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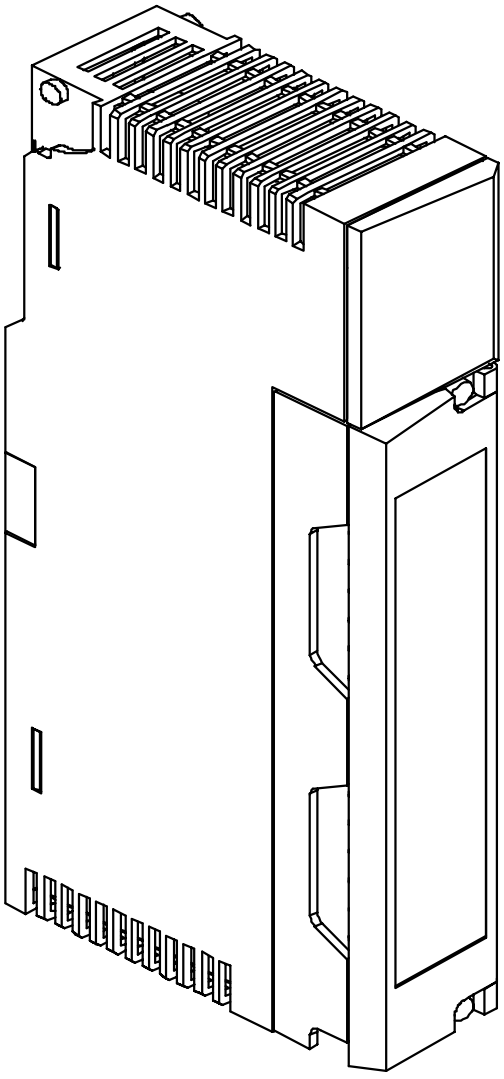
IFC 022

Quantum Feedback & Control Module

User's Guide

(5000-03)



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9/27/02

In this Chapter you will learn about:

- Important User Information
- Product Warranty
- Return Policy
- Technical Support
- Assumptions
- Contents of This User's Guide
- IFC 022 Module Basics

1.1. Important User Information

To ensure safe and satisfactory operation of the equipment described in this user's guide, as well as the equipment connected to and used with your IFC 022, all applicable local and national codes that apply to installing and operating the equipment must be followed.

WARNING ☞ **Failure to comply with applicable local and national codes and standards can result in damage to equipment and/or serious injury to personnel.**

Personnel responsible for the installation and/or operation of the equipment should study this user's guide and all referenced documentation prior to installation or operation of the equipment.

In no event is the provider of the equipment liable for any incidental, consequential or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with the use of this user's guide or the equipment.

The IFC 022 is designed to provide solutions for a wide variety resolver, encoder and servo applications. Therefore, it is the end user's responsibility to determine the acceptability of any products used in any application. The equipment provider assumes no responsibility for the User's misapplication of the IFC 022.

Since I^2T constantly strives to improve its products, we reserve the right to change this user's guide and any equipment mentioned herein at any time without notice.

1.2. Product Warranty

I^2T warrants that all equipment they manufacture will be free from defects in materials and workman-ship for a period of one (1) year from the date of invoice. Within this warranty period, I^2T shall, at its option, repair or replace – free of charge, any equipment covered by this warranty. This warranty does not cover any equipment damaged by improper installation, accident, alteration or misuse. In no event shall I^2T be liable for incidental or consequential damages or for delay in performance of this warranty.

1.3. Return Policy

Any equipment returned as new must be in the original, unopened shipping carton and is subject to a 20% restocking fee. All equipment returned to I^2T for repair or replacement, regardless of warranty status, must have return authorization. To receive return authorization, call the I^2T technical assistance number with the following product information:

- Product Part Number
- Serial Number
- Description of Problem

I^2T issues a Return Material Authorization (RMA) number. You must ship the product to I^2T with shipping charges prepaid and the RMA clearly marked on the outside of the shipping container. Title and risk of loss or damage remains with the customer until shipment is received by I^2T. All equipment returned for warranty repair must be in the original shipping container or additional handling charges apply. In special cases, I^2T will provide emergency replacement of defective equipment. For special cases, the customer must provide a Purchase Order number in the amount of a product being shipped plus any applicable taxes and shipping charges. In the event that the defective equipment is not returned within seven (7) days, I^2T bills the customer for the replacement equipment.

1.4. Technical Support

All I^2T products are sold through authorized Schneider Electric high-tech distributors. The customer should attempt to resolve any problems through their local distributor before contacting I^2T directly. Should your local distributor be unavailable or unable to solve a problem, contact I^2T Technical Support at (412) 828-1200.

1.5. Assumptions

To effectively use the IFC 022 User's Guide to install, develop and maintain your system, you should have a fundamental understanding of the following:

- Electronic concepts such as voltage, current, switches, etc.
- Motion control concepts such as position, velocity, acceleration, etc.,
- Ladder Logic programming skills
- Contents of this IFC 022 User's Guide.

1.6. Contents of This User's Guide

Each chapter provides a different level of help to get your system set up and ready to go. Below is a summary of each chapter's purpose.

Chapter / Appendix	Purpose
1 – Overview	Provides an overview of the items to be covered in this IFC 022 User's Guide.
2 – Introduction	Describes the IFC 022 and provides a brief overview of its features and design.
3 – Installation	Provides instructions for configuring, mounting and wiring the IFC 022 Quantum Feedback & Control Module.
4 – IFC 022 Setup Software	Allows the user to configure and test the module in a Windows environment.
5 – PLC Programming	Describes the IFC 022's user functions in detail and shows how to implement them in your application.
6 – Troubleshooting	Describes methods for isolating and resolving hardware and software problems. Describes the Diagnostics LEDs and the fault registers returned to the PLC.
A – Calculating User Units	Provides information on calculating user units.
B – Drawings	Provides drawings showing Module/Field interconnections and mechanical drawings of resolvers.

1.7. IFC 022 Module Basics

This section provides a user with an understanding of the capabilities of the IFC 022 Module. The IFC 022 is designed to be an easy-to-use PLC-based Feedback & Control Module. Some of the uses of the IFC 022 are described below.

1.7.1. 2-Axis Resolver/Encoder Feedback Module

This application uses the IFC 022 to read the position or velocity of two resolver or encoder channels directly into the Schneider Quantum PLC. A user loadable function block maps registers from the module directly to the PLC. When using the function block, the position and velocity of each axis is written directly into PLC registers. For more complex applications, a command-response protocol transfers commands to and from the module from the PLC. The following is a list of I^2T resolvers, encoders, and cables that are compatible with the module when using the feedback mode.

Part No.	Description
3000-01	Flange Mount Heavy-Duty Resolver, 90 deg Connector, IP65 Sealed
3000-02	Flange Mount Heavy-Duty Resolver, straight Connector, IP65 Sealed
3000-07	Flange Mount Heavy-Duty Encoder (1024 PPR), 90 deg Connector, IP65 Sealed
3000-08	Flange Mount Heavy-Duty Encoder (1024 PPR), Straight Connector, IP65 Sealed
3000-09	Flange Mount Heavy-Duty 10 Turn Resolver, IP65 Sealed
3000-10	Flange Mount Heavy-Duty 100 Turn Resolver, IP65 Sealed
3000-11	Flange Mount Heavy-Duty 10,000 Turn Resolver, IP65 Sealed
4000-025	Resolver Cable, 25 foot
4000-050	Resolver Cable, 50 foot
4000-100	Resolver Cable, 100 foot
4006-025	Encoder Cable, 25 foot
4006-050	Encoder Cable, 50 foot
4006-100	Encoder Cable, 100 foot
4008-025	Absolute Resolver Cable, 25 foot
4008-050	Absolute Resolver Cable, 50 foot
4008-100	Absolute Resolver Cable, 100 foot

Table 1-1: Feedback Mode – Resolvers, Encoders, Cables

1.7.2. 2-Axis Motion Control Module

This application controls 2 servo motors. The module can take either resolver or encoder feedback for each axis and outputs either a 10Vdc command signal or a 3-phase torque command signal (to control Schneider 3-phase Cyberline Drives). The IFC 022 Module can easily perform complex motion functions using the loadable function block that I2T has developed. All motion programming is done via PLC logic. The following is a list of some of the motion functions available in the module.

- Blended Moves
- High-speed Registration
- Input Position Latching
- Programmable Limit Switch Function
- Move Table with 16 Move Profiles
- High-speed PID Control
- Cam Table Profile Functions

The following is a list of I^2T resolvers, encoders, and cables that are compatible with the module when using servo control mode.

Part No.	Description
BM75E	Servo Motor, NEMA 23, 75 oz-in, MS Conn, 1000 Line Encoder
BM130E	Servo Motor, NEMA 23, 130 oz-in, MS Conn, 1000 Line Encoder
BM200E	Servo Motor, NEMA 23, 200 oz-in, MS Conn, 1000 Line Encoder
BM250E	Servo Motor, NEMA 34, 260 oz-in, MS Conn, 1000 Line Encoder
BM500E	Servo Motor, NEMA 34, 510 oz-in, MS Conn, 1000 Line Encoder
BM800E	Servo Motor, NEMA 42, 780 oz-in, MS Conn, 1000 Line Encoder
BM1400E	Servo Motor, NEMA 42, 1365 oz-in, MS Conn, 1000 Line Encoder
BM2000E	Servo Motor, IEC, 130 in-lb, MS Conn, 1000 Line Encoder
BM3400E	Servo Motor, IEC, 210 in-lb, MS Conn, 1000 Line Encoder
BM4500E	Servo Motor, IEC, 280 oz-in, MS Conn, 1000 Line Encoder
BA10	Servo Amplifier, 5A Cont, 10A Peak, 120 Vac
BA20	Servo Amplifier, 10A Cont, 20A Peak, 120 Vac
BA30	Servo Amplifier, 15A Cont, 30A Peak, 120 Vac
BA50	Servo Amplifier, 25A Cont, 50A Peak, 230 Vac, 3-phase
BA75	Servo Amplifier, 37A Cont, 75A Peak, 230 Vac, 3-phase
BA100	Servo Amplifier, 50A Cont, 100A Peak, 230 Vac, 3-phase
PFC-xx	Cable, Encoder to Amplifier
PMC-xx	Cable, Amplifier to Motor for BM75, BM130, BM200, BM250
PMC1-xx	Cable, Amplifier to Motor for BM500, BM800, BM1400
PMC2-xx	Cable, Amplifier to Motor for BM2000, BM3400, BM4500
BAC2-3	Cable, Controller to Amplifier, 3 Foot

Table 1-2: Servo Control Mode –Resolvers, Encoders, Cables

In this Chapter you will learn about:

Product Description

Product Features

Hardware Block Diagram

2.1. Product Description

The IFC 022 Intelligent Feedback & Control is a single-wide Quantum PLC module that provides two channels of resolver/encoder feedback and control. The module has been built using the latest hardware components and surface mount technology and is certified by Schneider Electric (previously Modicon), to be a ModConnect product.

The IFC 022 can operate in one of three modes described in *Table 2-1*.

Mode	Description
1	Velocity & Position Feedback with Software Limit Switch.
2	PID Mode to do analog velocity tension control using resolver position or analog feedback. A high-speed on-board PID loop is updated as fast as 1 millisecond.
3	Positioning Mode to position DC, Flux Vector or Servo Drives with resolver or encoder feedback. A set of 16 position, speed, accel and decel registers are used to make moves from the PLC.

Table 2-1: Operational Modes of the IFC 022

To provide additional control features, the IFC 022 design includes 2 channels of resolver or encoder input, along with analog inputs, analog outputs, discrete inputs and discrete outputs.

The IFC Module can be configured by using the IFC Setup Software that is supplied with the module. This software package runs on any IBM compatible computer running Windows. The module configuration data is entered via the PC and downloaded to the module via the programming port on the front of the module. The configuration data is stored in Flash memory in the IFC Module so that data is maintained during a power loss.

A loadable function block has been developed for use with the IFC 022 to make programming the module easy. *Chapter 5* provides a detailed description of the user loadable.

The loadable function block provides eight functions described in *Table 2-2*.

Function	Description
0	Get Loadable Version
1	Read Position, Velocity and Status
2	Home Axes
3	Point to Point Moves
4	Download Move Tables
5	Move Execute
6	Copy Setup Data from the Module to the PLC
7	Copy Setup Data from the PLC to the Module

Table 2-2: Functions of the Loadable Function Block

2.1.1. Function 0 – Get Loadable Version

Returns the version of the loadable.

2.1.2. Function 1 – Read Position, Velocity and Status

Allows the IFC 022 to write position, velocity and diagnostic information directly into user-defined PLC registers.

2.1.3. Function 2 – Home Axes

Allows Axis 1 and/or Axis 2 to initiate a homing sequence. The user loads the appropriate PLC registers with the speed and direction of the homing move. The module then begins to search for its digital inputs. Once the input is detected, the module will move to the next resolver null or marker pulse and set its position to zero or the home offset position.

2.1.4. Function 3 – Point to Point Moves

Point-to-Point moves are accomplished by loading the appropriate registers of the loadable function block with the desired position, speed, acceleration and deceleration of the move. An additional register in the function block specifies the move as absolute, relative negative or relative positive.

2.1.5. Function 4 – Download Move Table

Allows for 16 move table entries to be loaded to the module. Each table entry contains a position, velocity, acceleration and deceleration. Once the table has been loaded to the module, a move can be initiated by using Function 5 below.

2.1.6. Function 5 – Move Execute

By setting bits in a register from the PLC, any of the 16 move positions can be executed. A corresponding bit will be set in another PLC register when the move has been completed.

2.1.7. Function 6 – Copy Setup Data from the Module to the PLC

Copy the IFC 022's setup data to the PLC. The setup data can then be downloaded to a new module without using the MMI software.

2.1.8. Function 7 – Copy Setup Data from the PLC to the Module

Copies setup data to the IFC 022 that was previously saved using Function 6.

2.2. Product Features

The IFC 022 Module incorporates many features. Each feature is described below.

2.2.1. Module Type

Quantum PLC compatible 2 Channel Feedback & Control.

2.2.2. Resolution

Resolvers are 4096 counts/rev where encoder resolution can range from 100 to 100,000 counts per revolution. With this feature the user may convert resolver counts to user units for use in the PLC. The module will count position up to 655,350,000 depending on user units.

2.2.3. Information Throughput

Reads position and calculates velocity every 500 microseconds. Presents data to PLC every scan.

2.2.4. Tracking Rate

Uses the latest R-to-D Tracking Converter and provides 375 Revolutions per Second Maximum Tracking Rate. The maximum encoder pulse input rate is pulses per second.

2.2.5. Feedback Type

Resolver: The user may use any transmit type resolver. Although it is the responsibility of the purchaser to ultimately choose which type of resolver to use, we recommend an I^2T brushless resolver to ensure the best possible performance. Auto voltage referencing circuit allows use of different resolvers with varying cable lengths and transformation ratios on each channel.

Encoder: Quadrature with from 100 to 100,000 pulses per revolution.

2.2.6. Discrete Inputs

One 10 to 30Vdc input per Resolver Channel can be used for axis referencing or position latching.

2.2.7. Discrete Outputs

One 12 or 24Vdc sourcing or sinking output per Resolver Channel can be used for high-speed control of devices based on resolver position.

2.2.8. Analog Inputs

One ±10Vdc input per channel can be used for input to a fast PID for tension or dancer control.

2.2.9. Analog Outputs

Two analog outputs per channel can be used as input to a DC Variable Frequency or Flux Vector drive for velocity control. The user can set the analog output to ±10Vdc, 0 to 10Vdc or 0 to 5Vdc operation via software setup.

2.2.10. Parameter Storage

Provides On-board Flash Memory.

2.2.11. External Voltage Requirements

External ±12Vdc @ 1.7 amps must be supplied by the customer.

2.2.12. Environmental Conditions

- Operating Temperature: 0 to 60°C
- Relative Humidity: 5 to 95 % (non-condensing)
- Storage Temperature: -40 to 85 °C

2.3. Hardware Block Diagram

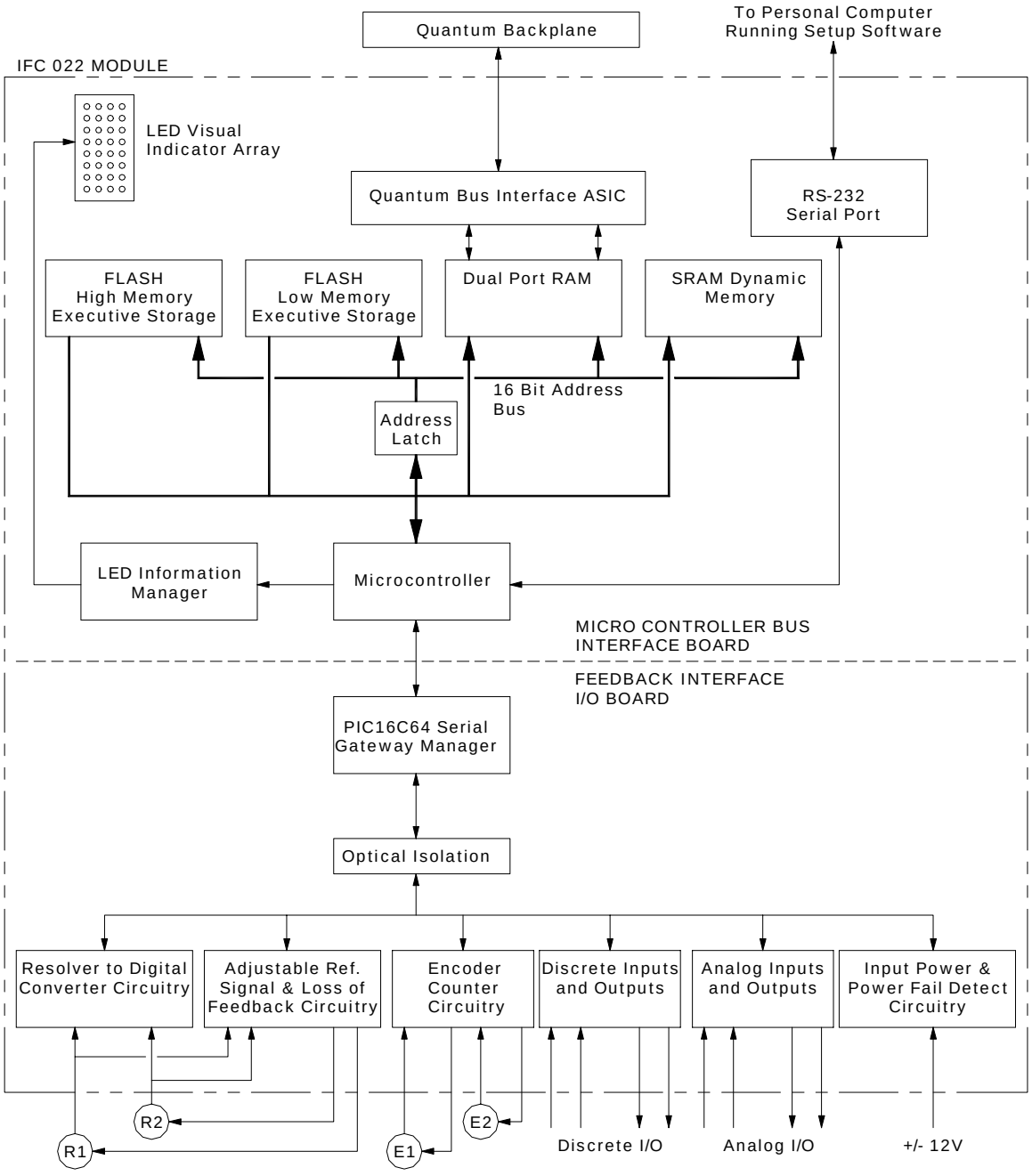


Figure 2-1: IFC 022 Module Block Diagram

The IFC 022 provides two channels of 12-bit resolver feedback differential amplifiers for maximum noise immunity. There is also an auto voltage referencing circuit that adjusts the resolver signal strength to provide minimum error rates for each channel. The auto voltage referencing circuit adjusts the reference signal to each resolver so that a 2 Volt RMS sine and cosine signal are returned from the resolver. This feature allows resolvers with a wide variety of transformation ratios to be connected to the module.

