,919

Table 7.2 Multi-Word Data Format

Write Setup Data Commands

Once you are in Setup Mode, use one of the following commands to write the Setup parameters to the ANA2. There are five different commands, three for single resolver transducers, one for AMCI dual resolver transducers, and one for foreign dual resolver transducers.

Single Resolver Transducers

Word	Configuration Data	Range
0	Command Word	See Below
1	CH1 Setup Word	See ***Setup Word Format*** on page 49.
2	CH1 Full Scale Count	2 to 65,536 16#0000:0002 to 16#0001:0000
3		
4	CH1 Preset Value	0 to (Full Scale Count -1) 16#0000 to 16#FFFF max.
5	CH2 Setup Word	See ***Setup Word Format*** on page 49
6	CH2 Full Scale Count	2 to 65,536 16#0000:0002 to 16#0001:0000
7		
8	CH2 Preset Value	0 to (Full Scale Count -1) 16#0000 to 16#FFFF max.
9	Reserved for future use	0

Figure 7.3 Command Format: Single Resolver Transducers Setup

Command Word Value

- 16#B011 - Program Channel 1. Data values in words 5 through 9 are ignored.
- 16#B021 - Program Channel 2. Data values in words 1 through 4 are ignored.
- 16#B031 - Program Channels 1 and 2. All data values must be correct.

AMCI Dual Resolver Transducers

Word	Configuration Data	Range
0	Command Word	16#B002
1	Setup Word	See ***Setup Word Format*** on page 49
2	Transducer Type	100, 180, 1000, 1800
3	Number of Turns	100: 1, 2, 4, 5, 10, 20, 25, 50, 100
		180: 1, 2, 3, 4, 5, 6, 9, 10, 12, 15, 18, 20, 30, 36, 45, 60, 90, 180
		1000: 10, 20, 40, 50, 100, 200, 250, 500, 1000
		1800: 10, 20, 30, 40, 50, 60, 90, 100, 120, 150, 180, 200, 300, 360, 450, 600, 900, 1800
4	Full Scale Count	2 to (65,536 * Number of Turns†): 100, 180 turn 2 to (65,53.6 * Number of Turns†): 1000, 1800 turn
5		
6	Preset Value	0 to (Full Sale Count -1)
7		
8	Reserved for future use	0
9	Reserved for future use	0

† "Number of Turns" refers to the value of the Number of Turns parameter programmed in word 2.

Figure 7.4 Command Format: AMCI Dual Resolver Transducer Setup

Write Setup Data Commands (continued)

Foreign Dual Resolver Transducers

Word	Configuration Data	Range
0	Command Word	16#B004
1	Setup Word	See ***Setup Word Format*** on page 49
2	Transducer Type	Range of 2 to 128. Sets the maximum number of turns the transducer can encode.
3	Number of Turns	Any factor of the number defined by the Transducer Type parameter. For example:
		64:1, 2, 4, 8, 16, 32, 64
		128:1, 2, 4, 8, 16, 32, 64, 128
4	Full Scale Count	2 to (65,536 * Number of Turns†)
5		
6	Preset Value	0 to (Full Sale Count -1)
7		
8	Reserved for future use	0
9	Reserved for future use	0

† "Number of Turns" refers to the value of the Number of Turns parameter programmed in word 3.

Figure 7.5 Command Format: Foreign Dual Resolver Transducer Setup

Write Setup Data Commands (continued)

Setup 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	Gearing Type	0	0	0	0	0	0	Transducer Fault Latch	Count Direction

Figure 7.6 Configuration Word Format

Bits 15 - 9: Reserved – Must always be reset to "0".

Bit 8: Gearing Type – This bit is ignored when a Single Resolver Transducer programming block or an AMCI Dual Resolver Transducer programming block is written to the ANA2. When programming the ANA2 for a Foreign Dual Resolver Transducer, set this bit to "0" to setup the ANA2 for a reduction type multi-turn transducer. Set this bit to "1" to setup the ANA2 for a vernier type multi-turn transducer.

Bits 7 - 2: Reserved – Must always be reset to "0".

Bit 1: Transducer Fault Latch – When this bit equals "0", the ANA2 will clear transducer fault errors as soon as it can correctly determine position based on the resolver signals. When this bit is set to "1", the ANA2 will latch transducer faults when they occur and will leave the error flag set until the fault is cleared by the host controller.