The resolver position and velocity are sampled by the module 2,000 times every second. Module data is presented to the PLC each scan, with the new information being the last value read. This means that the maximum throughput time for the readings is 500 microseconds plus 1 PLC scan time. User units can be used so that numbers are presented to the PLC in the units being used on the machine.

In this Chapter you will learn about:

- Inspecting the Shipment
- Typical System Components
- List of Components
- Installation Precautions
- Panel Layout
- IFC 022 System Wiring

3.1. Inspect the Shipment

Check your IFC 022 packages, upon receipt, for obvious damage that may have occurred during shipment. Report any damage to the shipping company immediately. I^2T cannot be held responsible for damage incurred during shipment. Along with your IFC 022 Quantum Intelligent Feedback & Control Module (P/N 1002-01), the following parts should be included:

- Windows Setup Software (P/N 2000-03)

In addition, one of the following must be ordered

- 50-pin Non-absolute Breakout Module (P/N 6000-01)

  - or -

- 76-pin 100 Servo Breakout Module (P/N 6000-04)

Retain the shipping container in case you need to return the IFC 022 for any reason. Any damage incurred due to improper packing is the responsibility of the shipper and will further delay the repair or replacement of your parts. Resolvers, resolver cables and programming cables are shipped in separate containers. These items must also be inspected for damage as they are received. *Figure 3-1* shows a diagram of the parts necessary to setup and operate a typical IFC 022 control system.

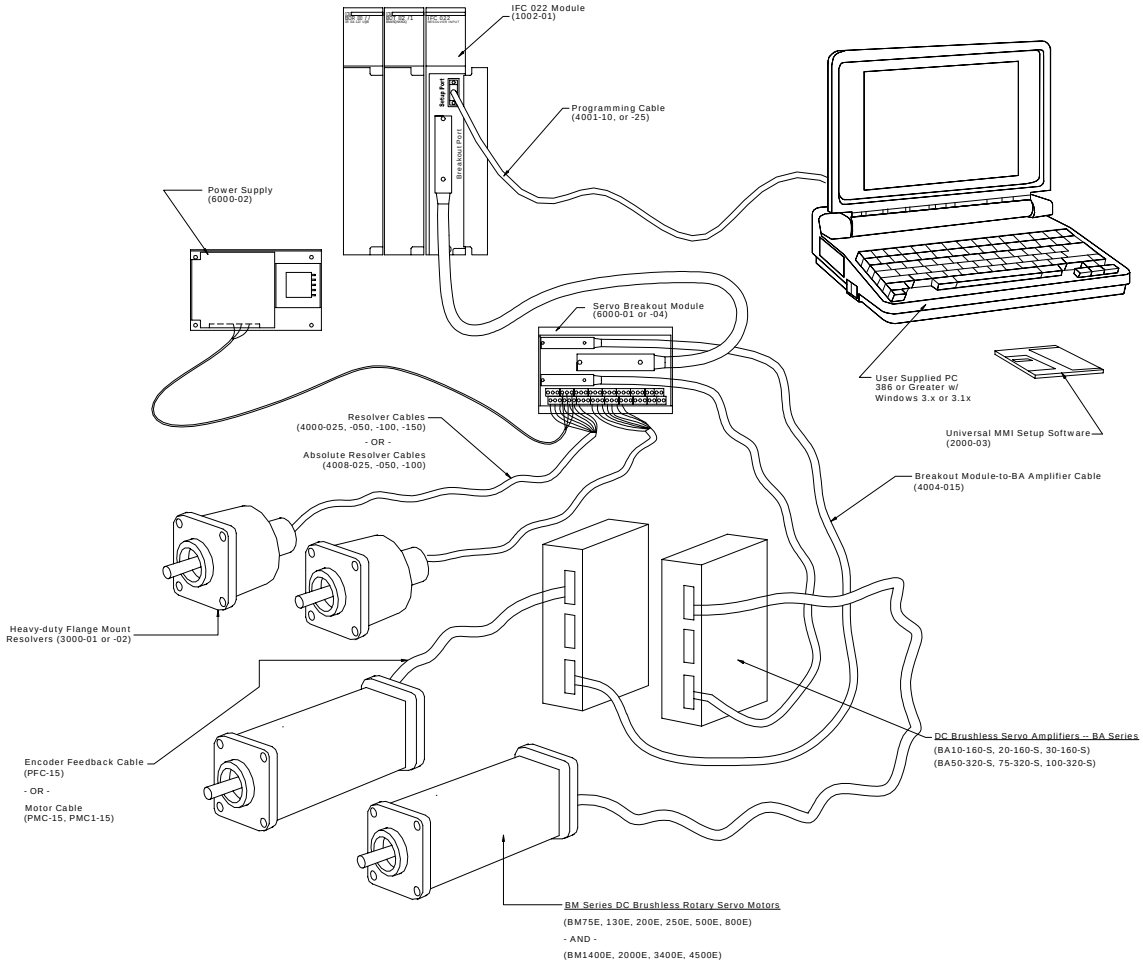


Figure 3-1: Typical Servo Control System

3.2. Components of a Typical System

Refer back to *Table 1-1* and *Table 1-2* for a complete list of components that I²T can supply to make a complete IFC 022 resolver control system.

3.3. Installation Precautions

Before installing the IFC 022 there are several precautions to take. If for any reason, you are unsure about the system design, call your distributor or I²T technical assistance before completing your design.

3.3.1. Electrical Noise

Minimize the possibility of electrical noise before you install your IFC 022. By observing the following installation precautions, you can prevent electrical noise problems.

CAUTION ☞ Do not route high-voltage wires and low level signals in the same conduit. Always run the resolver cables in their own conduit or with other low-level signals.

Ensure that all components are properly grounded.

Ensure that all wiring is properly shielded. All shields should only be tied to the earth ground pin on the breakout module. This terminal must then be tied to a good earth ground.

Always use twisted-pair shielded cables when running signals.

Always use isolated circuits for remote signals. Use isolated analog and digital signals when possible.

Never cut the resolver cables to land on a terminal strip. Always run the resolver cables from the resolver directly to the IFC 022 breakout module. This will keep the shielding scheme intact and minimize the possibility of creating ground loops.

Put surge suppression components on all electrical coils: Resistor/Capacitor filters, MOVs, Zener and clamping diodes.

3.3.2. Heat & Humidity

All PLC equipment should be housed in an enclosure that will prevent exposure to dirt, dust, liquids and harsh environments. To ensure personal safety and long life of the IFC 022, pay special attention to the following environmental conditions:

NOTE **Always operate the IFC 022 at an ambient temperature between 0 and 60°C.**

Always store the IFC 022 at an ambient temperature between -40 and 85°C.

Maintain a relative humidity below 95% (non-condensing).

3.4. Panel Layout

The IFC 022 should be installed in an enclosure that will protect it from atmospheric contaminants such as oil, metallic particles, moisture and dirt. The National Electrical Manufacturers Association (NEMA) established standards that define the degree of protection that electrical enclosures provide. The enclosure that you use for PLC equipment should, as a minimum, conform to a NEMA 12 standard.

The IFC 022 can be mounted in any Quantum PLC local or remote I/O slot. The IFC 022 Module draws 5V @ 300 mA from the Quantum PLC backplane. Add this to the power requirements of the rest of the modules in the I/O rack to avoid exceeding backplane or PLC power supply capabilities. An external ±12Vdc power supply capable of delivering 1.7A must be supplied by the customer. This 1.7A supply is available from I²T (P/N 6000-02). The ±12Vdc is used to drive the resolvers and for digital I/O and analog I/O. This voltage is completely isolated from the PLC backplane to protect the other equipment in the PLC rack. The IFC module communicates with the Quantum processor directly over the backplane, so no external wiring between the module and the processor is required. When performing your panel layout, locate the IFC Breakout Module as close as possible to the bottom of the IFC Module to avoid noise problems. A three (3) foot breakout cable is supplied with the module, so the breakout module must be located within 2-1/2 feet of the module. The signals on the breakout module are low-level signals, so care should be taken not to run high-voltage cables near the module.

There are two breakout modules to choose from for your servo application. The first breakout (P/N 6000-01) is a 50-connection, screw type terminal block that accepts 22 to 12 gauge wire. The other breakout module (P/N 6000-04) is a 76-pin connection. Both breakout modules can be DIN rail mounted or mounted directly to the panel. Dimensions of the cable and breakout modules required for panel mounting are illustrated in *Figure 3-2.*

NOTE **Due to the EMI generated by power switching devices, any devices mounted in the same control panel as the IFC 022 should be located as far away as possible from PLC equipment and should have surge-suppressing devices installed on their terminals. This includes motor contactors, motor starters and relays.**

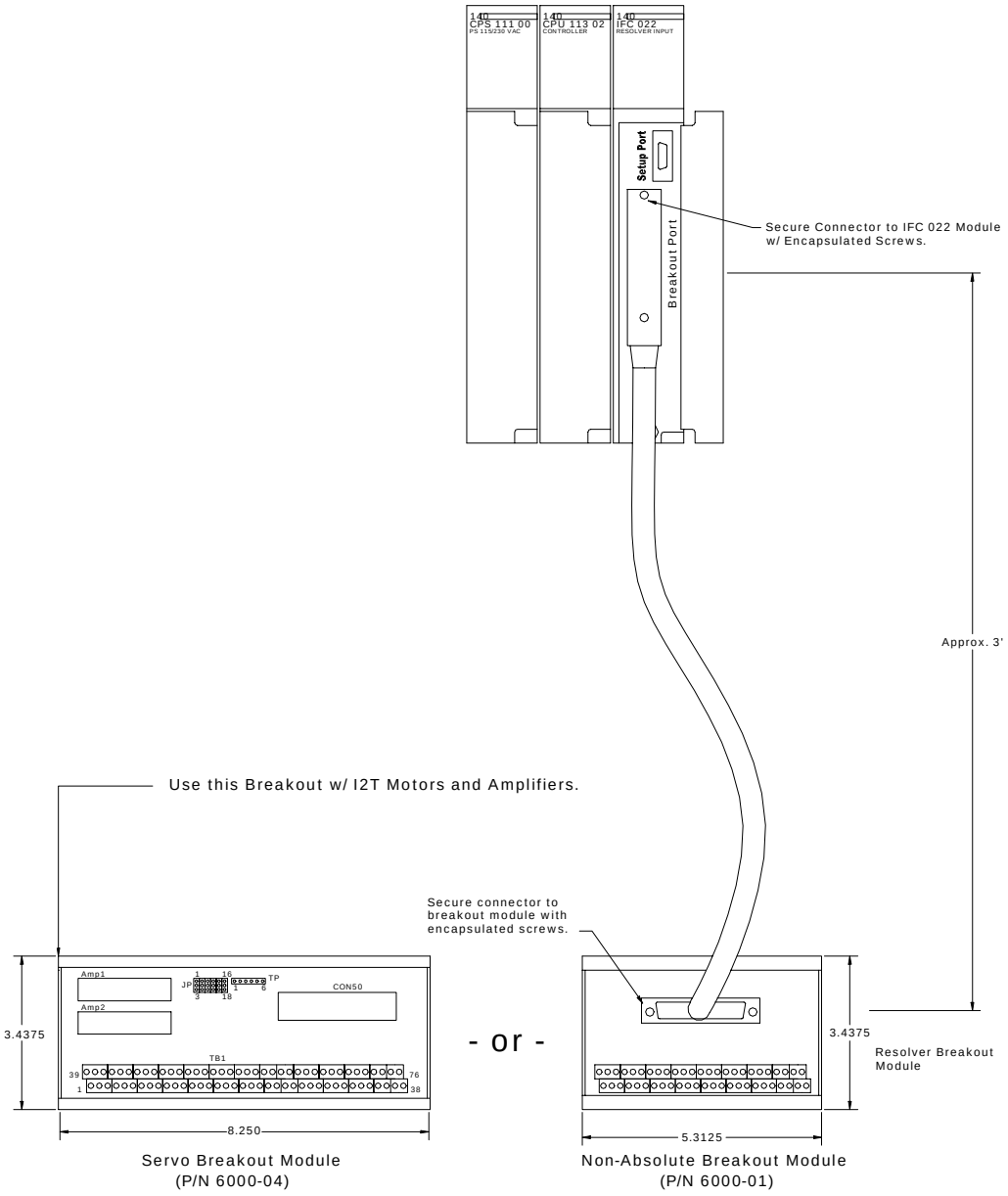


Figure 3-2: Panel Mounting of the Cable and Breakout Modules

3.5. Resolver Mounting

Resolvers available from I²T are flange mount type. For styles of resolvers, refer to *Appendix B* of this manual.

When controlling a piece of equipment, your mechanical system should be as stiff as possible. Ideally, the resolver shaft should be mounted directly to the part of the machine to be monitored or controlled. Should it be necessary to interface the resolver through a gearbox, an anti-backlash gearbox should be used to minimize the amount of error introduced.

To minimize introduced noise, run the resolver cable in its own conduit, away from any high power cables. Resolver cables are available from I²T in 25, 50 and 100 foot lengths. To build your own resolver cables, Belden 9730 or exact equivalent cable must be used and the shields must be terminated to a ground pin on the breakout module. Do not terminate the shields at the resolver end of the cable. Resolver cable lengths should not exceed 100 feet. The resolver cable connects to the resolver using a military-style connector, Part No. MS-3106A16S-1S. A drawing of the resolver cable is shown in *Appendix B.* To avoid problems, wire the resolver cable exactly as shown in the drawing.

3.6. Breakout Module Connections

This section describes the customer connections required between the field devices and the IFC 022 Breakout Module. All connections will be made to the 50-pin breakout module. *Table 3-2* provides a list of these connections.

NOTE **The earth ground terminal on the breakout module must be tied to a good earth ground. All shields must be tied to this point. Do not tie shields to the power supply ground on pins 23 and 24 to the breakout module.**

Pin	Signal Name	Description	Pin	Signal Name	Description
1	REF 1+	Resolver Channel 1 Reference +	26	ENC1 A+	Axis 1 Encoder A+ Channel
2	REF 1-	Resolver Channel 1 Reference -	27	ENC1 A-	Axis 1 Encoder A- Channel
3	COS 1+	Resolver Channel 1 Cosine +	28	ENC1 B+	Axis 1 Encoder B+ Channel
4	COS 1-	Resolver Channel 1 Cosine -	29	ENC1 B-	Axis 1 Encoder B- Channel
5	SIN 1+	Resolver Channel 1 Sine +	30	ENC1 Z+	Axis 1 Encoder Z+ Channel
6	SIN 1-	Resolver Channel 1 Sine -	31	ENC1 Z-	Axis 1 Encoder Z- Channel
7	REF 2+	Resolver Channel 2 Reference +	32	ENC2 A+	Axis 2 Encoder A+ Channel
8	REF 2-	Resolver Channel 2 Reference -	33	ENC2 A-	Axis 2 Encoder A- Channel
9	COS 2+	Resolver Channel 2 Cosine +	34	ENC2 B+	Axis 2 Encoder B+ Channel
10	COS 2-	Resolver Channel 2 Cosine -	35	ENC2 B-	Axis 2 Encoder B- Channel
11	SIN 2+	Resolver Channel 2 Sine +	36	ENC2 Z+	Axis 2 Encoder Z+ Channel
12	SIN 2-	Resolver Channel 2 Sine -	37	ENC2 Z-	Axis 2 Encoder Z- Channel
13	FWD AX1	Forward Input Axis 1	38	SIGNAL COM AX1	COM 1
14	REV AX1	Reverse Input Axis 1	39	HOME AX1	Home Input Axis 1
15	FAULT AX1	Fault Input Axis 1	40	HOME AX2	Home Input Axis 2
16	FWD AX2	Forward Input Axis 2	41	SIGNAL COM AX2	COM 2
17	REV AX2	Reverse Input Axis 2	42	AMP ENABLE AX1	Amplifier Enable Axis 1
18	FAULT AX2	Fault Input Axis 2	43	AMP ENABLE AX2	Amplifier Enable Axis 2
19	+TORQ CMD AX1 / ICMDA AX1	Positive Torque Command – Axis 1, Current Command A – Axis 1	44	+ANALOG IN AX1	Positive Analog Input Axis 1
20	ICMDB AX1	Current Command B – Axis 1	45	-ANALOG IN AX1	Negative Analog Input Axis 1
21	+TORQ CMD AX2 / ICMDA AX2	Positive Torque Command – Axis 2, Current Command A – Axis 2	46	+ ANALOG IN AX2	Positive Analog Input Axis 2
22	ICMDB AX2	Current Command B – Axis 2	47	- ANALOG IN AX2	Negative Analog Input Axis 2
23	SIGNAL COMMON	Input Common	48	+12VDC EXTERNAL	+12Vdc Input (customer supplied)
24	SIGNAL COMMON	Input Common	49	-12VDC EXTERNAL	-12Vdc Input (customer supplied)
25	NC		50	NC	No Connection

Table 3-1: Breakout Module Connections

3.7. Resolver Connections

Table 3-2 provides a list of the resolver connections.

Pin	Signal Name	Description
1	REF 1+	Resolver Channel 1 Reference +
2	REF 1-	Resolver Channel 1 Reference -
3	COS 1+	Resolver Channel 1 Cosine +
4	COS 1-	Resolver Channel 1 Cosine -
5	SIN 1+	Resolver Channel 1 Sine +
6	SIN 1-	Resolver Channel 1 Sine -
7	REF 2+	Resolver Channel 2 Reference +
8	REF 2-	Resolver Channel 2 Reference -
9	COS 2+	Resolver Channel 2 Cosine +
10	COS 2-	Resolver Channel 2 Cosine -
11	SIN 2+	Resolver Channel 2 Sine +
12	SIN 2-	Resolver Channel 2 Sine -

Table 3-2: Resolver Connections

The IFC 022 accepts a transmit-type resolver. To minimize position errors, I²T recommends the use of their resolvers. The IFC 022 sends a 5 kHz sinusoidal reference signal to the resolver, a sine and cosine signal are generated by the resolver and returned to the module. The cosine signals vary with the position of the shaft of the resolver. A tracking resolver to digital (R to D) converter on the module converts the sine and cosine signals to a 12-bit position value.

To read accurate, jitter-free position values from the IFC module, the resolver sine, cosine and reference signals must be kept clear of electrical noise. This is done by running the resolver wiring away from high-voltage signals and by using shielded twisted-pair cable for resolver signals. I²T has designed the IFC module with balanced inputs for the resolver signals. This method requires more wires going to the resolver, but it also provides better noise immunity than single-ended designs. For a typical resolver wiring diagram, see *Appendix B.*

To avoid potential noise problems, resolver shields must be tied to the earth ground pin on the breakout module. Do not tie the shields to the power supply common.

If the electrical environment is extremely noisy, it may be necessary to bypass the resolver signals at the breakout module. Do this by placing 0.1µF / 25V capacitors directly across the ref, sine and cosine signal pairs of the resolver experiencing noise problems.

The following is a list of the limit switch connections to the standard IFC 022 (P/N 1101-01). A 12Vdc power supply must be connected to the IFC 022 for isolation voltage generation. You may also use this power supply to feed voltage to the over-travel and home-limit switches. I²T can supply a 12Vdc power supply (P/N 6100-01) for the limit switch voltage. It is necessary to connect a normally closed (N.C.) type of limit switch to the forward and reverse limit switch pins for Axis 1 and 2. This is a Fail Safe connection that faults the axes in the event continuity is broken in this circuit. You may connect a normally closed (N.C.) or normally open (N.O.) limit switch to the home limit switch pin.

3.7.1. Encoder Connections

Table 3-3 identifies the encoder connections of the IFC 022.

Pin No.	Signal Name	Description
26	ENC 1 A+	Channel 1 Encoder Input A
27	ENC 1 A-	Channel 1 Encoder Input A not
28	ENC 1 B+	Channel 1 Encoder Input B
29	ENC 1 B-	Channel 1 Encoder Input B not
30	ENC 1 C+	Channel 1 Encoder Input C
31	ENC 1 C-	Channel 1 Encoder Input C not
32	ENC 2 A+	Channel 2 Encoder Input A
33	ENC 2 A-	Channel 2 Encoder Input A not
34	ENC 2 B+	Channel 2 Encoder Input B
35	ENC 2 B-	Channel 2 Encoder Input B not
36	ENC 2 C+	Channel 2 Encoder Input C
37	ENC 2 C-	Channel 2 Encoder Input C not

Table 3-3: Encoder Connections

3.7.2. Analog Inputs

Table 3-4 defines the analog input signals.

Pin No.	Signal Name	Description
44	AN IN 1+	Analog Input 1 +
45	AN IN 1-	Analog Input 1 -
46	AN IN 2+	Analog Input 2 +
47	AN IN 2-	Analog Input 2 -

Table 3-4: Analog Inputs

The IFC 022 provides two channels of ±10Vdc analog input. These inputs are 12-bit and can be read directly by the PLC as analog inputs or used as an input to the fast PID loop on the IFC module. You can connect analog transducers that have either differential or single-ended outputs. However, a differential output will provide better immunity to electrical noise than a single-ended output. For best results, use a device with differential output.

3.7.3. Analog Outputs

A description of each analog output can be found in *Table 3-5* below.

Pin No.	Signal Name	Description
19	+TORQ CMD AX1/ICMDA AX1	Positive Torque Command – Axis 1, Current Command A – Axis 1
20	ICMDB AX1	Current Command B – Axis 1
21	+TORQ CMD AX2/ICMDA AX2	Positive Torque Command – Axis 2, Current Command A – Axis 2
22	ICMDB AX2	Current Command B – Axis 2
23	SIGNAL COMMON	Output Common
22	SIGNAL COMMON	Output Common

Table 3-5: Analog Outputs

The IFC 022 provides two channels of ±10Vdc analog output for each axis at a maximum current of 1 Amp. These outputs are 12-bit and can be set directly by the PLC as analog outputs or used as an output from the fast PID loop on the IFC module to control processes. Through the IFC Setup Software (see *Chapter 4*) you set the analog outputs to operate at ±10Vdc, 0 to 10Vdc or 0 to 5Vdc.

3.7.4. Discrete Inputs

Four discrete inputs are defined in *Table 3-6.*

Pin No.	Signal Name	Description
13	FWD AX1	Forward Input Axis 1
14	REV AX 1	Reverse Input Axis 1
15	FAULT AX1	Fault Input Axis 1
16	FWD AX2	Forward Input Axis 2
17	REV AX2	Reverse Input Axis 2
18	FAULT AX2	Fault Input Axis 2
38	SIGNAL COM AX1	Input Common Axis 1
39	HOME AX1	Home Input Axis 1
40	HOME AX2	Home Input Axis 2
41	SIGNAL COM AX2	Input Common Axis 2

Table 3-6: Discrete Inputs

The IFC 022 provides eight 10 to 30Vdc discrete inputs on the module. If a pull-up resistor is required, it must be added by the user. If the field device supplies voltage, then pull-up resistors are not required.

3.7.5. Discrete Outputs

Table 3-7 describes the discrete outputs associated with the IFC 022 Module.

Pin No.	Signal Name	Description
42	AMP ENABLE AX 1	Amplifier Output Enable Axis 1
43	AMP ENABLE AX 2	Amplifier Output Enable Axis 2

Table 3-7: Discrete Outputs

The IFC provides two discrete outputs capable of sourcing or sinking up to 1 Amp. These outputs can be set directly by the PLC, or be set by the module to indicate that an over-speed condition or a fault has occurred. These outputs can also be used to control an external device based on resolver position, similar to a programmable limit switch.

3.7.6. External ±12Vdc Supply

Table 3-8 provides a list of the external ±12Vdc supply signals.

Pin No.	Signal Name	Description
48	+12Vdc IN	+12Vdc Input (customer supplied)
23, 24	SIGNAL COM	Common (customer supplied)
49	-12Vdc IN	-12Vdc Input (customer supplied)

Table 3-8: External ± 12Vdc Supply

An external ±12Vdc @ 1.7A must be supplied by the customer to the module. This power supply is available from I²T as an option. The power supply voltage is isolated from the PLC backplane and is used to generate the resolver signals and for the field I/O signals.

The minimum power supply requirements are:

+12V @ 300 mA

-12V @ 100 mA

If an application does not require any analog or digital I/O, the minimum power supply is adequate. Current requirements for external I/O services such as relays or lamps should be added to the minimum power supply requirements to determine the size of the supply suitable for the application.

In this Chapter you will learn about:

Software Installation

Running the Setup Software

Using the Setup Software

4.1. Software Installation

Before attempting to install the 32-bit universal HMI Setup Software on your computer, verify that your system meets the following requirements.

- Pentium 90 or higher
- Microsoft Windows 95, 98, NT, 2000 or XP
- 8 MB of RAM or higher
- 12 MB Hard Disk (free space) or higher
- CD-ROM drive
- VGA Monitor or higher

The Universal HMI Setup Software (P/N 2000-03) is used to configure the IFC 022 during installation. I²T includes this Setup Software with the IFC 022 Quantum I/O Base Servo Control Module on an *Install* CD.

This *Install* CD can install the following applications:

HMI Setup Software, MPL Development Environment, PLS Interface Software.

Also, Firmware and Loadables for all I²T Modules.

The following procedure explains how to install the Universal HMI Setup Software onto your hard disk:

1. Insert the *Install* CD into the CD-ROM drive.
2. If your system supports the auto-run feature, installation will start automatically.

   If your system does not support the auto-run feature, select **Start** on the task bar, select **Run**, then enter the letter of the CD-ROM drive and the word Install.exe (example: D:\Install.exe).
3. Follow the instructions as they appear.

4.2. Running the Setup Software

Before proceeding, you must have successfully completed the software installation described in *Section 4.1*.

Next, connect your PC to the IFC 022 Quantum I/O Base Servo Control Module using an I²T Modbus Programming Cable (P/N 4001-10). For a detail drawing of this cable, see *Appendix B*.

4.2.1. Windows 95/98/NT/2000/XP Startup

To begin running your IFC 022, start Windows 95, 98, NT, 2000 or XP and double click on the I²T "HMI Setup Software" icon that was previously installed on the Windows desktop during the installation.

The software automatically establishes the baud rates and serial port parameters to match your IFC 022 module.

To verify that your PC is communicating with the IFC 022, check to see if the #2 Green LED (Top Row) is flashing on the front of the module and that the computer screen indicates "I²T Module Interface - Connected to IFC 022 Quantum I/O Base Servo Control Module".

Another way of verifying communications is that the icons on the software tool bar change from gray to color

4.3. Using the Setup Software

Help files were placed on your hard drive during the install procedure in section 4.1. Please refer to these files for details on using the Universal HMI Setup Software and for a listing of the command packets used to communicate with the IFC 022 module.

To access the help files simply press the **F1** key or use the **Help** Pull-down Menu and select **Help Topics**.

NOTE ☝ **Once you finish setting up the IFC 022 parameters, Copy them to Flash (under the *Module* Pull-down Menu) Memory so they will not be lost during power-down.**

NOTE ☝ **Any Windows Setup Software function described in the *Help Topics* can also be done in real-time by issuing commands from the PLC. The IFC 022 uses a User Loadable Function Block (FN43) to make programming the module easy. If your PLC programming software requires that you have the loadable in a specific directory, you must copy the FN43.dat file to that directory**

In this Chapter you will learn about:

PLC Configuration

Using User Loadable

5.1. PLC Configuration

The following section explains how to setup the PLC configuration and traffic cop (I/O configuration) for the IFC 022 Module. The IFC 022 comes with a User Loadable Function Block on two 3½" Windows setup diskettes. The user loadable (FN43) has the following modes of operation:

Mode 0. Get Loadable Version

Mode 1. Position, Speed, Status and Programmable Limit Monitor Mode

Mode 2. Two Axis Homing Mode

Mode 3. Two Axis Point-to-Point Move Profile Mode

Mode 4. Sixteen-Point Download Move Table Mode

Mode 5. Sixteen-Point Execute Move Table Mode

Mode 6. Copy Setup Data to PLC

Mode 7. Copy Setup Data to IFC 022

The eight modes of operation are described later in this chapter. You can program the IFC 022 with or without using the FN43 User Loadable. This loadable has been designed to make the module easy to use for the above modes of operation. If one of the above modes of operation can control the user application, install the FN43 User Loadable using either Modsoft or the Taylor PLC programming software. Please refer to your PLC programming software for the proper installation procedure of user loadables.

5.1.1. Traffic-Copping the Module

Knowledge of programming Quantum Programmable Controllers is critical to properly install and program the IFC 022. The procedures described in this section may vary based on the type of programming software that you are using. Once the FN43 User Loadable is installed, traffic-cop the IFC 022 as follows.

HEAD: 00	**DROP: 01**	**RACK: 02**	**RACK OVERVIEW**		**HUT:00003**	**PORT:00**
Slot	Card	Bus mA	Reference Numbers		DESCRIPTION	
101	MSB101-00	1200	30001-30006	40001-40006	Motion Enc	
102						
103						
104						
105						
106						
107						

Verify the IFC 022 Module is traffic-copped as a MSB101 Motion Module using six (6) 3XXXX registers and six (6) 4XXXX registers. The IFC 022 can reside in any slot in the Quantum rack, but the traffic cop configuration must match the actual location of the module. The above example assumes that the IFC 022 Module resides in Drop 1, Rack 2, Slot 1. Once traffic-copping is complete and the PLC placed in the run mode, ensure that the health of the module is OK by checking the following:

1. Ensure that the IFC 022 Module Active light is on and the watchdog LED flashing (Green Status LED 1).
2. Ensure that the following Fault LEDs segments are not on.
    - Resolver Board Watchdog Error (Red Fault LED 1)
    - Serial Comm Error (Red Fault LED 2)
    - PLC Comm Error (Red Fault LED 3)
    - Data Corrupted Error (Red Fault LED 4)
3. Log on to the Quantum processor with your programming software and make sure that the IFC 022 Module Health Bit is okay.

The module is now ready for programming.

5.1.2. Configuring the IFC 022

The IFC 022 contains default setup information established at the factory. To use the IFC 022 with your mechanical configuration, you must first configure the module using the IFC 022 Windows Setup Software provided. Configuring the module via the Windows Setup Software package is described in *Chapter 4*. After you have configured the module, write the configuration data to Flash RAM for storage. The configuration data is read from the Flash RAM on each subsequent power-up of the module. It is only necessary to change the configuration data when a mechanical part of the system changes, such as a gear ratio. To save the configuration to Flash RAM, select **Setup->FLASH** under the **Comm** menu of the IFC 022 Setup Software.

5.2. Using the User Loadable

As stated earlier, the FN43 User Loadable has eight different modes of operation, which are selected by putting the Function # in the first node of the FN43. Each operating mode is described in detail below.

5.2.1. Mode 0 – Get Loadable Version

Mode 0 returns the version of the loadable. *Figure 5-1* shows the Mode 1 operation of the FN43 User Loadable.

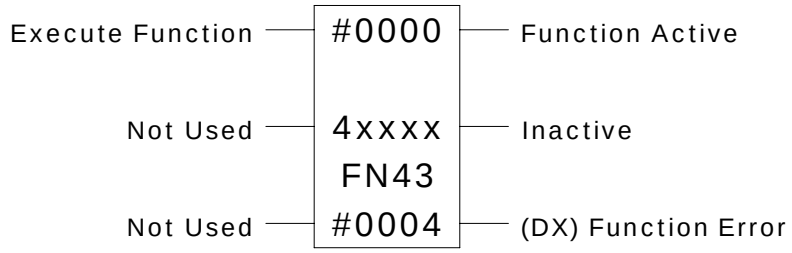


Figure 5-1: Get Loadable Version Operation of FN43

The top output indicates the module is active. This output should always be on when input power is applied to the top input. The middle is not used.

The bottom output indicates a DX Function Fault. This fault condition indicates incorrect node information.

This function returns the loadable version in the first register specified in FN43 block.

5.2.1.1. Mode 0 - PLC Read/Reserved Registers

Below in *Table 5-1* is a list of the read registers associated with Mode 0.

Register	Description
Read Registers	
4XXXX+0	Loadable Version
4XXXX+1	Reserved for Internal Use
4XXXX+2	Reserved for Internal Use
4XXXX+3	Reserved for Internal Use

Table 5-1: Mode 0 - PLC Read/Reserved Registers

5.2.2. Mode 1 - Position/Speed Monitor

Mode 1 allows the PLC program to monitor the position and speed of both resolvers in user units. This mode also allows the PLC program to monitor the status of each Resolver Channel such as faults, discrete and analog input status, and software programmable limit states. In this mode, the PLC program can turn on and off the discrete output of each channel as well as setting the value of each analog output from 0 to 4095. This analog value sets the voltage of the analog output to the range (i.e., 0-10Vdc, ±10Vdc or 0-5Vdc) selected in the **Axis** screen of the IFC 022 Windows Setup Software. See *Chapter 4* for more information on using the IFC 022 Setup Software. The FN43 User Loadable makes it easy for the PLC programmer to setup and interrogate the IFC 022 Module. The loadable writes the Traffic-copped 4XXXX registers to the module and reads the Traffic-copped 3XXXX registers from the module transparent to the users ladder logic. The user must only read and write data to/from 4XXXX registers to designated registers. In Mode 1, the loadable uses a user-defined group of 19 registers for passing information to and from the module. These 19 registers are divided into groups of write and read registers. The write registers are used to send analog output values to the module and the read registers for interrogating the module. *Figure 5-2* shows the Mode 1 operation of the FN43 User Loadable.

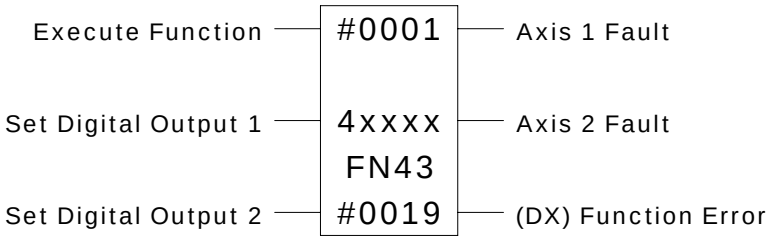


Figure 5-2: Mode 1 Position/Speed Monitor Operation of FN43

To place the IFC 022 in Mode 1, write a 1 in the top node of the FN43 function block. The middle node specifies the starting 4XXXX register for the 19 consecutive function block data registers. For Mode 1, place a 19 in the bottom node to designate the number of registers being used by the function block.

When power is applied to the top input, the function block is executed. Power should remain on the top input at all times when the module is in use. If the IFC 022 outputs are under command control (i.e., not tied to the programmable limits switch etc.). The outputs can be controlled by applying power to the middle and bottom nodes. When power is applied to the middle input, Axis 1's discrete output turns on. When power is removed from the middle input, Axis 1's output turns off. When power is applied to the bottom input, Axis 2's discrete output turns on. When you remove power form the bottom input, the output of Axis 2 turns off.

The top output indicates that Axis 1 is faulted. The middle output indicates a fault on Axis 2.

The bottom output indicates a DX Function Fault. This fault condition usually implies incorrect node information, the IFC-022 is not present, or a module communication error.

The loadable constantly sends the analog output values to the module and constantly updates the PLC read registers using the 6 input and 6 Output Registers defined in the PLC traffic-cop. The fault register is only updated when a module fault occurs.

The following information provides a list of Mode 1 User Loadable registers.

5.2.2.1. Mode 1 - PLC Write Registers

Below in *Table 5-2* is a list of the write registers associated with Mode 1. A detailed description of each register follows.

Register	Description
PLC Write Registers	
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)
4XXXX+2	Analog Output 1
4XXXX+3	Analog Output 2

Table 5-2: Mode 1 - PLC Write Registers

4XXXX ***Starting Traffic-copped Output Register***

Enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must range between 0001 and 9999, and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

Enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

4XXXX+2 ***Analog Output 1***

The user writes the Analog Output 1 voltage to this register. This number should range between 0 and 4095. Values above 4095 are ignored. If the analog output range in the IFC 022 Setup Software is set to ±10Vdc then a value of 0 in this register represents –10V out, and a value of 4095 represents 10V out. If the analog output range is set between 0 and 10Vdc then a value of 0 would represent 0V and a value of 4095 would represent 10V. This register is constantly sent to the module by the loadable.

4XXXX+3 ***Analog Output 2***

The user writes the Analog Output 2 voltage to this register. This number should range between 0 and 4095. Values above 4095 are ignored. If the analog output range in the IFC 022 Setup Software is set to ±10Vdc then a value of 0 in this register represents –10V out, and a value of 4095 represents 10V out. If the analog output range is set between 0 and 10Vdc then a value of 0 would represent 0V and a value of 4095 would represent 10V. This register is constantly sent to the module by the loadable.

5.2.2.2. Mode 1 - PLC Read/Reserved Registers

Below in *Table 5-3* is a list of the read registers associated with Mode 1. A detailed description of each register follows.

Register	Description
Axis 1 Read Registers (Read Only)	
4XXXX+4	Axis Position High Word (user units)
4XXXX+5	Axis Position Low Word (user units)
4XXXX+6	Axis Speed (user units)
4XXXX+7	Axis Status and Limits
4XXXX+8	Analog Input 1 Value (0 - 4095)
Axis 2 Read Registers (Read Only)	
4XXXX+9	Axis Position High Word (user units)
4XXXX+10	Axis Position Low Word (user units)
4XXXX+11	Axis Speed (user units)
4XXXX+12	Axis Status and Limits
4XXXX+13	Analog Input 2 Value (0 - 4095)
Module Fault Registers (Read Only)	
4XXXX+14	Module Fault Status Word
4XXXX+15	Module Inputs Status Word
4XXXX+16	Axis 1 Latched Faults
4XXXX+17	Axis 2 Latched Faults
Internal Registers	
4XXXX+18	Reserved for Internal Use

Table 5-3: Mode 1 - PLC Read/Reserved Registers

4XXXX+4 ***Axis 1 Position High Word***

This register contains the high word of the Channel 1 Resolver position in User units. A new position value is calculated every 500 microseconds by the module. This register should be used together with the position low word to form a two-register position value. The position is represented in modulo 10000.

4XXXX+5 ***Axis 1 Position Low Word***

This register contains the low word of the Channel 1 Resolver position in User units. This register should be used together with the position high word to form a two-register position value. The position is represented in modulo 10000.

Example 1: If the module has been setup so that position is in inches and has two decimal places and the high word is 50 and the low word is 8051, then the actual resolver position value in User units is 5080.51 inches.

Example 2: If the module has been setup so that position is in millimeters and has one decimal place and the high word is 5 and the low word is 623, then the actual resolver position value in User units is 5062.3 millimeters.

4XXXX+6 ***Axis 1 Speed***

Contains the current speed of the Channel 1 Resolver in User units per second or per minute.

4XXXX+7 ***Axis 1 Status and Limits***

Contains Channel 1 module status and limits data. The information contained in each status bit is described below:

Bit 1 ***Channel 1 Fault*** - This bit is set high by the module anytime a fault exists for Channel 1. The fault status word must be read to determine the nature of the fault.

Bit 2 ***Digital Input 1 Status*** - Shows the current state of Digital Input 1.

Bit 3 ***Not Used***

Bit 4 ***Digital Output 1 Status*** - Shows the current state of Digital Output 1.

Bit 5 ***Homed*** - Indicates whether the Channel 1 Resolver has been homed. Resolver positions are only valid after the axis has been homed.

Bit 6 ***Overspeed / Underspeed –*** Indicates that the resolver is rotating below the underspeed value set or above the overspeed value set by the user.

Bit 7 ***+EOT Limit Reached*** – Indicates that the current Channel 1 Resolver position is greater than the preset +EOT position.

Bit 8 ***-EOT Limit Reached*** – Indicates that the current Channel 1 Resolver position is less than the preset -EOT position.

Bit 9 ***Software Limit Switch 0*** – Shows the current status of the software limit switch 0. **When = 0**: the current resolver position is less than the Limit Switch 0 On Position or greater than the Limit Switch 0 Off Position. **When = 1**: the current resolver position is greater than the Limit Switch 0 On Position and less than the Limit Switch 0 Off Position.

Bit 10 ***Software Limit Switch 1*** – Shows the current status of the Channel 1 software limit switch 1.