Bit 0: Count Direction – When this bit equals "0", AMCI transducers will increase counts with clockwise rotation of the shaft if the transducer cable is wired as shown in this manual. When this bit equals "1", AMCI transducers will increase counts with counter-clockwise rotation of the shaft if the transducer cable is wired as shown in this manual. Note that it is possible to reverse count direction by swapping pair connections in the cable. See ***Transducer Wiring*** starting on page 25 for more information.

Save to Flash and Exit Command

Setup parameter changes are not accepted until you exit Setup Mode. If the ANA2 experiences a hardware reset or power loss while in Setup Mode, the parameter change is also lost. If you wish to store the parameter changes you just wrote to the ANA2, then you must exit Setup Mode with this command.

ANA2 Word	Value	Description
0	16#800E	Command Word to exit Setup Mode and save parameters to flash memory
1 – 9	16#0000	Not Used

Figure 7.7 Save and Exit Command: Network Output Data

The ANA2 will set the Acknowledge Bit and exit Setup Mode. The unit will enter Measurement Mode if you are using single resolver transducers or an AMCI dual resolver transducer. The unit will enter Alignment Mode of you are using a foreign dual resolver transducer.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Exit Mode Command

Changes to the Setup parameters are lost if you do not save them to flash memory when you exit Setup Mode. If you are in Setup Mode and the ANA2 experiences a hardware reset or power loss, changes to the parameters are also lost. If you want to save the parameters to flash and use them, then you must exit Setup Mode with the ***Save to Flash and Exit Command*** as described on the previous page.

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

ANA2 Word	Value	Description
0	16#800F	Command Word to exit Setup Mode
1 – 9	16#0000	Not Used

Figure 7.8 Exit Command: Network Output Data

The ANA2 will set the Acknowledge Bit and exit Setup Mode. The unit will enter Measurement Mode using the last saved values of the Setup parameters.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

CHAPTER 8
ALIGNMENT MODE DATA FORMAT

This chapter covers the steps needed to program the ANA2 while it is in its Alignment Mode. You can use Alignment Mode with any dual resolver, multi-turn transducer to check its alignment and type. Alignment is required for all foreign dual resolver, multi-turn transducers to guarantee proper operation.

Transmit Bit

The Transmit Bit is used to tell the ANA2 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 ANA2 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 ANA2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANA2. This condition also applies when switching between modes.

Entering Alignment Mode

The ANA2 will allow you to enter Alignment Mode after power up as long as valid Configuration and Setup data exists. If the ANA2 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 35 for a full description of the In Alignment Mode and Module Initialized bits.

You can also enter Alignment Mode from Setup Mode or Measurement Mode at any time. You enter Alignment Mode by writing the following data to the ANA2.

ANA2 Word	Value	Description
0	16#9000	Command Word to enter Alignment Mode
1	16#1298	Password
2 – 9	16#0000	Not Used

Figure 8.1 Enter Alignment Mode: Network Output Data

NOTE If you are using a foreign dual resolver, multi-turn transducer, you are required to use Alignment Mode to guarantee the proper operation of your transducer. When using single resolver transducers or AMCI dual resolver multi-turn transducers, you can use Alignment Mode to check the operation of the resolvers.

ANA2 Response

The ANA2 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 35 for a full description of the response bits.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Network Input Data Format

The format of the Network Data when the ANA2 first enters Alignment Mode is shown below. The Module Status word contains the Acknowledge Bit and Error Code bits.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word ***Module Status Word Format*** described starting on page 35
1	Channel 1 Status Word ***Channel Status Word Format*** described starting on page 39
2	16#0000
3	Ch. 1 Position Value, (0 to 1,023) **Must be the Coarse Resolver**
4	16#0000
5	Channel 2 Status Word ***Channel Status Word Format*** described starting on page 39
6	16#0000
7	Ch. 2 Position Value, (0 to 1,023) **Must be the Fine Resolver**
8	16#0000
9	Reserved, 16#0000

Figure 8.2 Network Input Data: Initial Alignment Mode Format

Once you enter Alignment Mode, the ANA2 shows you the position of the two resolvers separately. This allows you to determine the type of multi-turn transducer you have and observe the alignment between them.

- Resolver position is always reported with a resolution of 1,024 counts per turn.
- Transducer faults are always self clearing while in Alignment Mode.
- Channel 1 must be the coarse resolver. Channel 2 must be the fine resolver.
- If the fine resolver position changes quickly compared to the coarse resolver position, your multi-turn transducer is most likely a reduction type transducer.
- If the fine and coarse resolver positions change at nearly the same rate, your multi-turn transducer is most likely a vernier type transducer.
- When you rotate the transducer's shaft, the counts of both resolvers must increase or decrease. If one is increasing and the other is decreasing, rotate the transducer's shaft in the direction that you want increasing counts and note which resolver has the decreasing counts. Reverse the S2 and S4 connections on the I/O Connector for this resolver.