Bit 11 ***Software Limit Switch 2*** – Shows the current status of the Channel 1 software limit switch 2.

Bit 12 ***Software Limit Switch 3*** – Shows the current status of the Channel 1 software limit switch 3.

Bit 13 ***Software Limit Switch 4*** – Shows the current status of the Channel 1 software limit switch 4.

Bit 14 ***Software Limit Switch 5*** – Shows the current status of the Channel 1 software limit switch 5.

Bit 15 ***Software Limit Switch 6*** – Shows the current status of the Channel 1 software limit switch 6.

Bit 16 ***Software Limit Switch 7*** – Shows the current status of the Channel 1 software limit switch 7.

4XXXX+8 ***Analog Input 1 Value***

Contains the value of the Analog Input 1. This value can range from 0 to 4095. An input of 0 represents –10V and an input of 4095 represents +10V.

4XXXX+9 ***Axis 2 Position High Word***

Contains the high word of the Channel 2 Resolver position in user units. A new position value is calculated every 500 uSec. by the module. This register should be used together with the position low word to form a two-register position value. The position is given in modulo 10000.

4XXXX+10 ***Axis 2 Position Low Word***

Contains the low word of the Channel 2 Resolver position in user units. Use this register together with the position high word to form a two-register position value. The position is represented in modulo 10000.

4XXXX+11 ***Axis 2 Speed***

Contains the current speed of the Channel 2 Resolver in user units per second or per minute.

4XXXX+12 ***Axis 2 Status and Limits***

Contains Channel 2 module status and limits data. Each status bit is described below:

Bit 1 ***Channel 2 Fault*** – Set high by the module anytime that a fault exists for Channel 2. The fault status word must be read to determine the nature of the fault.

Bit 2 ***Digital Input 2 Status*** **–** Shows the current state of Digital Input 2.

Bit 3 ***Not Used***

Bit 4 ***Digital Output 2 Status*** **–** Shows the current state of Digital Output 2.

Bit 5 ***Homed*** **–** Indicates whether the Channel 2 Resolver has been homed. Resolver positions are only valid after the axis has been homed.

Bit 6 ***Overspeed / Underspeed*** **–** Indicates that the resolver is rotating below the underspeed value set or above the overspeed value set by the user.

Bit 7 ***+EOT Limit Reached*** **–** Indicates that the current Channel 2 Resolver position is greater than the preset +EOT position.

Bit 8 ***-EOT Limit Reached*** **–** Indicates that the current Channel 2 Resolver position is less than the preset –EOT position.

Bit 9 ***Software Limit Switch 0*** **–** Shows the current status of the Channel 2 software limit switch 0. **When = 0:** the current resolver position is less than the Limit Switch 0 On Position or greater than the Limit Switch 0 Off Position. **When = 1:** the current resolver position is greater than the Limit Switch 0 On Position and less than the Limit Switch 0 Off Position.

Bit 10 ***Software Limit Switch 1*** **–** Shows the current status of the Channel 2 software limit switch 1.

Bit 11 ***Software Limit Switch 2*** **–** Shows the current status of the Channel 2 software limit switch 2.

Bit 12 ***Software Limit Switch 3*** **–** Shows the current status of the Channel 2 software limit switch 3.

Bit 13 ***Software Limit Switch 4*** **–** Shows the current status of the Channel 2 software limit switch 4.

Bit 14 ***Software Limit Switch 5*** **–** Shows the current status of the Channel 2 software limit switch 5.

Bit 15 ***Software Limit Switch 6*** **–** Shows the current status of the Channel 2 software limit switch 6.

Bit 16 ***Software Limit Switch 7*** **–** Shows the current status of the Channel 2 software limit switch 7.

4XXXX+13 ***Analog Input 2 Value***

Contains the value of the Analog Input 2. This value can range from 0 to 4095. An input of 0 represents -10V and an input of 4095 represents +10V.

4XXXX+14 ***Module Fault and Status Word***

Contains module fault and status information. This register is only updated when a fault occurs on the module. The fault information bits include:

Bits 1 - 7 Are Not Used.

Bit 8 ***Setup Data Changed*** **–** The active setup data is different than the Flash data. This will be cleared when the data is saved to Flash.

Bit 9 ***Module Code Checksum Failure*** **–** The module code checksum has failed. The module firmware has to be re-loaded.

Bit 10 ***Serial Checksum or Time-out*** **–** Error! Either a bad checksum was received from the serial port, or a message time-out occurred. Could occur if the serial cable was removed in the middle of a transmission.

Bit 11 ***Serial Command Error*** **–** A bad command was sent to the IFC 022 Module from your PC. Check the cable and make sure you have selected the right communication port.

Bit 12 ***PLC Command Error*** **–** A bad command has been sent to the IFC 022 Module from the PLC. Check your messages from the PLC.

Bit 13 ***Flash Default*** **–** Error! The IFC 022 Module is using default parameters. This bit should be on when the unit is first powered-up.

Bit 14 ***Flash Memory Error*** **–** This error should not occur. Consult factory if this error is seen.

Bit 15 ***Daughter Board Comm Error*** **–** This error should not occur. Consult factory if seen.

Bit 16 ***PLC Error*** **–** This error should not occur. Consult factory if this error is seen.

factory if this error is seen.

4XXXX+15 ***Module Inputs Status Word***

Contains axis specific fault and status information. This register is only updated when a fault occurs on the module. The fault information bits include:

Bit 1 ***Digital Input 1 State –*** The state of channel one's digital input.

Bit 2 ***Digital Input 2 State –*** The state of channel two's digital input.

Bit 3 ***Channel 1 Loss of Cosine Feedback –*** The cosine input on Channel 1 is missing or corrupted.

Bit 4 ***Channel 1 Loss of Sine Feedback –*** The sine input on Channel 1 is missing or corrupted.

Bit 5 ***Channel 1 Resolver Strength Error –*** The module is unable to drive the resolver reference high enough on channel one to achieve proper sine and cosine levels. Possibly a broken wire or bad resolver.

Bit 6 ***Channel 2 Loss of Cosine Feedback –*** The cosine input on Channel 2 is missing or corrupted.

Bit 7 ***Channel 2 Loss of Sine Feedback –*** The sine input on Channel 2 is missing or corrupted.

Bit 8 ***Channel 2 Resolver Strength Error –*** The module is unable to drive the resolver reference high enough on channel two to achieve proper sine and cosine levels. Possibly a broken wire or bad resolver.

Bits 9 - 16 Are Not Used.

4XXXX+16 ***Axis 1 Latched Faults***

These faults are latched once they are observed.

Bit 1-8 ***Not Used***

Bit 9 ***Dual Resolver Fault –*** The Dual Resolver startup sequence failed. One or both of the resolvers are bad or missing.

Bit 10 ***Module Fault –*** Communication with the PLC has failed.

Bit 11 ***Current Limit Fault*** – While under PID motion control, the average current command exceeded the specified limit.

Bit 12 ***-EOT Fault*** – A negative End of Travel limit was detected.

Bit 13 ***+EOT Fault*** – A positive End of Travel limit was detected.

Bit 14 ***Resolver Fault –*** The resolver connection has failed.

Bit 15 ***Daughter Card Fault –*** Communication between the base processor board and the daughter board has failed. Insure that power is supplied the breakout module.

Bit 16 ***Position Error Fault*** – While under PID motion control, the position command minus the observer position exceeded the specified limit.

4XXXX+17 ***Axis 2 Latched Faults***

See description above for Axis 1.

4XXXX+18 ***Reserved for Internal Use***

Used by the loadable. Do not write to this register.

5.2.2.3. FN43 PID Mode Operations

Operating modes 2 through 5 of the FN43 User Loadable Function Block are used to control the position and velocity of a drive/motor combination. The IFC 022 Module uses the resolver to close the position loop or velocity loop on the drive and motor. By adjusting the PID and Position Loop gains of the axis, the IFC 022 will be able to control the motor/drive in a servo-like manner. The types of motor/drive combinations that can be controlled by the IFC 022 are: AC vector drives, AC inverter drives, DC SCR type drives, DC servo and AC servo type drives. These types of drives must accept either a ±10Vdc torque command or a 0 to 10Vdc velocity reference with a discrete direction input.

NOTE **The IFC 022 must be setup from the Move pull down menu of the IFC 022 Windows Setup Software to control the shaft position of the motor. The PID gains, and the position loop gain must be tuned properly to ensure that the motor and load are stable (not oscillating) while the system is under PID control.**

WARNING **The user must ensure that the control system can be stopped from an Emergency Stop circuit. The user must follow all federal, state, local, and plant codes for protecting humans and machinery from automatic control equipment. If the system needs over travel limits to protect the machinery, the user must have these wired into either the e-stop circuit or another discrete input module. If the limits are wired into another input module the PLC logic must use these inputs to halt the motion of the axis being controlled by the IFC 022, after the limit is tripped. Failure to do this may cause mechanical destruction to the machinery, bodily harm, or death!!! See *Chapter 4* for more information on controlling a motor with the IFC 022.**

5.2.3. Mode 2 - Homing

Mode 2 allows the PLC program to home both Axis 1 and 2 under PID control from the IFC 022 Module. Please use extreme caution when enabling any type of motion from the IFC 022. *Figure 5-3* shows the Mode 2 operation of the FN43 User Loadable.

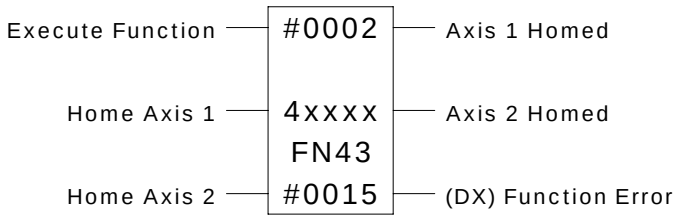


Figure 5-3: Mode 2 - Homing Operation of FN43

To place the IFC 022 in Mode 2, write a 2 in the top node of the FN43 function block. The middle node specifies the starting 4XXXX register for the 15 consecutive function block data registers. For Mode 2 place a 15 in the bottom node to designate the number of registers being used by the function block.

Before applying any power to the inputs of the FN43 Mode 2, the user must enter data into the PLC write registers of the function block. The Mode 2 operation of the FN43 function block uses 15 consecutive registers to write and read data between the PLC and the IFC 022 Module.

When power is applied to the top input, the function block is executed. Power should remain on the top input at all times when the module is in use. When power is applied to the middle input, the motor connected to Channel 1 of the IFC 022 will start moving in the direction specified in register 4XXXX+2 at the speed specified in registers 4XXXX+3 and 4XXXX+4. The motor will continue to move until the home switch connected to the IFC 022 Discrete Input 1 is asserted to the state checked on the **Axis Setup** screen of the IFC 022 Setup Software. After the home switch is asserted the axis will continue to move in the home direction and speed until it reaches the resolver null or marker pulse (absolute zero position on the resolver). After the axis stops, the top output of the FN43 User Loadable will be turned on and the axis' position will be set to 0 or to the user entered Home Offset value that was set on the IFC 022 Setup Software **Axis Setup** screen. When power is applied to the bottom input, the motor connected to Channel 2 of the IFC 022 will start moving in the direction specified in register 4XXXX+5 at the speed specified in registers 4XXXX+6 and 4XXXX+7. The motor will continue to move until the home switch connected to the IFC 022 Discrete Input 2 is asserted to the state checked on the **Axis Setup** screen of the IFC 022 Setup Software. After the home switch is asserted the axis will continue to move in the home direction and speed until it reaches the resolver null or marker pulse (absolute zero position on the resolver). After the axis stops, the middle output of the FN43 User Loadable will be turned on and the axis' position will be set to 0 or to the user entered Home Offset value that was set on the IFC 022 Setup Software **Axis Setup** screen.

The bottom output is used to indicate a DX Function Fault. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

NOTE **The homing inputs are recognized by the loadable on a transition from low to high and while power is applied to the top node. Homing will not occur if power is applied to top and home inputs simultaneously.**

If power is removed from the home input while homing, the axis will halt.

Axes will not enable and move if a fault is present on the axis.

5.2.3.1. Mode 2 - PLC Write Registers

There are eight PLC write registers associated with FN43's Mode 2 function block, see *Table 5-4*. A detailed description of each register will follow.

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)
4XXXX+2	Homing Direction of Axis 1 (0 = FWD, 1 = REV)
4XXXX+3	Homing Speed Axis 1 (High register)
4XXXX+4	Homing Speed Axis 1 (Low register)
4XXXX+5	Homing Direction of Axis 2 (0 = FWD, 1 = REV)
4XXXX+6	Homing Speed Axis 2 (High register)
4XXXX+7	Homing Speed Axis 2 (Low register)

Table 5-4: Mode 2 - PLC Write Registers

4XXXX ***Starting Traffic-copped Output Register***

Enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must range from 0001 to 9999, and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

Enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must range between 0001 and 9999, and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

4XXXX+2 ***Homing Direction of Axis 1***

User must enter a value of either 0 or 1. Placing a 0 in this register causes Axis 1 to home in the forward direction. When a 1 is placed in this register, Axis 1 will home in the counter forward (0 = FWD, 1 = REV).

4XXXX+3 ***Homing Speed Axis 1 (High Register)***

User should enter the whole number value in user units for the homing speed of Axis 1.

4XXXX+4 ***Homing Speed Axis 1 (Low Register)***

User enters the fractional portion in user units for the homing speed of Axis 1.

Example: 5.1234 in/sec
4XXXX+3 = 00005
4XXXX+4 = 01234

4XXXX+5 ***Homing Direction Axis 2***

User must enter a value of either 0 or 1. Placing a 0 in this register causes Axis 2 to home in the forward direction. When a 1 is placed in this register, Axis 2 will home in the reverse direction. (0 = FWD, 1 = REV).

4XXXX+6 ***Homing Speed Axis 2 (High Register)***

User enters the whole number value in user units for the homing speed of Axis 2.

4XXXX+7 ***Homing Speed Axis 2 (Low Register)***

User enters the fractional portion in user units for the homing speed of Axis 2.

Example: 5.1234 in/sec
4XXXX+3 = 00005
4XXXX+4 = 01234

5.2.3.2. Mode 2 - PLC Read/Reserved Registers

There are seven PLC read/reserved registers associated with FN43's Mode 2 function block, see *Table 5-5*. Do not write to these registers.

Register	Description
4XXXX+8	Reserved for Internal Use
4XXXX+9	Reserved for Internal Use
4XXXX+10	Reserved for Internal Use
4XXXX+11	Reserved for Internal Use
4XXXX+12	Reserved for Internal Use
4XXXX+13	Reserved for Internal Use
4XXXX+14	Reserved for Internal Use

Table 5-5: Mode 2 - PLC Read/Reserved Registers

5.2.3.3. Homing Methods

Homing to the Resolver Null or Marker Pulse with a Normally Open Home Switch

Use this method when a normally open home switch is being used and you want the resolver null or marker pulse to be the home position. This mode is selected by setting the USE RESOLVER NULL OR MARKER PULSE FOR HOMING and selecting HOME USING LOW TO HIGH TRANSITION in the Setup Software. In this mode, when homing is started, the module looks for a transition from low to high of the home switch input. When this transition is seen, the module then looks for the first resolver null or marker pulse to be the home position. If the home switch changes state back to low before a resolver null or marker pulse is seen, homing will be aborted. The home Switch State must be low when the resolver null or marker pulse is seen for homing to be completed. To ensure this occurs, your home switch should be on for at least one revolution of the resolver, but less than two revolutions. If you cannot ensure this, use one of the homing methods that only uses the home switch to determine home position.

Homing to the Resolver Null or Marker Pulse with a Normally Closed Home Switch

Use this method when a normally closed home switch is being used and you want the resolver null or marker pulse to be the home position. This mode is selected by setting the USE RESOLVER NULL OR MARKER PULSE FOR HOMING and selecting HOME USING HIGH TO LOW TRANSITION in the Setup Software. In this mode, when homing is started, the module looks for a transition from high to low of the home switch input. When this transition is seen, the module then looks for the first resolver null or marker pulse to be the home position. If the home switch changes state back to high before a resolver

null or marker pulse is seen, homing will be aborted. The home switch state must be high when the resolver null or marker pulse is seen for homing to be completed. To ensure this occurs, your home switch should be on for at least one revolution of the resolver, but less than two revolutions. If you cannot ensure this, use one of the homing methods that only uses the home switch to determine home position.

Homing to the Low to High Transition of the Home Switch

Use this method when a normally open home switch is being used and you do not want to use the resolver null or marker pulse. This mode is selected by selecting HOME USING LOW TO HIGH TRANSITION and not selecting the USE RESOLVER NULL OR MARKER PULSE FOR HOMING. In this mode, when homing is started, the module looks for a transition from low to high of the home switch input. When this transition is seen, the module sets the axis position to the home offset value.

Homing to the High to Low Transition of the Home Switch

Use this method when a normally closed home switch is being used and you do not want to use the resolver null or marker pulse. This mode is selected by selecting HOME USING HIGH TO LOW TRANSITION and not selecting the USE RESOLVER NULL OR MARKER PULSE FOR HOMING. In this mode, when homing is started, the module looks for a transition from high to low of the home switch input. When this transition is seen, the module sets the axis position to the home offset value.

Homing to the Resolver null or marker pulse

Use this method when you have an absolute system and you want the resolver null or marker pulse to be the home position. This mode is selected by setting the USE RESOLVER NULL OR MARKER PULSE FOR HOMING and not selecting any transition level in the Setup Software. In this mode, when homing is started, the module looks for the first resolver null or marker pulse to be the home position. No home switch is used.

5.2.4. Mode 3 - Single Point Move

NOTE **The description of the mode 3 of the loadable below applies to version 1.03 and later of the loadable. Previous versions did not allow for simultaneous or independent motion of the two axes. Users upgrading to this version will need to modify their register usage and PLC code.**

Mode 3 of the IFC 022 FN43 User Loadable allows the PLC to move an axis to a predefined position or an incremental distance. The PLC program sets up the move by writing the position, speed, acceleration and deceleration to predefined registers of the loadable. When the Execute Move input receives power, the loadable sends the data to the IFC 022 Module to execute the move. When the move is complete, the FN43 User Loadable will turn on its In Position output indicating that the move is complete and the axis is in position. Please use extreme caution when enabling any type of motion from the IFC 022 Module. *Figure 5-4* illustrates the use of FN43's Mode 3 operation.

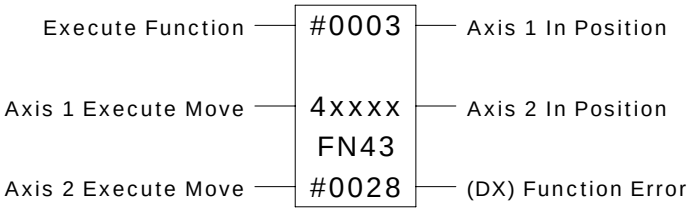


Figure 5-4: Mode 3 - Single Point Move Operation of FN43

To place the IFC 022 in Mode 3, write a 3 in the top node of the FN43 Function Block. The middle node specifies the starting 4XXXX register for the 28 consecutive function block data registers. For Mode 3 place a 28 in the bottom node to designate the number of registers used by the loadable.

Before applying any power to the inputs of the FN43 Mode 3, the user must enter data into the PLC write registers of the function block. The Mode 3 operation of the FN43 Function Block uses 26 consecutive registers to write and read data between the PLC and the IFC 022 Module.

The bottom output is used to indicate a DX Function Fault. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

NOTE **The Execute Move input is recognized by the loadable on a transition from low to high and while power is applied to the top node. Motion will not occur if power is applied to top and Execute Move input simultaneously.**

If power is removed from the Execute Move input while moving, the axis will halt.

Axes will not enable and move if a fault is present on the axis.

5.2.4.1. Mode 3 - PLC Write Registers

There are eighteen PLC write registers associated with FN43's Mode 3 function block, see *Table 5-6.* A detailed description of each register will follow.

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)
4XXXX+2	Axis 1 Move Type (0 = Abs, 1 = Inc Pos, 2 = Inc Neg)
4XXXX+3	Axis 1 Position (High Register in user units)
4XXXX+4	Axis 1 Position (Low Register in user units)
4XXXX+5	Axis 1 Velocity (High Register in user units)
4XXXX+6	Axis 1 Velocity (Low Register in user units)
4XXXX+7	Axis 1 Acceleration (Milliseconds 1 - 32767)
4XXXX+8	Axis 1 Deceleration (Milliseconds 1 - 32767)
4XXXX+9	Axis 1 Acc/Dec Mode (0 = constant, 1 = S curve)
4XXXX+10	Axis 2 Move Type (0 = Abs, 1 = Inc Pos, 2 = Inc Neg)
4XXXX+11	Axis 2 Position (High Register in user units)
4XXXX+12	Axis 2 Position (Low Register in user units)
4XXXX+13	Axis 2 Velocity (High Register in user units)
4XXXX+14	Axis 2 Velocity (Low Register in user units)
4XXXX+15	Axis 2 Acceleration (Milliseconds 1 - 32767)
4XXXX+16	Axis 2 Deceleration (Milliseconds 1 - 32767)
4XXXX+17	Axis 2 Acc/Dec Mode (0 = constant, 1 = S curve)

Table 5-6: Mode 3 - PLC Write Registers

4XXXX ***Starting Traffic-copped Output Register***

Enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must range from 0001 to 9999, and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

Enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must range between 0001 and 9999, and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

4XXXX+2 ***Axis 1 Move Type***

User enters the type of move. The choices for this value are a 0 for an Absolute Move, a 1 for an incremental positive move, or a 2 for an incremental negative move. Additional bits are use to disable the axis or change its velocity.

Bits 15,16 The choices for this value are a 0 (mask 00 binary) for an Absolute Move, a 1 (mask 01 binary) for an incremental positive move, or a 2 (mask 10 binary) for an incremental negative move.

Bit 14 This bit (mask 100 binary) will cause the axis to disable itself at the end of the move.

Bit 13 When this bit (mask 1000 binary) is activated and the axis is moving, the axis's velocity will be updated with the velocity values below. This bit is reset by the loadable when the velocity update is issued.

For Example, to issue a Absolute Move and disable the axis after the move, the value will be 4 decimal

4XXXX+3 ***Axis 1 Position High***

User must enter the whole number value for the position. Valid numbers range from 0 to 65535.

4XXXX+4 ***Axis 1 Position Low***

User must enter the fractional value for the position to move to. Valid numbers range from 0 to 9999.

4XXXX+5 ***Axis 1 Velocity High***

User must enter the whole number value of the velocity of the move.

4XXXX+6 ***Axis 1 Velocity Low***

User must enter the fractional value of the velocity of the move.

4XXXX+7 ***Axis 1 Acceleration***

User must enter the time for acceleration of the move in milliseconds.

4XXXX+8 ***Axis 1 Deceleration***

User must enter the time for deceleration of the move in milliseconds.

4XXXX+9 ***Axis 2 Acc/Dec Mode***

User enters either a 0 or 1. When set to 0 the acceleration and deceleration portions of the move be constant. When set to 1 the acceleration and deceleration will use S-curve (1-cosine) acceleration. This is sometimes referred to as anti-jerk, because of its tendency to smooth out the bottom and top portions of the move profile.

4XXXX+10 ***Axis 2 Move Type***

User enters the type of move. The choices for this value are a 0 for an Absolute Move, a 1 for an incremental positive move, or a 2 for an incremental negative move. Additional bits are use to disable the axis or change its velocity.

Bits 15,16 The choices for this value are a 0 (mask 00 binary) for an Absolute Move, a 1 (mask 01 binary) for an incremental positive move, or a 2 (mask 10 binary) for an incremental negative move.

Bit 14 This bit (mask 100 binary) will cause the axis to disable itself at the end of the move.

Bit 13 When this bit (mask 1000 binary) is activated and the axis is moving, the axis's velocity will be updated with the velocity values below. This bit is reset by the loadable when the velocity update is issued.

For Example, to issue a Absolute Move and disable the axis after the move, the value will be 4 decimal

4XXXX+11 ***Axis 2 Position High***

User must enter the whole number value for the position. Valid numbers range from 0 to 65535.

4XXXX+12 ***Axis 2 Position Low***

User must enter the fractional value for the position to move to. Valid numbers range from 0 to 9999.

4XXXX+13 ***Axis 2 Velocity High***

User must enter the whole number value of the velocity of the move.

4XXXX+14 ***Axis 2 Velocity Low***

User must enter the fractional value of the velocity of the move.

4XXXX+15 ***Axis 2 Acceleration***

User must enter the time for acceleration of the move in milliseconds.

4XXXX+16 ***Axis 2 Deceleration***

User must enter the time for deceleration of the move in milliseconds.

4XXXX+17 ***Axis 2 Acc/Dec Mode***

User enters either a 0 or 1. When set to 0 the acceleration and deceleration portions of the move be constant. When set to 1 the acceleration and deceleration will use S-curve (1-cosine) acceleration. This is sometimes referred to as anti-jerk, because of its tendency to smooth out the bottom and top portions of the move profile.

5.2.4.2. Mode 3 - PLC Read/Reserved Registers

There are ten LC read/reserved registers associated with FN43's Mode 3 function block, see *Table 5-7*.

Register	Description
4XXXX+18	Reserved for Internal Use
4XXXX+19	Reserved for Internal Use
4XXXX+20	Axis 1 PID Status Register
4XXXX+21	Reserved for Internal Use
4XXXX+22	Axis 1 Observed Position (High Register in user units)
4XXXX+23	Axis 1 Observed Position (Low Register in user units)
4XXXX+24	Axis 2 PID Status Register
4XXXX+25	Reserved for Internal Use
4XXXX+26	Axis 2 Observed Position (High Register in user units)
4XXXX+27	Axis 2 Observed Position (Low Register in user units)

Table 5-7: Mode 3 - PLC Read/Reserved Registers

4XXXX+18 ***Reserved***

4XXXX+19 ***Reserved***

4XXXX+20 ***Axis 1 PID Status Register***

Bit 1 ***Homing Off Input –*** The axis is homing off the input switch. Once off the switch it will reverse direction and continue homing.

Bit 2 ***Homing –*** The axis is currently homing.

Bit 3 ***Faulted –*** The axis is currently faulted.

Bit 4 ***Moving Continuously –*** The axis is moving continuously. Either a homing sequence or a start motion in progress.

Bit 5 ***Reserved***

Bit 6 ***Decelerating –*** The axis is decelerating.

Bit 7 ***Reserved***

Bit 8 ***In-Position –*** The axis is In Position or Done.

Bit 9 ***Reserved***

Bit 10 ***Reserved***

Bit 11 ***Reserved***

Bit 12 ***Reserved***

Bit 13 ***Reserved***

Bit 14 ***Reserved***

Bit 15 ***Moving Negative*** **–** The axis is moving in the negative direction.

Bit 16 ***Moving*** **–** The axis is moving.

4XXXX+21 ***Reserved***

4XXXX+22 ***Axis 1 Position High Word***

This register contains the high word of the Channel 1 Resolver position in user units

4XXXX+23 ***Axis 1 Position Low Word***

This register contains the low word of the Channel 1 Resolver position in user units

4XXXX+24 ***Axis 2 PID Status Register***

See description for Axis 1 above.

4XXXX+25 ***Reserved***

4XXXX+26 ***Axis 2 Position High Word***

This register contains the high word of the Channel 2 Resolver position in user units

4XXXX+27 ***Axis 2 Position Low Word***

This register contains the low word of the Channel 2 Resolver position in user units

5.2.4.3. How to Enter Data into the Loadable for a Given Move

Example:

To move Axis 1 from 10.5 inches to 26.75 inches at a rate of 15.34 inches per second. The axis must accel up to speed in 1 inch and decel to a stop in 1.5 inches using S-curve acceleration. Calculate the following and enter the data into the registers of the FN43 Mode 3 User Loadable:

Accel time = dist/.5*rate => 1.00/.5*15.34 = .13038 seconds
Decel time = dist/.5*rate => 1.50/.5*15.34 = .19557 seconds

Assume the module is traffic copped at 40001 and 30001.

Enter the data into the registers as shown on the following page:

For Absolute Move		*For Incremental Move*	
4XXXX	= 00001	4XXXX	= 00001
4XXXX+1	= 00001	4XXXX+1	= 00001
4XXXX+2	= 00000	4XXXX+2	= 00001
4XXXX+3	= 00026	4XXXX+3	= 00016
4XXXX+4	= 07500	4XXXX+4	= 02500
4XXXX+5	= 00015	4XXXX+5	= 00015
4XXXX+6	= 03400	4XXXX+6	= 03400
4XXXX+7	= 00130	4XXXX+7	= 00130
4XXXX+8	= 00196	4XXXX+8	= 00196
4XXXX+9	= 00001	4XXXX+9	= 00001

Apply power for the Axis 1 Execute Move input.

5.2.5. Mode 4 – Sixteen-Point Move Download

Mode 4 of the FN43 User Loadable allows the PLC to write data to the IFC 022 Sixteen-point Move Table. The PLC program keeps a data table of the position, speed, acceleration, and deceleration for up to 16 different positions for Axis 1 and 2. The PLC also keeps a mirror data table that is compared with the original data table. Changes to the original data table, cause the loadable to write the new data to the IFC 022 Module and then update the mirror table. *Figure 5-5* illustrates the use of the FN43 Mode 4 User Loadable.

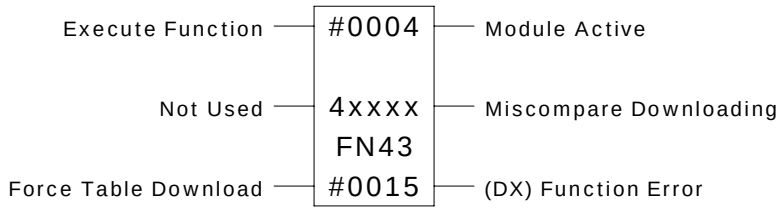


Figure 5-5: Mode 4 – Sixteen-Point Move Download Operation of FN43

To place the FN43 User Loadable in Mode 4 write a 4 in the top node of the function block. The middle node specifies the starting 4XXXX register for the 15 consecutive function block data registers. In the bottom node write a 15 which is the number of consecutive registers used by the loadable. When the top input receives power, the FN43 Mode 4 User Loadable starts comparing the original data table with the mirror table. If any data in the original data changes, the loadable will send the new data to the IFC 022 Module then update the mirror table. The middle input is not used. When the bottom input receives power, the FN43 Mode 4 User Loadable forces a download of all the data to the IFC 022 Modules move table. The top output passes power when the top input is on. The middle output turns on when the loadable finds a miscompare between the original data table and the mirror table.

The bottom output is used to indicate a DX Function Fault. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

The following describes the read/ write registers of the FN43's Mode 4 User Loadable:

5.2.5.1. Mode 4 - PLC Write Registers

There are five PLC write registers associated with FN43's Mode 4 function block, see *Table 5-8*. A detailed description of each register will follow.

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)
4XXXX+2	Starting Register for Original Data Table of Registers
4XXXX+3	Starting Register for Mirror Table of Registers
4XXXX+4	Total Number of Registers in Original Data Table

Table 5-8: Mode 4 - PLC Write Registers

The following describes the PLC write registers of FN43 Mode 5 User Loadable:

4XXXX ***Starting Traffic-copped Output Register***

Enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must range from 0001 to 9999, and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

Enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must range between 0001 and 9999, and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

4XXXX+2 ***Starting Register for Original Data Table of Registers***

Enter the number of the first 4XXXX Output Register of the original data.

4XXXX+3 ***Starting Register for Mirror Table of Registers***

Enter the number of the first 4XXXX Output Register of the mirrored.

4XXXX+4 ***Total Number of Registers in Original Data Table***

Enter the number of register in the original data.

5.2.5.2. Mode 4 - PLC Read/Reserved Registers

There are ten PLC read/reserved registers associated with FN43's Mode 4 function block, see *Table 5-9.* Do not write to these registers.

Register	Description
4XXXX+5	Reserved for Internal Use
4XXXX+6	Reserved for Internal Use
4XXXX+7	Reserved for Internal Use
4XXXX+8	Reserved for Internal Use
4XXXX+9	Reserved for Internal Use
4XXXX+10	Reserved for Internal Use
4XXXX+11	Reserved for Internal Use
4XXXX+12	Reserved for Internal Use
4XXXX+13	Reserved for Internal Use
4XXXX+14	Reserved for Internal Use

Table 5-9: Mode 4 - PLC Read/Reserved Registers

To find the number of registers used in the data table, use the following formula:

(# of points) x [2(pos regs) + 2 (velocity regs) + 1(accel reg) + 1(decel reg)]

For example:
16 positions * (2+2+1+1) = 192 data table registers and 192 mirror table registers. This value is placed in the user loadable register 4XXXX+4.

Table 5-10 is an example memory map of the FN43 Mode 4 User Loadable

Addr	Description	Value
40200	Starting Traffic Copped Read Register	00001
40201	Starting Traffic Copped Write Register	00001
40202	Starting Register of Original Data Table	06000
40203	Starting Register of Mirror Data Table	06200
40204	Total Number of Registers in Data Table	00192

Table 5-10: Mode 4 - FN43 Example Memory Map

Table 5-11, is a list of registers of the original and mirror tables used by the FN43 Mode 4 User Loadable for sending positions, speeds, accelerations, and decelerations for the 16 different moves of each axis in the resolver module.

Orig . Table Addr	Mirror Table Addr	Description	Value
46000	46200	Axis 1 Position 1 High Register	00010
46001	46201	Axis 1 Position 1 Low Register	05000
46002	46202	Axis 1 Position 2 High Register	00020
46003	46203	Axis 1 Position 2 Low Register	02500
46004	46204	Axis 1 Position 3 High Register	00030
46005	46205	Axis 1 Position 3 Low Register	07500
46030	46230	Axis 1 Position 16 High Register	00005
46031	46231	Axis 1 Position 16 Low Register	05000
46032	46232	Axis 2 Position 1 High Register	00010
46033	46233	Axis 2 Position 1 Low Register	05000
46034	46234	Axis 2 Position 2 High Register	00020
46035	46235	Axis 2 Position 2 Low Register	02500
46036	46236	Axis 2 Position 3 High Register	00030
46037	46237	Axis 2 Position 3 Low Register	07500
.	.	.	
.	.	.	
.	.	.	
46062	46262	Axis 2 Position 16 High Register	00005
46063	46263	Axis 2 Position 16 Low Register	05000
46064	46264	Axis 1 Velocity 1 High Register	00002
46065	46265	Axis 1 Velocity 1 Low Register	05000
46066	46266	Axis 1 Velocity 2 High Register	00004
46067	46267	Axis 1 Velocity 2 Low Register	05000
46068	46268	Axis 1 Velocity 3 High Register	00006
46069	46269	Axis 1 Velocity 3 Low Register	05000
46094	46294	Axis 1 Velocity 16 High Register	00008
46095	46295	Axis 1 Velocity 16 Low Register	05000
46096	46296	Axis 2 Velocity 1 High Register	00002
46097	46297	Axis 2 Velocity 1 Low Register	05000
46098	46298	Axis 2 Velocity 2 High Register	00004
46099	46299	Axis 2 Velocity 2 Low Register	05000
46100	46300	Axis 2 Velocity 3 High Register	00004
46101	46301	Axis 2 Velocity 3 Low Register	05000
.	.	.	
.	.	.	
.	.	.	
46126	46326	Axis 2 Velocity 16 High Register	00008
46127	46327	Axis 2 Velocity 16 Low Register	05000
46128	46328	Axis 1 Acceleration 1 Register	01000
46129	46329	Axis 1 Acceleration 2 Register	01500
46130	46330	Axis 1 Acceleration 3 Register	02000
.	.	.	
.	.	.	
.	.	.	

Table 5-11: Original & Mirror Data Table Registers

Orig . Table Addr	Mirror Table Addr	Description	Value
46143	46343	Axis 1 Acceleration 16 Register	01500
46144	46344	Axis 2 Acceleration 1 Register	01000
46145	46345	Axis 2 Acceleration 2 Register	01500
46146	46346	Axis 2 Acceleration 3 Register	02000
.	.	.	
.	.	.	
.	.	.	
46159	46359	Axis 2 Acceleration 16 Register	01500
46160	46360	Axis 1 Deceleration 1 Register	01000
46161	46361	Axis 1 Deceleration 2 Register	01500
46162	46362	Axis 1 Deceleration 3 Register	02000
.	.	.	
.	.	.	
.	.	.	
46175	46375	Axis 1 Deceleration 16 Register	01500
46176	46376	Axis 2 Deceleration 1 Register	01000
46177	46377	Axis 2 Deceleration 2 Register	01500
46178	46378	Axis 2 Deceleration 3 Register	02000
.	.	.	
.	.	.	
.	.	.	
46191	46391	Axis 2 Deceleration 16 Register	01500

Table 5-11 Cont'd: Original & Mirror Data Table Registers

5.2.6. Mode 5 - Execute Move from Table

Mode 5 of the IFC 022 FN43 User Loadable allows the PLC to execute one of the sixteen different moves stored in the Move Table in the IFC 022 for axis 1 or 2. The PLC executes a move by setting one bit out of sixteen in a Move Mask register for the axis to be moved. If the axis is enabled the IFC 022 will command the axis to move to the position corresponding to the bit selected in the move mask register. When the move is complete the IFC 022 will set a corresponding bit in the Move Complete Mask register to inform the PLC that the move is complete and the axis is in-position. When the PLC initiates another move the Move Complete bit will be reset. *Figure 5-6* illustrates the use of the FN43 Mode 5 User Loadable.

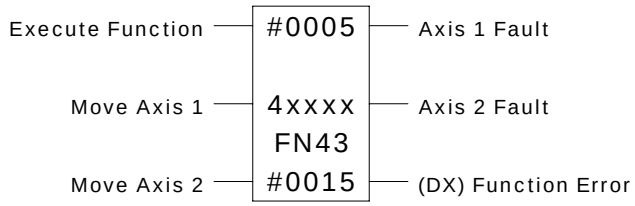


Figure 5-6: Mode 5 - Execute Move from Table Operation of FN43

To place the FN43 User Loadable in Mode 5 write a 5 in the top node of the function block. The middle node specifies the starting 4XXXX register for the 15 consecutive function block data registers. For Mode 5 place a 15 in the bottom node to designate the number of registers used by the loadable. Before applying any power to the inputs of the FN43 Mode 5 User Loadable, it must be configured by entering data into the PLC write registers. See the FN43 Mode 5 register description described below. After the loadable has been configured, power can be applied to its inputs.

When power is applied to the top input, the function block begins to execute. Power should remain on the top input at all times when this mode is in use.

When power is applied to the middle input and Axis 1 is enabled (bit 3 in register 4XXXX+4 is set) and a bit is selected in the Move Mask register (4XXXX+2), the move stored in the IFC 022 corresponding to the bit selected in the Move Mask for Axis 1 will be executed. When the move is complete, a corresponding bit in the Move Complete Mask register will be set for Axis 1 (4XXXX+5). When power is applied to the bottom input and Axis 2 is enabled (bit 11 in register 4XXXX+4 is set) and a bit is selected in the Move Mask register (4XXXX+3), the move stored in the IFC 022 corresponding to the bit selected in the Move Mask for Axis 2 will be executed. When the move is complete, a corresponding bit in the Move Complete Mask register will be set for Axis 2 (4XXXX+6). When one contact is used to turn on both the middle and the bottom inputs, the move selected in register 4XXXX+2 and 4XXXX+3 for axes 1 and 2 will start at the same time. By doing this a coordinated 2 axis move can be accomplished with the IFC 022. If a fault occurs on Axis 1, the top output will turn on. If a fault occurs on Axis 2, the middle output will turn on. When the faults are cleared, these outputs will turn off.