Once you issue the ***Align Transducer Command***, the ANA2 responds by showing the combined multi-turn position value.

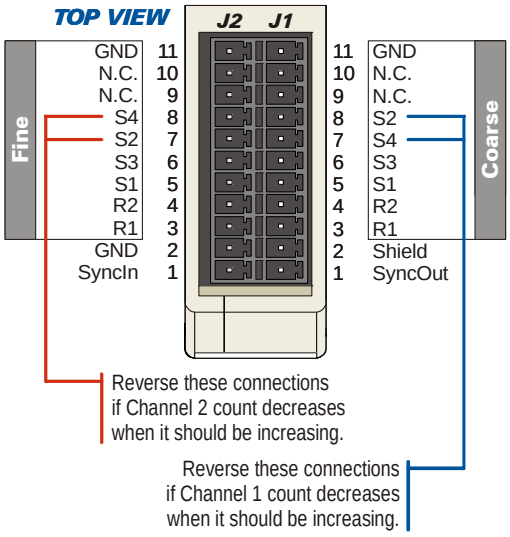


Figure 8.3 Reverse Count Directions

Align Transducer Command

The Align Transducer command will force the ANA2 module to calculate the coarse resolver offset needed to bring the two resolvers into alignment. The coarse resolver offset is an internal offset only and is not the same as the Position Offset generated when you preset the position value.

Word	Configuration Data	Range
0	Command Word	16#9001
1-9	Not Used	16#0000

Figure 8.4 Command Format: Align Transducer

ANA2 Response

The ANA2 responds to an Align Transducer 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 ANA2 is configured for single resolver transducers, the module will respond with a Command Error, (Error Code 1).
- If a transducer fault exists on either channel, the ANA2 will respond with a Command Error, (Error Code 1).

See ***Module Status Word Format*** starting on page 35 for a full description of the response bits.

If the command was successful, the Network Input Data will change to the following format.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word ***Module Status Word Format*** described starting on page 35
1	Channel 1 Status Word (Coarse Resolver) ***Channel Status Word Format*** described starting on page 39
2	Multi-turn Position Value, 32 bit format
3	
4	16#0000
5	Channel 2 Status Word (Fine Resolver) ***Channel Status Word Format*** described starting on page 39
6	16#0000
7	16#0000
8	16#0000
9	Reserved, 16#0000

Figure 8.5 Network Input Data: Transducer Aligned Format

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

- Once successfully aligned, the position value is set to halfway through the first turn.
- The multi-turn position reported while in Alignment Mode is set by the value of the Full Scale Count parameter you programmed while in Setup Mode.
- If the multi-turn position value is not stable after aligning the transducer, check your wiring. If no problem is found, verify that the correct configuration data for your resolvers was written to the ANA2. While troubleshooting, it is also possible to configure the module for two independent single turn resolvers. This would allow you to see the resolver position with a resolution greater than 1,024 counts per turn.

Align Transducer Command (continued)

Multi-Word Position Format

The multi-turn position value reported back to the PLC can exceed ±32,768 counts. Therefore, it requires two words of storage and it is transmitted as a 32 bit value. The least significant word (LSW) contains the lower sixteen bits of the value and the most significant word (MSW) contains the remaining bits. Many host platforms only show 16 bit values in 2's-compliment notation. Therefore, it is possible for a negative value to appear in the least significant word.

Value (dec)	Value (hex)	MSW (hex)	MSW (dec)	LSW (hex)	LSW (dec)
50,800	16#0000:C670	16#0000	0	16#C670	-14,736
11,772,561	16#00B3:A291	16#00B3	179	16#A291	-23,919

Table 8.1 Multi-word Data Format

Save to Flash and Exit Command

Alignment changes are not accepted until you exit Alignment Mode. The coarse resolver offset is lost if you do not store it in flash memory when you exit the mode. If the ANA2 experiences a hardware reset or power loss while in Alignment Mode, the parameter change is also lost. If you wish to store the coarse resolver offset parameter you just wrote to the ANA2, then you must exit Alignment Mode with this command.

ANA2 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 8.6 Save and Exit Command: Network Output Data

The ANA2 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 ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Exit Mode Command

Alignment changes are lost if you do not store the coarse resolver offset in flash memory when you exit Alignment Mode. If you are in Alignment Mode and the ANA2 experiences a hardware reset or power loss, changes to the coarse resolver offset 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 above.

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

ANA2 Word	Value	Description
0	16#800F	Command Word to exit Alignment Mode
1 – 9	16#0000	Not Used

Figure 8.7 Exit Command: Network Output Data

The ANA2 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 the foreign dual-resolver transducer has not been aligned, or Measurement Mode if valid alignment data exists.

At this point, you must reset the Transmit Bit (Output Word 0, bit 15), before the ANA2 will accept another command. The easiest way to do this is to write a value of zero into the Command Word. The ANA2 will respond by resetting the Acknowledge Bit.

Notes

CHAPTER 9
MEASUREMENT MODE DATA FORMAT

This chapter covers the data that can be written to and read from the ANA2 while it is in its Measurement Mode. While in this mode you can enable or disable channel status LED's, preset the position value and clear transducer faults. Both position and velocity data is available to the host controller while in this mode.

Transmit Bit

The Transmit Bit is used to tell the ANA2 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 ANA2 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 ANA2 will respond by resetting the Acknowledge Bit. At this point, another command can be written to the ANA2. This condition also applies when switching between modes.

Entering Measurement Mode

The ANA2 will allow you to enter Measurement Mode after power up as long as valid Configuration and Setup data exists. When using a foreign dual resolver transducer, valid Alignment data must also be present. If the ANA2 powers up with the In Measurement Mode and Module Initialized bits set to "1", then you can enter Measurement Mode. See ***Module Status Word Format*** starting on page 35 for a full description of the In Measurement Mode and Module Initialized bits.

NOTE The ANA2 automatically attempts to clear transducer faults when it enters Measurement Mode.

Measurement Mode Command

Once Measurement Mode is available, the following command structure is used.

ANA2 Word	Value	Description
0	16#88XX	Command Word to enter Measurement Mode XX: Described below
1 – 9	16#0000	Not Used

Figure 9.1 Measurement Mode Command Format

Measurement Mode Command (continued)

Measurement Mode Command Word 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Transmit Bit	0	0	0	1	0	0	0	Clear Transducer Faults	Store Position Offsets in Flash	Apply Preset CH2	Apply Preset CH1 or Multi-turn	Disable LED CH2	Enable Data CH2	Disable LED CH1	Enable Data CH1 or Multi-turn

Figure 9.2 Measurement Mode Command Word 0 Format

Bit 15: Transmit Bit – ANA2 only accepts a command when this bit makes a 0 → 1 transition. This bit must equal one when sending a command to the ANA2.

Bits 14 - 12: Reserved – Must always be reset to “0”.

Bit 11: Reserved – Must always be set to “1”.

Bits 10 - 8: Reserved – Must always be reset to “0”.

Bit 7: Clear Transducer Faults – Setting this bit to “1” will clear all latched transducer faults.

Bit 6: Store Position Offset in Flash – If this bit is set to “1” when the Apply Preset Channel 1 and/or the Apply Preset Channel 2 bits are set, the resulting position offset is stored in Flash memory.

NOTE The ANA2 Flash memory has a 10,000 write cycle limit. If your application requires you to preset the position values repeatedly, do not set this bit when issuing an Apply Preset command.

Bit 5: Apply Preset Channel 2 – Setting this bit to “1” will preset the Channel 2 position to the Preset Value programmed in Setup Mode. If the ANA2 is presently configured for a dual resolver multi-turn transducer, setting this bit will cause a programming error.

Bit 4: Apply Preset Channel 1 or Multi-turn – Setting this bit to “1” will preset the Channel 1 position to the Preset Value programmed in Setup Mode. If the ANA2 is presently configured for a dual resolver multi-turn transducer, setting this bit will preset the multi-turn position value.

Bit 3: Disable LED: Channel 2 – Setting this bit to “1” will prevent the CH 2 Status LED on the front of the ANA2 from displaying status information. This is commonly used to prevent the channel from displaying a transducer fault when the channel is not used. This setting does not affect the LED when it is being used to show the status of the module. See ***Status LED’s*** on page 15 for more information.

Bit 2: Enable Data Channel 2– Setting this bit to “1” will enable position and velocity readings on channel 2. If the ANA2 is presently configured for a dual resolver multi-turn transducer, setting this bit will cause a programming error. If this bit is set to “0”, the position and tachometer values for channel 2 will be set to zeros.

Bit 1: Disable LED: Channel 1 – Setting this bit to “1” will prevent the CH 1 Status LED on the front of the ANA2 from displaying status information. This is commonly used to prevent the channel from displaying a transducer fault when the channel is not used. This setting does not affect the LED when it is being used to show the status of the module. See ***Status LED’s*** on page 15 for more information.