The bottom output is used to indicate a DX Function Fault. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

NOTE **The Move inputs are recognized by the loadable on a transition from low to high and while power is applied to the top node. Motion will not occur if power is applied to top and move inputs simultaneously.**

5.2.6.1. Mode 5 - PLC Write Registers

The following *Table 5-12* provides a description of the 5 write registers used by the FN43 Mode 5 User Loadable:

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)
4XXXX+2	Axis 1 Move Mask
4XXXX+3	Axis 2 Move Mask
4XXXX+4	Axis 1 & 2 Absolute/± Incremental Move, Enable Mask

Table 5-12: Mode 5 - PLC Write Registers

The following is a detailed description of the PLC write registers of the FN43 Mode 5 User Loadable:

4XXXX ***Starting Traffic-copped Output Register***

The user must enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

The user must enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

4XXXX+2 ***Axis 1 Move Mask***

The PLC uses this register to select the corresponding move from the IFC 022 Axis 1 move table. Only 1 bit can be selected at a time. (i.e., If bit 9 is selected in this register, the IFC 022 will move Axis 1 to the position which is stored in the 9th place of the move table of Axis 1. It will move at the speed with an acceleration /deceleration stored in the 9th position of Axis 1's move table.

4XXXX+3 ***Axis 2 Move Mask***

The PLC uses this register to select the corresponding move from the IFC 022 Axis 2 move table. Only 1 bit can be selected at a time. (i.e., If bit 9 is selected in this register, the IFC 022 will move Axis 2 to the position which is stored in the 9th place of the move table of Axis 2. It will move at the speed with an acceleration /deceleration stored in the 9th position of Axis 2's move table.

4XXXX+4 ***Axis 1 & 2 Absolute/± Incremental Move, Enable Mask***

The PLC uses this register to enable the axes and to setup a Incremental or Absolute Move for Axis 1 and 2.

Absolute Moves are indicated by the absence of Bit 1 and Bit 2.

The following is a description of the bits in this register:

Bit 1 ***Axis 1 Incremental Move Positive –*** When this bit is set, Axis 1 will move a relative distance in the positive direction from its present position. If this bit and bit 2 are zero, Axis 1 will move to the absolute position selected by the bit in the move mask referenced from the resolver's zero position.

Bit 2 ***Axis 1 Incremental Move Negative –*** When this bit is set, Axis 1 will move a relative distance in the negative direction from its present position. If this bit and bit 1 are zero, Axis 1 will move to the absolute position selected by the bit in the move mask referenced from the resolver's zero position.

Bit 3 ***Axis 1 Enable –*** When this is bit is set and Axis 1 is configured correctly and there are no faults on this axis, Axis 1 will enable its PID to control the motion of the drive/motor.

Bits 4 - 8 Are Not Used.

Bit 9 ***Axis 2 Incremental Move Positive –*** When set, Axis 2 will move a relative distance in the positive direction from its present position. If this bit and bit 10 are zero, Axis 2 will move to the absolute position selected by the bit in the move mask referenced from the resolver's zero position.

Bit 10 ***Axis 2 Incremental Move Negative*** – When set, Axis 2 will move a relative distance in the negative direction from its present position. If this bit and bit 9 are zero, Axis 2 will move to the absolute position selected by the bit in the move mask referenced from the resolver's zero position.

Bit 11 ***Axis 2 Enable*** – When this is bit is set and Axis 2 is configured correctly and there are no faults on this axis, Axis 2 will enable its PID to control the motion of the drive/motor.

Bits 12 - 16 Are Not Used.

5.2.6.2. Mode 5 - PLC Read/Reserved Registers

Register	Description
4XXXX+5	Axis 1 Move Complete Mask
4XXXX+6	Axis 2 Move Complete Mask
4XXXX+7	Axis 1 Status
4XXXX+8	Axis 2 Status
4XXXX+9	Reserved for Internal Use
4XXXX+10	Reserved for Internal Use
4XXXX+11	Reserved for Internal Use
4XXXX+12	Reserved for Internal Use
4XXXX+13	Reserved for Internal Use
4XXXX+14	Reserved for Internal Use
4XXXX+15	Reserved for Internal Use
4XXXX+16	Reserved for Internal Use

Table 5-13: Mode 5 - PLC Read/Reserved Registers

The following is a detailed description of the PLC read/reserved registers of the FN43 Mode 5 User Loadable:

4XXXX+5 ***Axis 1 Move Complete Mask***

The PLC uses this register to monitor when the selected move in register 4XXXX+2 has been completed. i.e. If bit 9 in 4XXXX+2 was selected and the IFC 022 moved Axis 1 to the position in the 9th table position, bit 9 in this register will be turned on as soon as the move is completed.

4XXXX+6 ***Axis 2 Move Complete Mask***

The PLC uses this register to monitor when the selected move in register 4XXXX+3 has been completed. i.e. If bit 9 in 4XXXX+3 was selected and the IFC 022 moved Axis 2 to the position in the 9th table position, bit 9 in this register will be turned on as soon as the move is completed.

4XXXX+7 ***Axis 1 Status***

The PLC uses this register to monitor Axis 1's status while it is either moving or stopped. The following is a description of each of the status bits in this register:

Bit 1 ***Homing Off*** – When this bit is a 1 the axis is moving off the home input during a homing sequence.

Bit 2 ***Homing*** – This bit will be set to a 1 when the axis has been given a HOME command. This bit will be reset to a 0 when the homing function has been completed.

Bit 3 ***Faulted*** – This bit will be set to a 1 when the axis is faulted. This bit will be reset to 0 when the faults are cleared for this axis.

Bit 4 ***Moving Continuously –*** This bit is a 1 when the axis has been given a command to move indefinitely at a constant velocity. This bit will be 0 when the axis is stopped.

Bit 5 ***Reserved***

Bit 6 ***In-Decel*** – When this bit is a 1, the axis is decelerating to a stop. This bit will be reset to 0 as soon as the axis is in the in-position band set by the user.

Bit 7 ***Reserved***

Bit 8 ***In-Position*** – When this bit is a 1, the axis is within the In-Position band set by the user.

Bit 9 ***Velocity Feed Forward*** – When 1, the velocity feed forward gain for this axis is enabled. When this is enabled the axis will try to run with minimal or no following error. Following error is the difference between the commanded position and the actual position of the axis.

Bit 10 ***Reverse Output Mode*** – When this bit is a 1 the reverse output mode of the motion PID is enabled. When this is enabled the axis will apply torque in the opposite direction of the force exerted by the load.

Bit 11 ***Enabled*** – When this bit is a 1 the motion PID for this axis is enabled. This allows the IFC 022 to control the motion of this axis.

Bit 12 ***In Negative Current Clamp*** – When this bit is a 1 the value in the Analog Output Register is at the same value as the value set for the Negative Current Clamp on the PID tuning screen in the IFC 022 Windows Setup Software setup software.

Bit 13 ***In Positive Current Clamp*** – When this bit is a 1 the value in the Analog Output Register is at the same value as the value set for the Positive Current Clamp on the PID tuning screen in the IFC 022 Windows Setup Software setup software.

Bit 14 ***Reserved***

Bit 15 ***Moving Minus*** – When this bit is a 1 the axis is moving is a negative direction. When this bit is a 0 the axis is moving in the positive direction.

Bit 16 ***Moving*** – When this bit is a 1 the axis is moving. When this bit is a 0 the axis is stopped.

4XXXX+8 ***Axis 2 Status***

The PLC uses this register to monitor Axis 2's status while it is either moving or stopped. The bits for this register are the same as described in register 4XXXX+7. These bits are updated independently from Axis 1.

4XXXX+9 - 4XXXX+14 Are used by the loadable for storing variables. Do not write to these resisters.

5.2.7. Mode 6 – Copy Setup Data from the Module to the PLC

Mode 6 of the IFC 022 FN43 User Loadable allows the PLC to copy the axes setup data from the Module to the PLC. The data stored in the PLC can then be loaded to the same or a new module by using Mode 7 of the loadable. This allows the PLC to initialize the module instead of using the MMI software. *Figure 5-7* illustrates the use of the FN43 Mode 6 User Loadable.

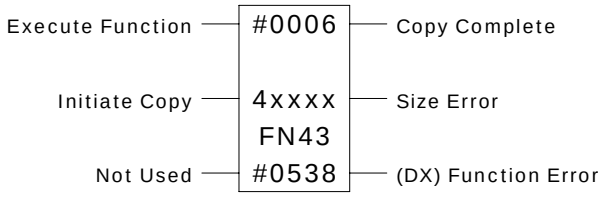


Figure 5-7: Mode 6 – Copy Setup Data Operation of FN43

To place the FN43 User Loadable in Mode 6 write a 6 in the top node of the function block. The middle node specifies the starting 4XXXX register for the 538 consecutive function block data registers. For Mode 6 place a 538 in the bottom node to designate the number of registers used by the loadable. Before applying any power to the inputs of the FN43 Mode 6 User Loadable, it must be configured by entering data into the PLC write registers. See the FN43 Mode 6 register description described below. After the loadable has been configured, power can be applied to its inputs. When power is applied to the top input, the function block begins to execute. Power should remain on the top input at all times when this mode is in use. When power is applied to the middle input, the function proceeds to copy the setup data from the module to the PLC registers. Once the process is complete, the top output will go active.

The bottom node of 538, specifying the number of registers necessary for this function, is valid for Firmware Version 1.00. If later versions of firmware require additional registers a Size Error may be activated on the middle output. In this case, the user can determine the correct value for this node by reading the register at the base register plus 9.

The bottom output is used to indicate a fault condition. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

Only IFC 022 Firmware Versions 1.00 and later support this function.

NOTE **The Copy Input is recognized by the loadable on a transition from low to high and while power is applied to the top node. Coping will not occur if power is applied to top and copy inputs simultaneously.**

5.2.7.1. Mode 6 - PLC Write Registers

The following *Table 5-14* provides a description of the registers used by the FN43 Mode 6 of the user loadable:

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)

Table 5-14: Mode 6 - PLC Write Registers

The following is a detailed description of the PLC write registers of the FN43 Mode 6 User Loadable:

4XXXX ***Starting Traffic-copped Output Register***

The user must enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

The user must enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

5.2.7.2. Mode 6 - PLC Read/Reserved Registers

The following *Table 5-15* provides a description of the read/reserved registers used by the FN43 Mode 7 of the user loadable:

Register	Description
4XXXX+2	Reserved for Internal Use
4XXXX+3	Reserved for Internal Use
4XXXX+4	Reserved for Internal Use
4XXXX+5	Reserved for Internal Use
4XXXX+6	Reserved for Internal Use
4XXXX+7	Reserved for Internal Use
4XXXX+8	Reserved for Internal Use
4XXXX+9	Number of Registers Required
4XXXX+10	Start of Setup Data
.	.
.	.
.	.
4XXXX+537	End of Setup Data

Table 5-15: Mode 6 - PLC Read/Reserved Registers

The following is a detailed description of the PLC read registers of the FN43 Mode 6 User Loadable:

4XXXX+2 - 4XXXX+8 Are reserved for internal use.

4XXXX+9 ***Total Register Required by Function 6***

The value will be 528 for Firmware Version 1.00. Later Firmware Version may require addition registers. Use this value to adjust the bottom note of the FN43 block if necessary. The bottom node should be equal to this value plus 10.

4XXXX+10 - 4XXXX+537 Contains the Setup Data.

5.2.8. Mode 7 – Copy Setup Data from the PLC to the Module

Mode 7 of the IFC 022 FN43 User Loadable allows the PLC to copy the axes setup data that had been saved by using Mode 6 of the loadable from the PLC to the Module. This allows the PLC to initialize the module instead of using the MMI software. *Figure 5-8* illustrates the use of the FN43 Mode 6 User Loadable.

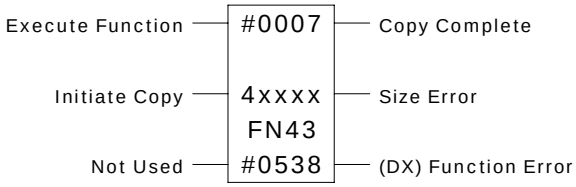


Figure 5-8: Mode 7 – Copy Setup Data Operation of FN43

To place the FN43 User Loadable in Mode 6 write a 6 in the top node of the function block. The middle node specifies the starting 4XXXX register for the 538 consecutive function block data registers. For most cases this register should be the same one used in the middle node of the Mode 6 FN43 block used to save the data.

For Mode 7 place a 538 in the bottom node to designate the number of registers used by the loadable. Before applying any power to the inputs of the FN43 Mode 7 User Loadable, it must be configured by entering data into the PLC write registers. See the FN43 Mode 7 register description described below. After the loadable has been configured, power can be applied to its inputs. When power is applied to the top input, the function block begins to execute. Power should remain on the top input at all times when this mode is in use. When power is applied to the middle input, the function proceeds to copy the setup data from the module to the PLC register. Once the process is complete the, the top output will go active.

It is important to note the copy process starts when the middle input goes active after being inactive and it must stay active until the process completes.

The bottom node of 538, specifying the number of registers necessary for this function, is valid for Firmware Version 1.00. If later versions of firmware require additional registers a Size Error may be activated on the middle output. In this case, the user must use Mode 6 to determine the correct value for this node. See Mode 6 for more information.

Size Error may also occur if the data size save in the PLC does not match the data size in the firmware. This may be a result of incompatible Firmware Versions or corrupted data in the PLC.

The bottom output is used to indicate a DX Function Fault. This fault condition usually indicates incorrect node information, the IFC 022 is not present, or a module communication error.

Only IFC 022 Firmware Versions 1.00 and later support this function.

NOTE **The Copy Input is recognized by the loadable on a transition from low to high and while power is applied to the top node. Coping will not occur if power is applied to top and copy input simultaneously.**

5.2.8.1. Mode 7 - PLC Write Registers

The following *Table 5-16* provides a description of the two write registers used by the FN43 Mode 7 of the user loadable:

Register	Description
4XXXX	Starting Traffic-copped Output Register (40001 - 49999)
4XXXX+1	Starting Traffic-copped Input Register (30001 - 39999)

Table 5-16: Mode 7 - PLC Write Registers

The following is a detailed description of the PLC write registers of the FN43 Mode 7 User Loadable:

4XXXX ***Starting Traffic-copped Output Register***

The user must enter the number of the first 4XXXX Output Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 1234 is register 41234

4XXXX+1 ***Starting Traffic-copped Input Register***

The user must enter the number of the first 3XXXX Input Register that has been traffic-copped to the module. This number must be in the range 0001 to 9999 and must match the register defined in the traffic-cop.

Example: 0334 is register 30334

5.2.8.2. Mode 6 - PLC Read/Reserved Registers

The following *Table 5-17* provides a description of the read/reserved registers used by the FN43 Mode 7 of the user loadable:

Register	Description
4XXXX+2	Reserved for Internal Use
4XXXX+3	Reserved for Internal Use
4XXXX+4	Reserved for Internal Use
4XXXX+5	Reserved for Internal Use
4XXXX+6	Reserved for Internal Use
4XXXX+7	Reserved for Internal Use
4XXXX+8	Reserved for Internal Use
4XXXX+9	Reserved for Internal Use
4XXXX+10	Start of Setup Data
.	.
.	.
.	.
4XXXX+537	End of Setup Data

Table 5-17: Mode 7 - PLC Read/Reserved Register

In this Chapter you will learn about:

- Troubleshooting Procedures
- Diagnostic LEDs
- Setup Software Diagnostics
- PLC Diagnostics

6.1. Troubleshooting Procedure

The information in this chapter will help you isolate and resolve system hardware and software problems.

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you have accomplished this, you can effectively begin to resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it runs independently. You may have to dismantle your system and put it back together piece-by-piece to detect the problem. If you have additional components available, you may want to try replacing them with existing components or components that are working in another system. You should also try removing features until the component is running in its most basic mode.

Determine if the problem is mechanical, hardware or software-related. Try to recreate or repeat the problem. Do not attempt to make quick rationalizations about the problem. Random events may appear to be related, but they are not necessarily contributing factors to the problem. You must carefully investigate and decipher the events that occur leading up to the problem occurring.

You could be experiencing more than one problem. Try to isolate and solve one problem at a time. Document all testing and problem isolation procedures for review with a technician at a later time. When you feel that you have exhausted all possibilities and the problem still exists, call your local distributor or I²T Technical Support at (412) 828-1200. Please have the following information available when you call.

- Product Part Numbers
- Product Serial Number
- Detailed Description of Problem
- Description of Application

6.2. Diagnostic LEDs

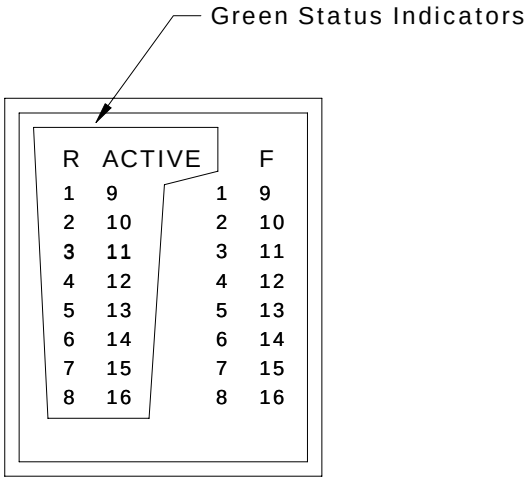
A diagnostic LED array is mounted on the front of the IFC 022 Module. This LED array consists of 35 segments, with 3 common segments, 16 segments dedicated to axis Channel 1 and 16 segments dedicated to axis Channel 2. There are two sets of segments labeled 1 through 16, with each segment representing a different piece of status or fault information. More than one fault can be displayed at any time by multiple segments being illuminated. Segments 1 through 16 on the left-hand side are green and are for displaying module status information. Segments 1 through 16 on the right-hand side are red and are for displaying fault information.

6.2.1. Status LEDs

Table 6-1 shows a list of the status bits for each channel. A detailed description follows.

Segment	Color	Status Bit Description
R	Green	Not Used
Active	Green	Module OK and Running
F	Red	Module Code Checksum Fault

Table 6-1: Green & Red Channel Status Bits



Segment	Color	Status Bit Description
1	Green	Module Heartbeat
2	Green	Serial communications active
3	Green	PLC communications active
4	Green	Not Used
5	Green	Channel 1 Resolver Okay
6	Green	Channel 2 Resolver Okay
7	Green	Channel 1 In-position
8	Green	Channel 2 In-position
9	Green	Digital Input 1 is On
10	Green	Digital Input 2 is On
11	Green	Digital Output 1 is On
12	Green	Digital Output 2 is On
13	Green	PID Mode 1
14	Green	PID Mode 2
15	Green	PID Mode 1 Active
16	Green	PID Mode 2 Active

Table 6-2: Green Channel Status Bits

6.2.1.1. Module Heartbeat

This status LED continuously blinks when the module functions properly.

6.2.1.2. Serial Communications Active

This LED blinks when there is communications between the user's PC and the IFC 022 Module through the serial port.

6.2.1.3. PLC Communications Active

This LED blinks while the PLC issues commands to the IFC 022 Module.

6.2.1.4. Channel 1 Resolver Okay

This LED is on when the Channel 1 Resolver is seen properly by the IFC022 Module and position is being read. ***Note:*** There is no circuitry to detect whether the module is reading an encoder signal properly. This should be done by turning the encoder and watching the position count using the module setup software.

6.2.1.5. Channel 2 Resolver Okay

This LED is on when the Channel 2 Resolver is seen properly by the IFC 022 Module and position is being read.

6.2.1.6. Channel 1 In-position

This LED is on when the IFC 022 Module is in positioning mode and the Channel 1 motor is within the in-position band of its commanded position. This LED is not used if the module is not in positioning mode.

6.2.1.7. Channel 2 In-position

This LED is on when the IFC 022 Module is in positioning mode and the Channel 2 motor is within the in-position band of its commanded position. This LED is not used if the module is not in positioning mode.

6.2.1.8. Digital Input 1 is On

Following the state of the Channel 1 Digital Input, this LED is ON when the input is ON and OFF when the input is OFF.

6.2.1.9. Digital Input 2 is On

Following the state of the Channel 2 Digital Input, this LED is ON when the input is ON and OFF when the input is OFF.

6.2.1.10. Digital Output 1 is On

Following the state of the Channel 1 Digital Output, this LED is ON when the output is ON and OFF when the output is OFF.

6.2.1.11. Digital Output 2 is On

Following the state of the Channel 2 Digital Output, this LED is ON when the output is ON and OFF when the output is OFF.

6.2.1.12. Channel 1 in PID Mode

This LED is ON when the Channel 1 of the module is in PID mode.