Bit 0: Enable Data Channel 1 or Multi-turn – Setting this bit to “1” will enable position and velocity readings on channel 1. If the ANA2 is presently configured for a dual resolver multi-turn transducer, setting this bit will enable the multi-turn position and velocity values. If this bit is set to “0”, the position and tachometer values for channel 1 will be set to zeros.

Measurement Mode Command (continued)

Measurement Mode Command Word 0 (continued)

NOTE The ANA2 acts on the state of all of the bits whenever a command is written to the module. Therefore, all of the bits must be in their correct states when writing a command to the ANA2. For example, setting only the Clear Transducer Faults bit (16#8840) will clear the transducer faults and disable both channels (the two Enable Channel bits both equal "0"). This is probably not the result you are looking for. The section below lists the correct command values for common situations.

Enable/Disable Data Command Values

16#8800 - Disable data on both channels, both Status LED's enabled

16#880A - Disable data on both channels, both Status LED's disabled

16#8809 - Enable channel 1 data and its LED, disable channel 2 data and its LED

16#8801 - Enable channel 1 single turn data, both Status LED's enabled

16#8801 - Enable channel 1 multi-turn data, both Status LED's enabled

16#8806 - Enable channel 2 single turn data and its LED, disable channel 1 data its LED (Error if configured for dual resolver transducer)

16#8805 - Enable data and Status LED's on channels 1 and 2. (Error if configured for dual resolver transducer)

Preset Command Values

16#8819 - Apply preset to channel 1, enable channel 1 and its LED, disable channel 2 and its LED, store resulting offset in RAM

16#8859 - Apply preset to channel 1, enable channel 1 and its LED, disable channel 2 and its LED, store resulting offset in Flash memory

16#8811 - Apply preset to dual resolver, multi-turn transducer, enable multi-turn channel, store resulting offset in RAM

16#8851 - Apply preset to dual resolver, multi-turn transducer, enable multi-turn channel, store resulting offset in Flash memory

16#8815 - Apply preset to channel 1, enable channels 1 and 2 and the Status LED's, store resulting offset in RAM

16#8855 - Apply preset to channel 1, enable channels 1 and 2 and the Status LED's, store resulting offset in Flash

16#8826 - Apply preset to channel 2, enable channel 2 and its LED, disable channel 1 and its LED, store resulting offset in RAM

16#8866 - Apply preset to channel 2, enable channel 2 and its LED, disable channel 1 and its LED, store resulting offset in Flash

16#8825 - Apply preset to channel 2, enable channels 1 and 2 and the Status LED's, store resulting offset in RAM

16#8865 - Apply preset to channel 2, enable channels 1 and 2 and the Status LED's, store resulting offset in Flash

16#8835 - Apply preset to channels 1 and 2, enable channels 1 and 2 and the Status LED's, store resulting offsets in RAM

16#8875 - Apply preset to channels 1 and 2, enable channels 1 and 2 and the Status LED's, store resulting offsets in Flash

NOTE Commands 16#8813 through 16#8873 will result in a command error if the ANA2 is configured for a dual resolver, multi-turn transducer

Measurement Mode Command (continued)

Clear Transducer Fault Command Values

16#8889 - Clear transducer faults, enable channel 1, disable channel 2

16#8881 - Clear transducer faults, enable multi-turn channel

16#8886 - Clear transducer faults, enable channel 2, disable channel 1

16#8885 - Clear transducer faults, enable channels 1 and 2

NOTE Commands 16#8842 and 16#8843 will result in a command error if the ANA2 is configured for a dual resolver, multi-turn transducer

Network Input Data Format

Single Resolver Format

The format of the Network Input Data when the ANA2 is configured for single resolver transducers is shown below.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word *Module Status Word Format* described starting on page 35
1	Channel 1 Status Word *Channel Status Word Format* described starting on page 39
2	16#0000
3	CH 1 Position Value or 16#0000 if channel is disabled.
4	CH 1 Velocity Value or 16#0000 if channel is disabled.
5	Channel 2 Status Word *Channel Status Word Format* described starting on page 39
6	16#0000
7	CH 2 Position Value or 16#0000 if channel is disabled.
8	CH 2 Velocity Value or 16#0000 if channel is disabled.
9	Reserved, 16#0000

Figure 9.3 Network Input Data: Measurement Mode Format

Network Input Data Format (continued)

Dual Resolver Multi-turn Format

The format of the Network Input Data when the ANA2 is configured for a dual resolver multi-turn transducer is shown below.

ANA2 Word	ANA2 Network Input Data
0	Module Status Word ***Module Status Word Format*** described starting on page 35
1	Channel 1 (Coarse Resolver) Status Word ***Channel Status Word Format*** described starting on page 39
2	32 bit Position Value or 16#0000:0000 if channel is disabled.
3	
4	Velocity Value or 16#0000 if channel is disabled.
5	Channel 2 (Fine Resolver) Status Word ***Channel Status Word Format*** described starting on page 39
6	16#0000
7	16#0000
8	16#0000
9	Reserved, 16#0000

Figure 9.4 Network Input Data: Measurement Mode Format

Multi-Word Position Format

The multi-turn position value reported back to the PLC can exceed ±32,768 counts. Therefore, it requires two words of storage and it is transmitted as a 32 bit value. The least significant word (LSW) contains the lower sixteen bits of the value and the most significant word (MSW) contains the remaining bits. Many host platforms only show 16 bit values in 2's-compliment notation. Therefore, it is possible for a negative value to appear in the least significant word.

Value (dec)	Value (hex)	MSW (hex)	MSW (dec)	LSW (hex)	LSW (dec)
50,800	16#0000:C670	16#0000	0	16#C670	-14,736
11,772,561	16#00B3:A291	16#00B3	179	16#A291	-23,919

Table 9.1 Multi-word Data Format

Notes

APPENDIX A
THE RESOLVER

This appendix explains how a resolver works and the resolver characteristics you must be aware of when configuring the ANA2 to use your resolvers.

History of the Resolver

Resolvers are members of a family of devices known as synchros. The use of synchros in industrial applications dates back to at least the early 1900's when they were used for gate and valve position feedback on the Panama Canal. Resolvers themselves started to gain wide spread use during World War II and have been used by all branches of the military. Among other applications, resolvers were used by the U.S. Navy as components in analog computers that were the "brains" of gun fire control systems from the 1950's until the mid 1970's. Resolvers are still in use today in both military and commercial applications for angular position feedback on land and sea vehicles as well as aircraft flight control surfaces. Since the early 1970's, resolvers have been used in diverse and demanding industrial fields such as mining and metals, press control, and nuclear waste containment. All in all, resolvers have been used for the last 60+ years in applications like yours, where failure is not an option.

Types of Resolvers

There are many different types of resolvers, but the two most commonly used in industrial applications are the Transmitter and the Control Transformer. Understanding the difference between the two types is best achieved by understanding a simplified explanation of how they might have been used in the naval gun fire control system.

Transmitters were installed in the analog computer. When the computer finished calculating the solution set, the angles of the shafts of the Transmitters were at the required angles for the gun turrets. As shown in figure A.1, Transmitters basically perform a polar to rectangular conversion on a vector. The magnitude of the vector is equal to the magnitude of a Reference Voltage applied to the Transmitter and the angle of the vector is the angle of the shaft.