6.2.1.13. Channel 2 in PID Mode

This LED is ON when the Channel 2 of the module is in PID mode.

6.2.1.14. Channel 1 PID Mode Enabled

This LED is ON when the Channel 1 PID is active and the module is controlling the PID output based on the error signal.

6.2.1.15. Channel 2 PID Mode Enabled

This LED is ON when the Channel 2 PID is active and the module is controlling the PID output based on the error signal.

6.2.2. Fault LEDs

Table 6-3 shows a list of the fault bits for each channel. A detailed description follows.

Segment	Color	Fault Bit Description
1	Red	Watchdog Error
2	Red	Serial Communications Error
3	Red	PLC Communications Error
4	Red	Data Corrupted Error
5	Red	Channel 1 Loss of Resolver Feedback
6	Red	Channel 2 Loss of Resolver Feedback
7	Red	Channel 1 Resolver Range Error
8	Red	Channel 2 Resolver Range Error
9	Red	Channel 1 Speed Fault
10	Red	Channel 2 Speed Fault
11	Red	Channel 1 EOT Fault
12	Red	Channel 2 EOT Fault
13	Red	Channel 1 PID Fault
14	Red	Channel 2 PID Fault
15	Red	Channel 1 Not Homed
16	Red	Channel 2 Not Homed

Table 6-3: Red Channel Status Bits

6.2.2.1. Watchdog Error

A hardware problem occurred and caused the resolver board to stop communicating. Verify that proper supply voltage are applied to the breakout module. If this fault cannot be reset by powering the system down, call I^2T Technical Support at (412) 828-1200.

6.2.2.2. Serial Communications Error

Bad commands are being sent to the IFC 022 Module from the serial port. Check cabling and computer setup.

6.2.2.3. PLC Communications Error

Bad commands are being sent to the IFC 022 Module from the PLC. Check the command messages from the PLC.

6.2.2.4. Data Corrupted Error

The setup data being used by the IFC 022 Module is defaulted or corrupted. Download new data from the setup software to correct the problem.

6.2.2.5. Channel 1 Loss of Resolver Feedback

A signal is not being returned from either the sine or cosine of the resolver connected to Channel 1. This could result from a loose or broken wire, incorrect resolver wiring, or a bad resolver. Check the wiring and put an oscilloscope on the reference, sine and cosine signals. There should be a 5 kHz sine wave on each of these signals. When this error occurs, the Channel 1 homed light goes out, since Channel 1 no longer knows its position when the resolver signal is lost. To continue, clear the fault and home the Channel 1 Resolver.

6.2.2.6. Channel 2 Loss of Resolver Feedback

A signal is not being returned from either the sine or cosine of the resolver connected to Channel 2. This could result from a loose or broken wire, incorrect resolver wiring, or a bad resolver. Check the wiring and put an oscilloscope on the reference, sine and cosine signals. There should be a 5 kHz sine wave on each of these signals. When this error occurs, the Channel 2 homed light goes out, since Channel 2 no longer knows its position when the resolver signal is lost. To continue, clear the fault and home the Channel 2 Resolver.

6.2.2.7. Channel 1 Range Error

The IFC 022 Module is outputting 7V RMS on the reference signal to the resolver and cannot get at least 2V RMS back on the sine or cosine signals. The range is only checked on power-up and could indicate a wiring problem or a bad resolver.

6.2.2.8. Channel 2 Range Error

The IFC 022 Module is outputting 7Vrms on the reference signal to the resolver and cannot get at least 2Vrms back on the sine or cosine signals. The range is only checked on power-up and could indicate a wiring problem or a bad resolver.

6.2.2.9. Channel 1 Speed Fault

The Channel 1 Resolver exceeded the overspeed value entered or is below the underspeed value entered in the configuration data. This fault remains on as long as the overspeed or underspeed condition exists.

6.2.2.10. Channel 2 Speed Fault

The Channel 2 Resolver exceeded the overspeed value entered or is below the underspeed value entered in the configuration data. This fault remains on as long as the overspeed or underspeed condition exists.

6.2.2.11. Channel 1 EOT Fault

The Channel 1 position value exceeded the EOT+ position or is below the EOT- position that the user previously entered in the configuration data. This fault remains on as long as one of the over-travel positions is exceeded.

6.2.2.12. Channel 2 EOT Fault

The Channel 2 position value exceeded the EOT+ position or is below the EOT- position that the user previously entered in the configuration data. This fault remains on as long as one of the over-travel positions is exceeded.

6.2.2.13. Channel 1 PID Fault

The PID control loop detects a problem on Channel 1 such as excessive position error or motor current that is too high. The IFC 022 Module turns off the Channel 1 PID control loop whenever this fault condition exists.

6.2.2.14. Channel 2 PID Fault

The PID control loop detects a problem on Channel 2 such as excessive position error or motor current that is too high. The IFC 022 Module turns off the Channel 2 PID control loop whenever this fault condition exists.

6.2.2.15. Channel 1 Not Homed

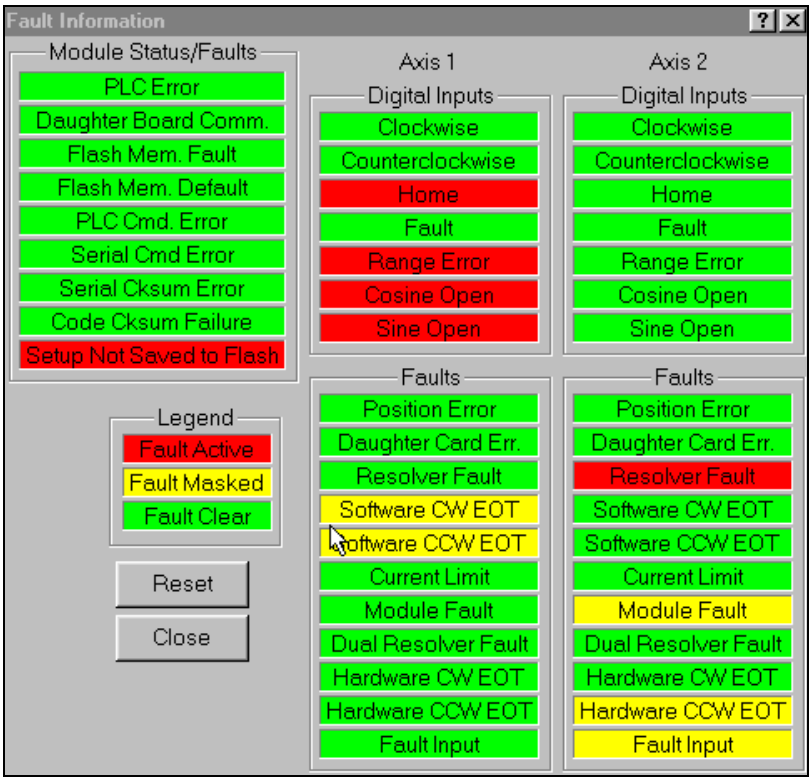
The Channel 1 motor has not been homed. This LED is ON whenever the IFC 022 Module has been powered-up before homing. An Absolute Move should not be done while this fault exists.

6.2.2.16. Channel 2 Not Homed

The Channel 2 motor has not been homed. This LED is ON whenever the IFC 022 Module has been powered-up before homing. An Absolute Move should not be done while this fault exists.

6.3. Setup Software Diagnostics

The user can perform module diagnostics in two different ways. The first way is to use the Setup Software package to look at fault information. This is done by going to the **Tools** Pull-down Menu followed by selecting **Faults**. The following fault information screen appears.



6.4. PLC Diagnostics

The second way to perform diagnostics on the module is to look at the module status registers in the PLC. The same information seen on the **Fault** screen is also available in the PLC.

6.4.1. Using PLC Fault Registers for Diagnostics

When a module fault occurs, fault registers are returned to the PLC for the user to interrogate. See *Chapter 4* for a description of the register values returned from the card. *Table 6-4* and *Table 6-5* provide a list of the faults returned in the Fault Registers. The following registers are returned to the PLC via the loadable function block:

- Axis 1 Status and Limits (Register 4XXXX + 7)
- Axis 2 Status and Limits (Register 4XXXX + 12)
- IFC 022 Module Fault and Status Word (Register 4XXXX + 14)
- IFC 022 Module Input Status Word (Register 4XXXX + 15)
- Axis 1 Latched Faults (Register 4XXXX + 16)
- Axis 2 Latched Faults (Register 4XXXX + 17)

A description of the bits in these registers can be found in Chapter 4.

In this Chapter you will learn about:

Application Calculations

A.1. Application Calculations

This section describes how to calculate user units for your application. There are some limitations to the user unit number because of the way that numbers are stored in the PLC. This section will help you select a user unit value that will give you the resolution that you want and show you how to calculate the maximum number of revolutions that the resolver will travel before a rollover occurs.

Position values are always stored in two PLC registers using Modulo 10,000 format. The following are some examples of how numbers are stored in the PLC using this format.

Number	PLC High Register	PLC Low Register
583	00000	00583
10,020	00001	00020
125,933	00012	05933
17,592,015	01759	02015
107,921,882	10792	01882

The resultant number is obtained by using the following formula.

Position = (PLC High Register * 10000) + PLC Low Register

The low register is always 9999 or less and the high register can be any number from 0 to 65535. Using Modulo 10,000, the largest number that can be shown is 655,359,999. This will be the largest number of position counts that can be passed to the PLC by the IFC 020 module. You must keep this in mind when entering your user units if you are measuring position over a long distance.

User units are entered in units of counts per revolution of the resolver via the setup software. So entering a value of 0.0001 for the user units will give you 1 count per resolver revolution in the low PLC register. Entering a value of 0.0010 for user units will give you 10 counts per resolver revolution in the low register. Entering a value of 1.0000 will give you 10,000 counts per revolution in the low register or 1 count per revolution in the high register. The maximum output of the resolver is 4,096 counts per revolution, limiting the resolution as larger user unit values are entered. The maximum number of revolutions that the resolver will turn without rolling over is 65,535 / user units, with a maximum of number of 1,047,363. Using the above example, if your user units were set to 1.0000, then the maximum number of resolver revolutions would be 65,535 / 1.0000 or 65,535. If your user units were set to 0.0010, the maximum number of resolver revolutions would be 65,535 / 0.0010 or 65,535,000. But our maximum number of revolutions is 1,047,363 in all cases.

Appendix A — *IFC 022 CALCULATING USER UNITS*

In most applications, you will be configuring the resolver module to rollover at a specified number, so you will not need to worry about the maximum number of resolver revolutions. The only applications that rollover is a concern are totalizer applications, where the resolver will be measuring position over a long distance. The maximum number of resolver revolutions is 1,047,363. This number may be reduced depending on the user units that you are using.

The following table shows the maximum number of revolutions for different user unit values.

User Units	Counts/Rev.	Resolver Position	PLC High Register	PLC Low Register	Max. No. (Revs.)	Max. Posn. Value
0.0010	10	2,000 (200 revs)	00000	02000	1,047,363	10,473,630
0.0200	200	2,000 (10 revs)	0000	02000	1,047,363	10,473,630
0.500	5000	2,000 (0.4 revs)	0000	02000	131,070	655,350,000
1.2500	1250	2,000 (0.16 revs)	0000	02000	52,428	655,350,000
360.0000	3600000	2,000 (0.00055 revs)	0000	02000	182	655,350,000

NOTE ☝ **As larger user units are entered, the counts per revolution increase, but the actual resolution of the system is limited to 4,096 counts per revolution. For the example using user units of 1.2500, the position reported back to the PLC would increment 3 counts for every resolver count.**

The following are some real-world examples of setting user units.

A.1.1. Example 1

Your resolver is mounted on a drum with a 1 to 1 ratio and you want to report position back to the PLC in hundredths of a degree of drum rotation. Your user units would be 3.6000, giving you 36000 counts per drum revolution. Your rollover value would be set to 3.6000 because you want the position to rollover each revolution of the drum. The following values would be returned in the PLC position registers.

Drum Position	PLC High Register	PLC Low Register
45 degrees	00000	04500
90 degrees	00000	09000
270 degrees	00002	07000
359 degrees	00003	05900

If you were not using a rollover value, the maximum number of drum revolutions before a rollover would occur would be 65,535 / 3.6 or 18,204.

A.1.2. Example 2

Your resolver is mounted on a 12 inch circumference wheel that is measuring the length of a strip of steel. You want a resolution of 0.1 inches reported back to the PLC. Your user units would be 0.0120, giving you 120 counts per wheel revolution. You would not use a rollover value because you want to measure the maximum length of steel. The following values would be returned in the PLC position registers.

Steel Position	PLC High Register	PLC Low Register
10.5 inches (0.875 feet)	0000	00105
65.2 inches (5.4 feet)	0000	00652
190.8 inches (15.9 feet)	0000	01908
20054.3 inches (1671.2 feet)	0000	00543

The maximum number of feet that could be measured using this resolution would be 1,047,363 inches.

A.1.3. Example 3

Your resolver is mounted on a ballscrew with a pitch of 8 revs per inch. You want a resolution of 0.0001 inches reported back to the PLC. Your user units would be 0.1250, giving you 1250 counts per resolver revolution or 10,000 counts per inch of travel. You would not use a rollover value because your ballscrew has a limited length of travel. The following values would be returned in the PLC position registers.

Ballscrew Position	PLC High Register	PLC Low Register
0.2250	00000	02250
1.1592	00001	01592
22.9923	00022	09923
100.5820	00100	05820

In this Chapter you will learn about:

Drawings

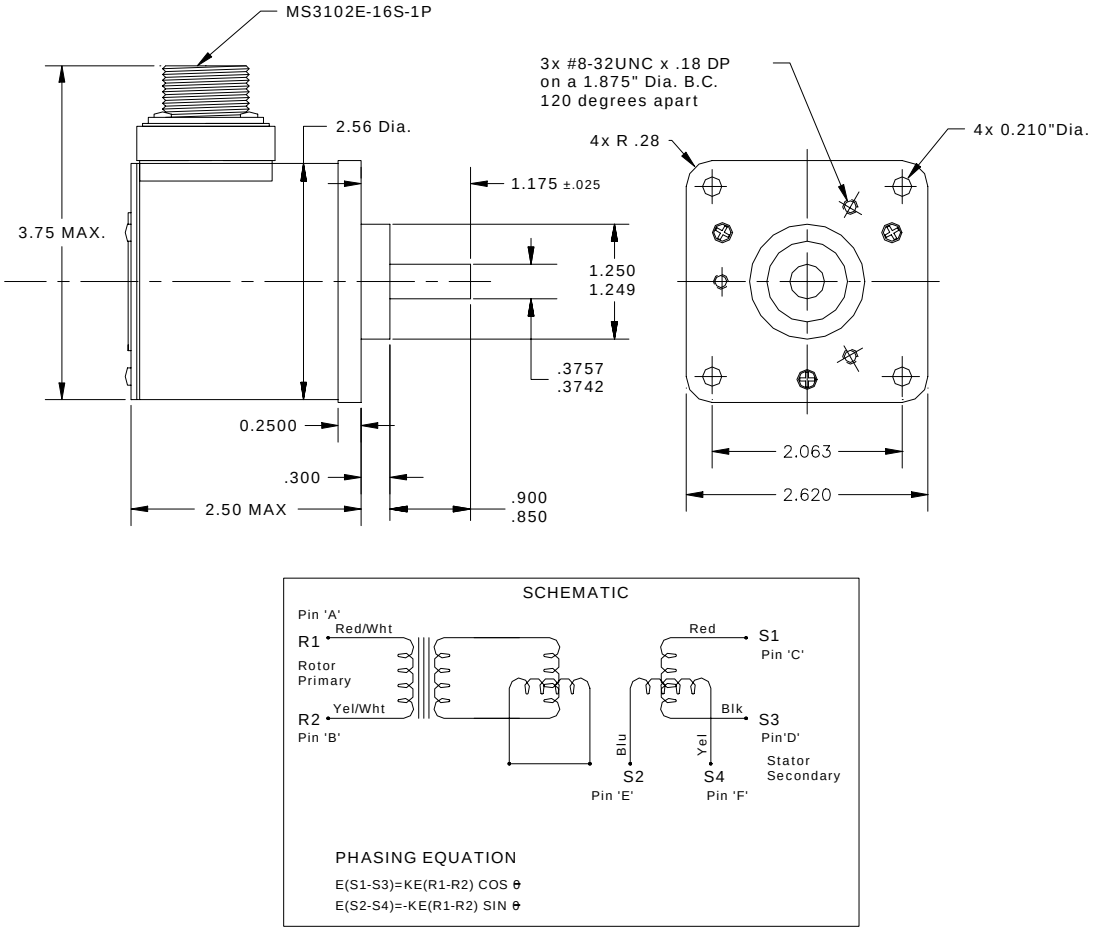


Figure B-1: Industrial Brushless Resolver - Flange Mounting (P/N 3000-01)

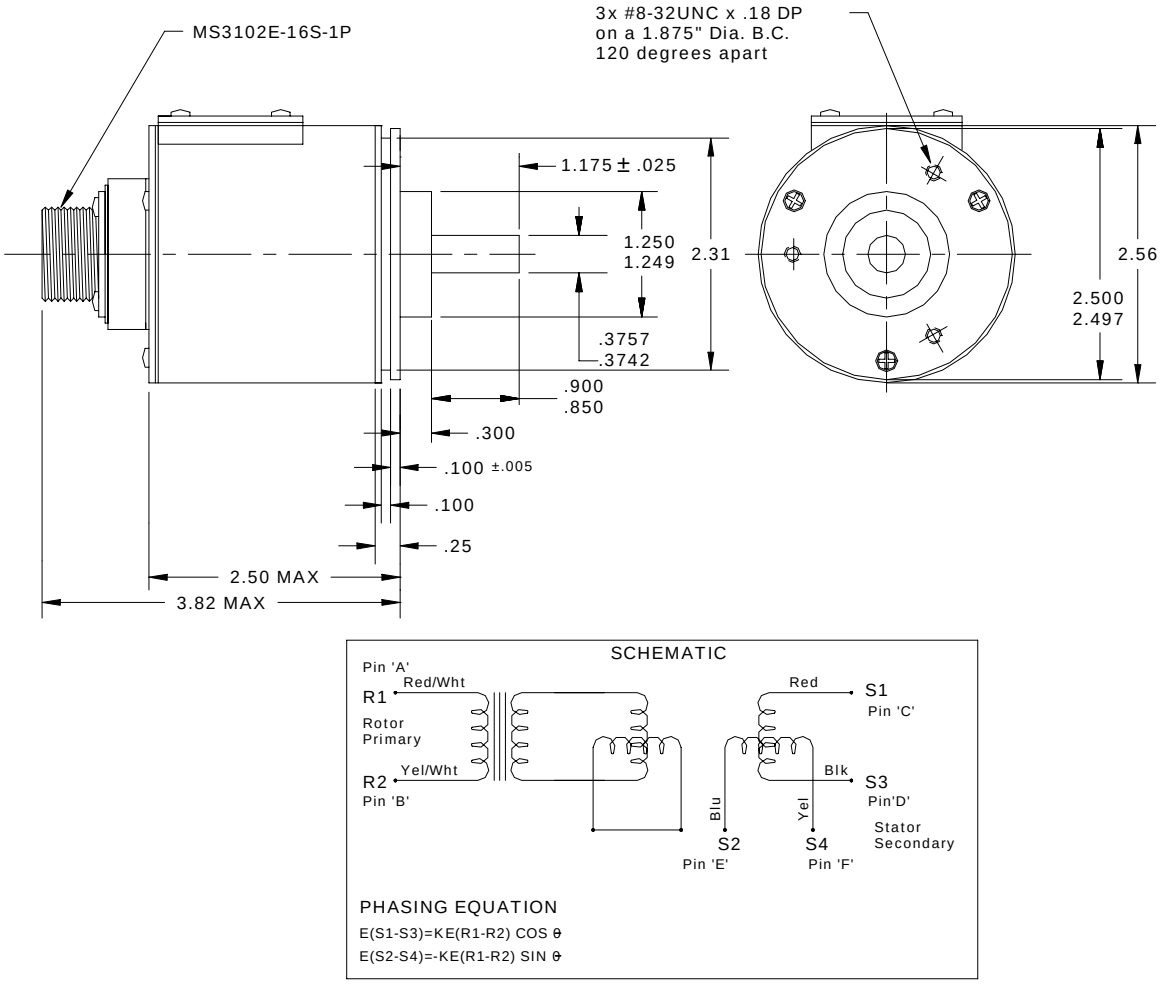


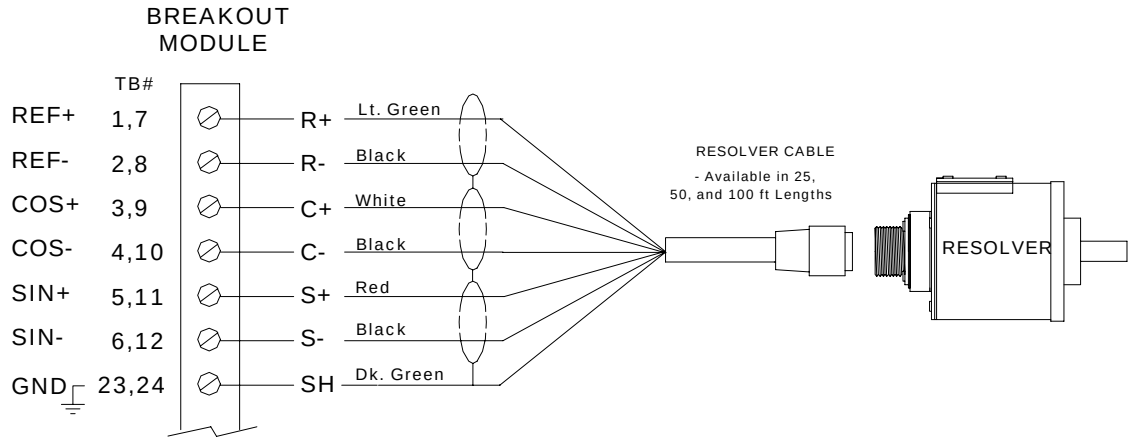
Figure B-2: Industrial Brushless Resolver Flange Mounting (PN 3000-02)