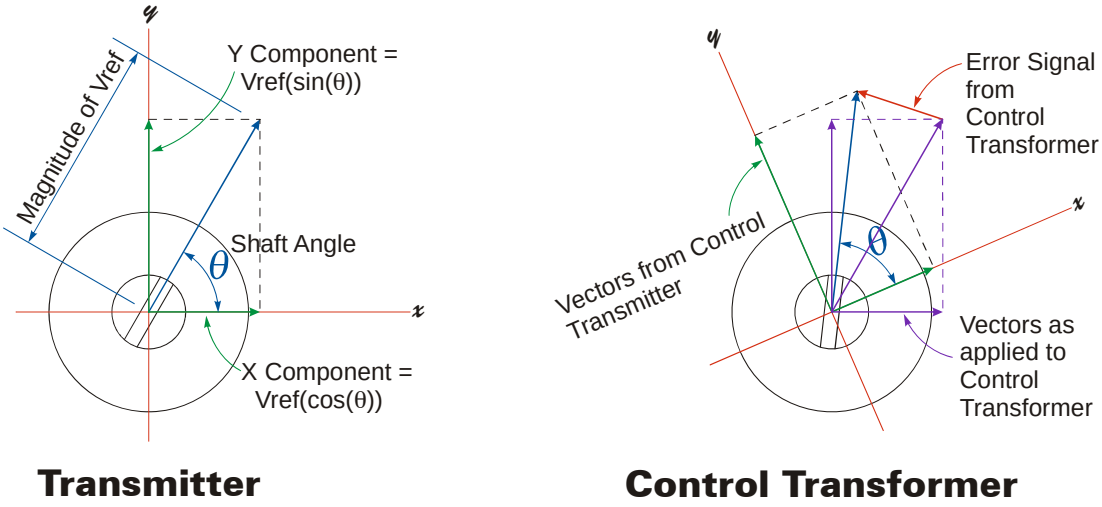


Figure A.1 Resolvers as Vector Converters

The Transmitter converts this vector to X and Y values that are equal to the Reference Voltage multiplied by the cosine or sine of the angle of the Transmitter's shaft. These two voltage are *transmitted* by cable (hence the term Transmitter), to Control Transformers that are connected to the gun turret. The Control Transformers *transform* these voltages back to a vector quantity. If the shaft of the Control Transformer is not at the same absolute angle as the Transmitter, the two coordinate planes are effectively rotated with respect to one another. The Control Transformer outputs an error signal equal to the magnitude of the Reference Voltage multiplied by the sine of the angle of error. This signal is used by the turret control system to rotate the turret until the shaft angles of the Transmitter and Control Transformer are equal and the error voltage is zero.

Types of Resolvers (continued)

The fact that this appendix introduces two different types of resolvers implies an important fact:

NOTE Resolvers are uni-directional sensors. You cannot apply a reference voltage to a Control Transformer and expect to receive accurate sine/cosine voltages on the other windings. Likewise, you cannot apply sine/cosine voltages to a Transmitter and expect an accurate error signal.

For most control systems, the Transmitter is the obvious choice as a position feedback sensor. The ANA2 is designed to work exclusively with Transmitter resolvers. Using a Control Transformer style of resolver with the ANA2 will not result in accurate readings.

How a Transmitter Resolver Works

Cut-away views of a size 11 Transmitter resolver are shown in figure A.2. The top view shows the resolver with half of the outer steel shell removed.

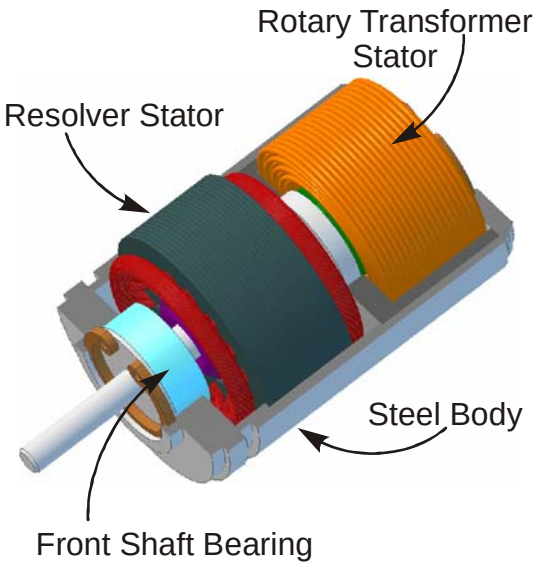
- As you can see, the resolver is a completely passive analog device. It does not contain sensitive electronics or optics that can degrade or fail over time. The resolver is basically a specialized transformer that shares construction techniques with both transformers and motors.
- Because the resolver works as a transformer, AC voltages must be applied to the resolver for it to operate. Applying a DC voltage to any of the windings may destroy the resolver.

The resolver stator contains the sine and cosine windings. These windings are spaced 90° apart when wound on the stator lamination stack.

A rotary transformer is located in the rear of the resolver. It couples the energy from the Reference Voltage into its rotor which is then passed on to the rotor of the resolver itself. Both of these items are shown in the bottom view of the figure which has half of the rotary transformer stator and resolver stator removed.

When the Reference Voltage is applied to the device, the resolver rotor generates a magnetic field that rotates with the rotor as the shaft is spun. Rotating this field alters how it couples into the sine and cosine windings.

At two points in the shaft's 360° rotation, none of the rotor's magnetic field will be coupled into the sine winding and its output voltage will be zero. At one of these points, the cosine winding voltage will be at its maximum and *in phase* with the Reference Voltage. This shaft position is defined as the 0° position of the resolver. At the other point where the sine output is zero volts, the cosine winding voltage will be at its maximum and *180° out of phase* with the reference voltage. This shaft position is defined as the 180° point of the resolver. The 90° and 270° points are similarly defined when the cosine output is zero and the sine voltage is in phase or out of phase with the Reference Voltage.



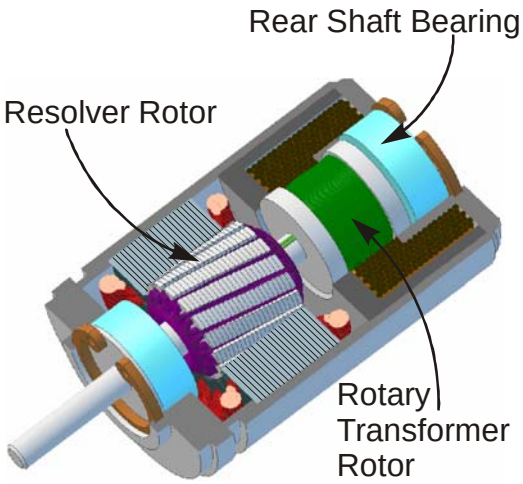


Figure A.2 Resolver Internals

How a Transmitter Resolver Works (continued)

Figure A.3 below is a schematic representation of a Transmitter resolver. The schematic shows industry standard wire colors for the resolver wires. Information on wiring a resolver to the ANA2 can be found in figure 3.7 ***Resolver to Cable Connections***, found on page 26.

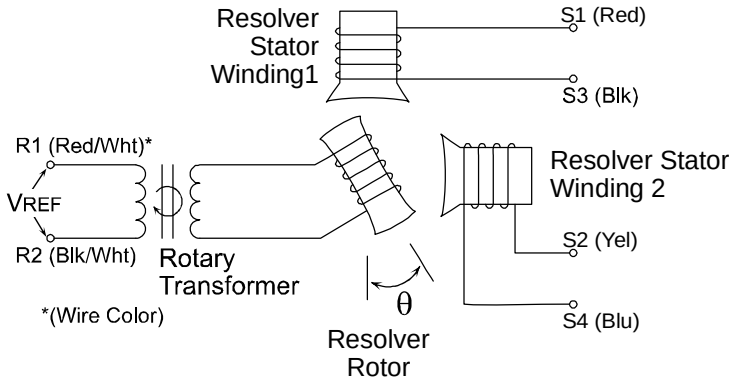


Figure A.3 Transmitter Resolver Schematic

Interpreting Resolver Specifications

When specifying a resolver for use with the ANA2 module, the three most important specifications are:

- **Reference Voltage** - The specified operating reference voltage
- **Reference Voltage Frequency** - The specified operating reference voltage frequency
- **Transformation Ratio (TR)** - The ratio of output voltage to input voltage when the output voltage is at it's maximum value. This is typically specified at the resolver's 0° position, but it is valid at any of the resolver's 90° points.

Resolvers use different wire gauges and different turns ratios, which means that they operate at different voltages and frequencies. Voltages generally range from 6 to 12 Vac while frequencies range from 400 Hz to 5000 Hz. Transformation Ratios generally range from 0.45 to 1.4. The ANA2 supports a much wider range for these setting to accommodate resolver-like devices such as variable reluctance transducers.

Published reference voltage specifications should be considered maximum values at the specified frequency. Using a higher voltage at the listed frequency may cause the iron cores in the resolver to saturate. This will significantly affect positional accuracy.

However, you can use a lower reference voltage setting without losing positional accuracy. This opens up the possibility of lowering the reference voltage frequency. Generally speaking, if you supply half of the specified reference voltage to the resolver, you can halve the reference frequency as well.

Lowering the reference voltage frequency increases the length of transducer cable you can place between the transducer and the ANA2 by decreasing the effects of cable capacitance. This is why the default Reference Frequency setting for AMCI transducers is 2.5 KHz instead of 5.0 KHz as specified for the R11X-J style resolvers. Using a Reference Voltage setting of 3.25 Vac instead of the specified 7.0 Vac keeps the resolver cores from saturating at this frequency.

How the ANA2 Works

The ANA2 generates a reference voltage at the programmed voltage and frequency. This voltage is fed into the rotor of the resolver and the resolver performs the polar to rectangular conversion, returning the sine and cosine voltages.

The ANA2 uses the programmed Transformation Ratio parameter to digitally adjust the gains of the input amplifiers that sense the sine and cosine voltages. The ANA2 simultaneously samples the sine and cosine waveforms at the waveform peak and performs an A-D conversion on these values. At this point, the ANA2 has digital values of the sine and cosine of the angle of the resolver's shaft.

Thinking back to trigonometry class, SIN θ / COS θ = TAN θ. With this value calculated, the ANA2 uses a lookup table to determine the shaft angle θ. As you may remember, the tangent function repeats every 180°. The ANA2 uses the signs of the sine and cosine values to determine the quadrant the shaft angle is in.

Calculating the ratio of the sine value to the cosine value has the important benefit of removing the absolute value of the reference voltage from the equation entirely. This means that changes in the reference voltage, such as those that result from changes to environmental conditions or aging, are ignored.

Notes

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