Description	Given In	Range
Temperature Range	Degrees C	-55 to +125
Rotor Moment of Inertia	Oz-In-Sec	0.0032
Weight	Nom. Lbs.	1.6
Radial Play	1 Lb. Load	0.0015
End Play	5 Lb. Load	0.005 Max.
Shaft Friction	Max. Oz-In	2.0

Table B-1: Mechanical Specifications to Figure B-1 and B2

Description (7000 Hz)	Given In	Range
Input Voltage	Volts	4.25
Input Current	Max. mA	55
Input Power	Nom. Watts	0.14
Impedance ZRO	Ohms	62 + J61
Impedance ZRS	Ohms	54 + J54
Impedance ZSO	Ohms	80 + J137
Impedance ZSS	Ohms	67 + J122
Transformation Ratio	± 5%	0.470
Output Voltage	± 5% Volts	2.0
DC Rotor Resistance	± 15% Ohms	36
DC Stator Resistance	± 15% Ohms	15
Sensitivity	mV/Deg.	35
Max. Error from E-Z	Minutes	± 7
Phase Shift (open circuit)	Nom. Degrees	4 ± 3°
Null Voltage	Max. mV	20
Hypot to Case	60Hz VRMS	500
Hypot between Phases	60Hz VRMS	250

Table B-2: Electrical Specifications to Figure B-1 and Figure B-2



Note: All shields should be taken to earth ground terminal on breakout module.

Figure B-3: Resolver Wiring for 25, 50, 100 and 150 Ft. Cables (PN 4000-XXX)

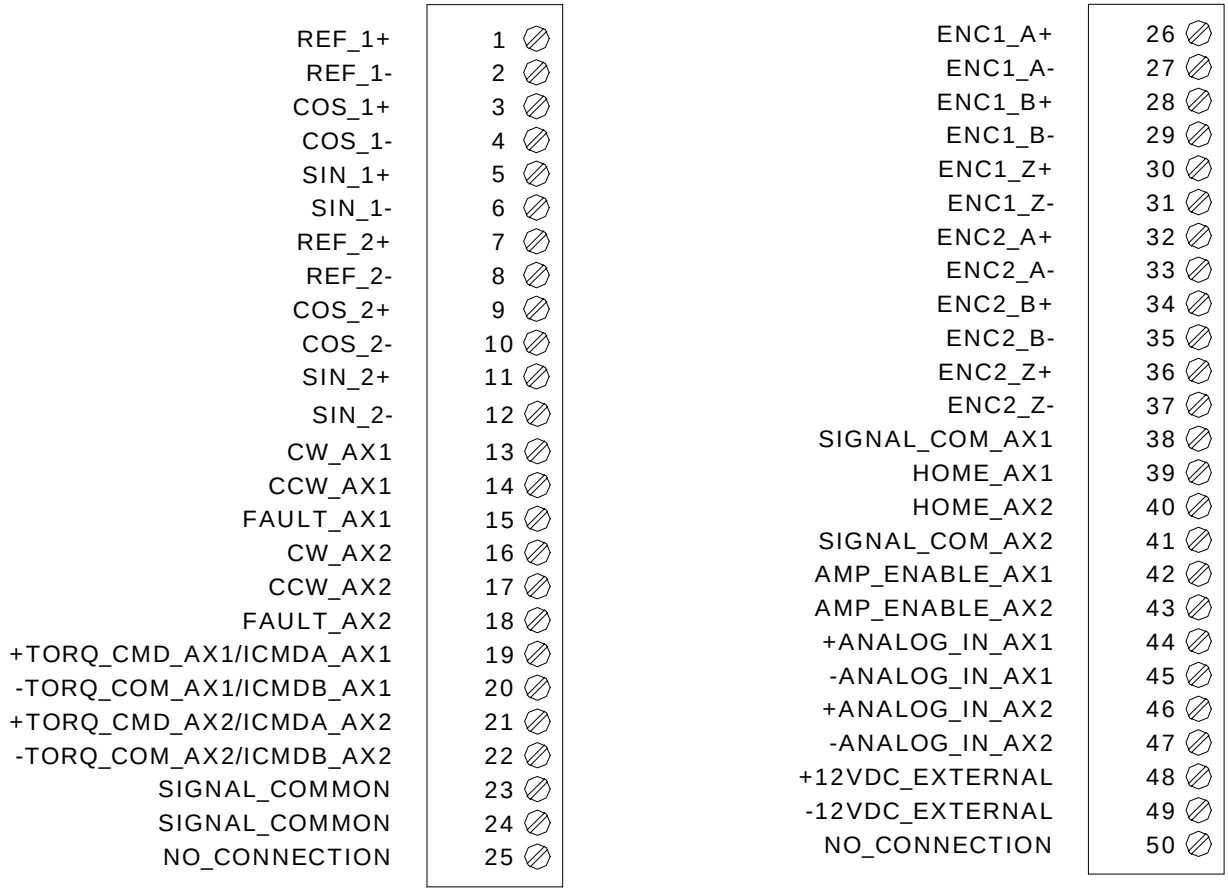


Figure B-4: Non-Absolute Breakout Module Wiring (PN 6000-01)

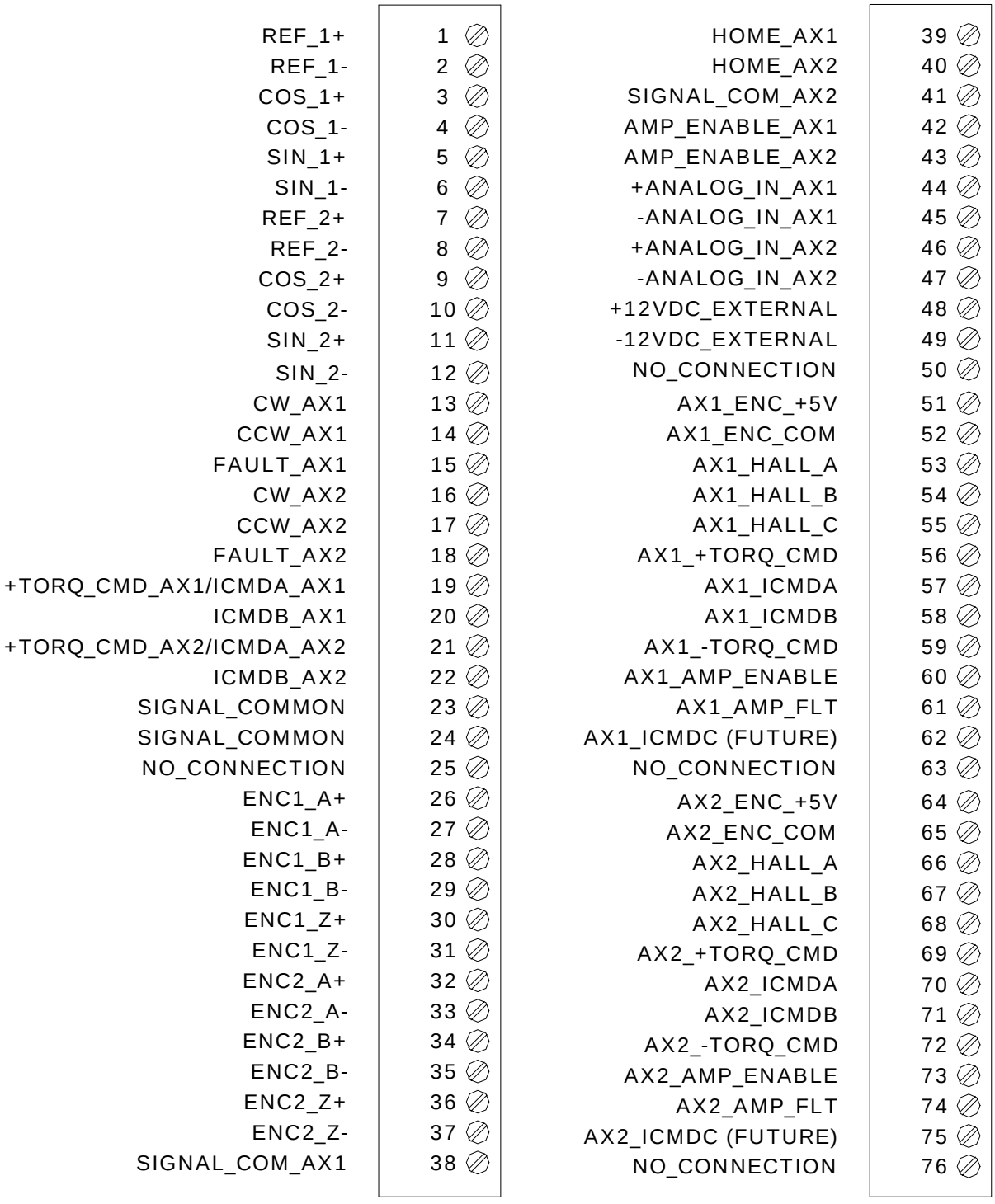


Figure B-5: Servo Breakout Module Wiring (PN 6000-04)

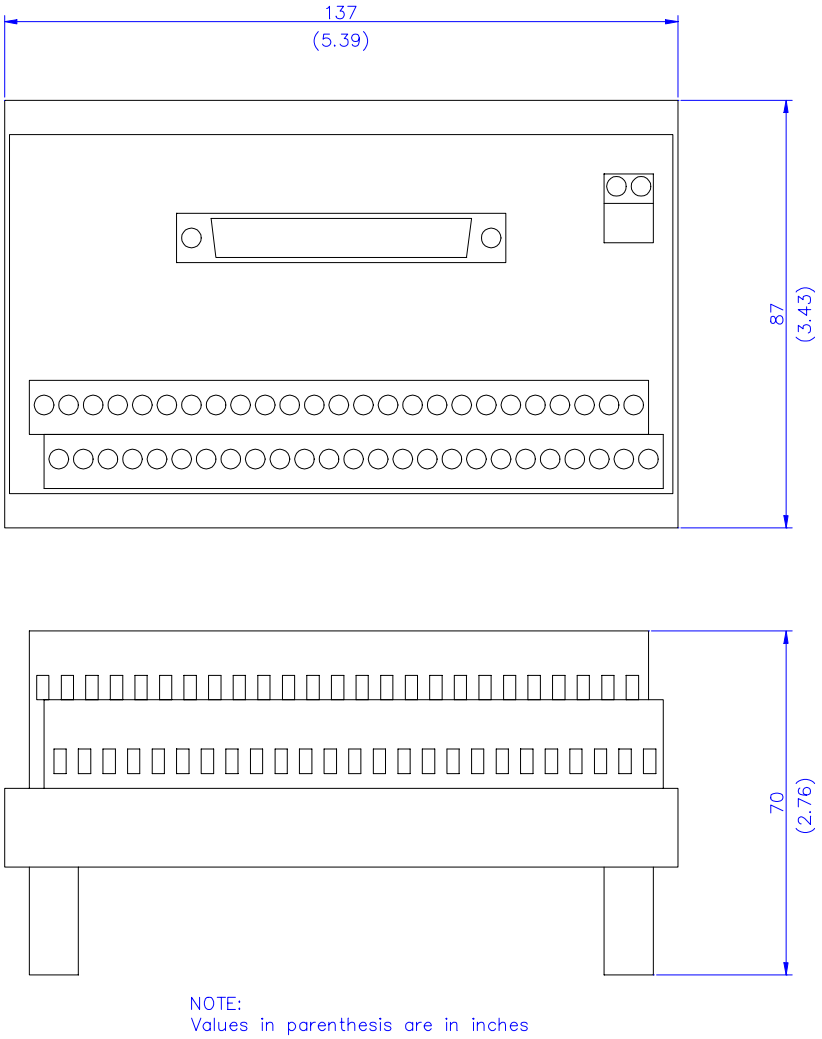


Figure B-6: Non-Absolute Breakout Module Dimensions (P/N 6000-01)

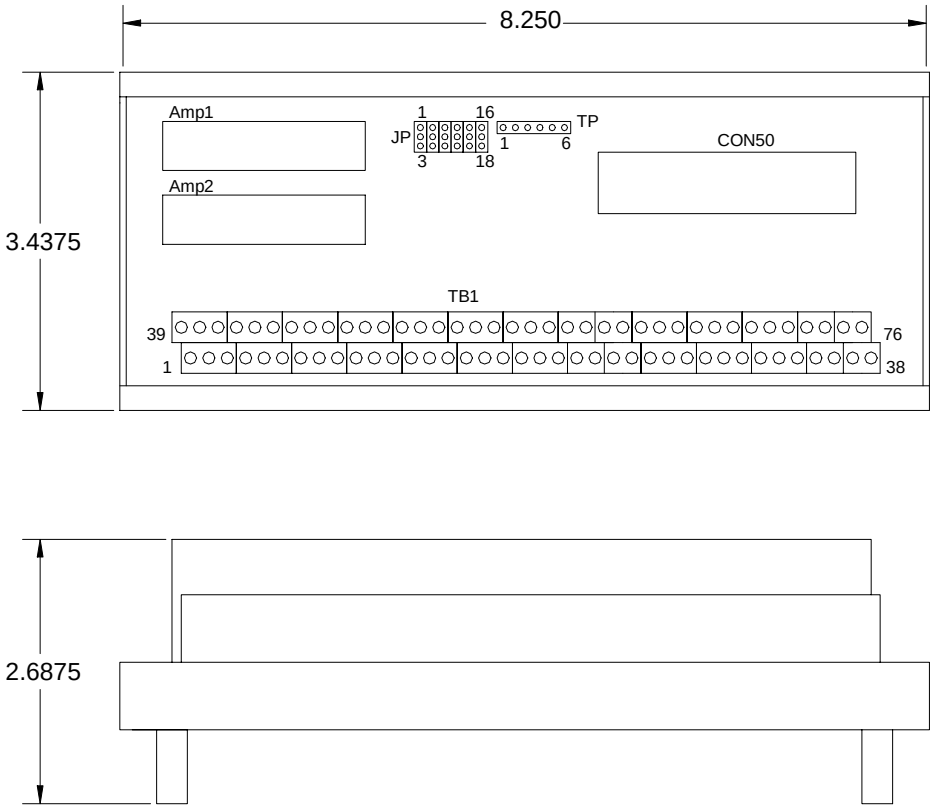


Figure B-7: Servo Breakout Module Dimensions (P/N 6000-04)

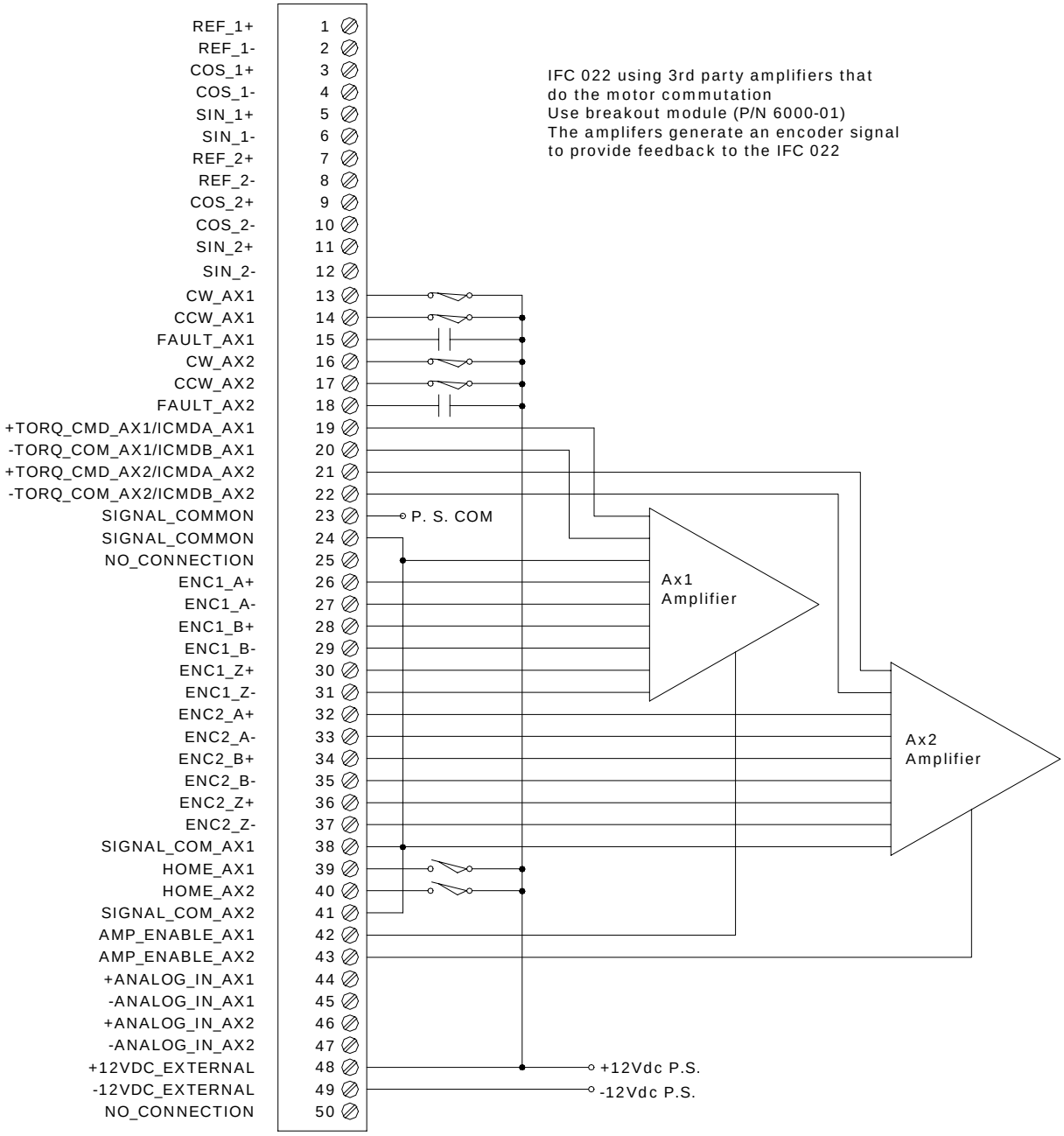


Figure B-8: 3rd Party Amplifier with Commutation Capability

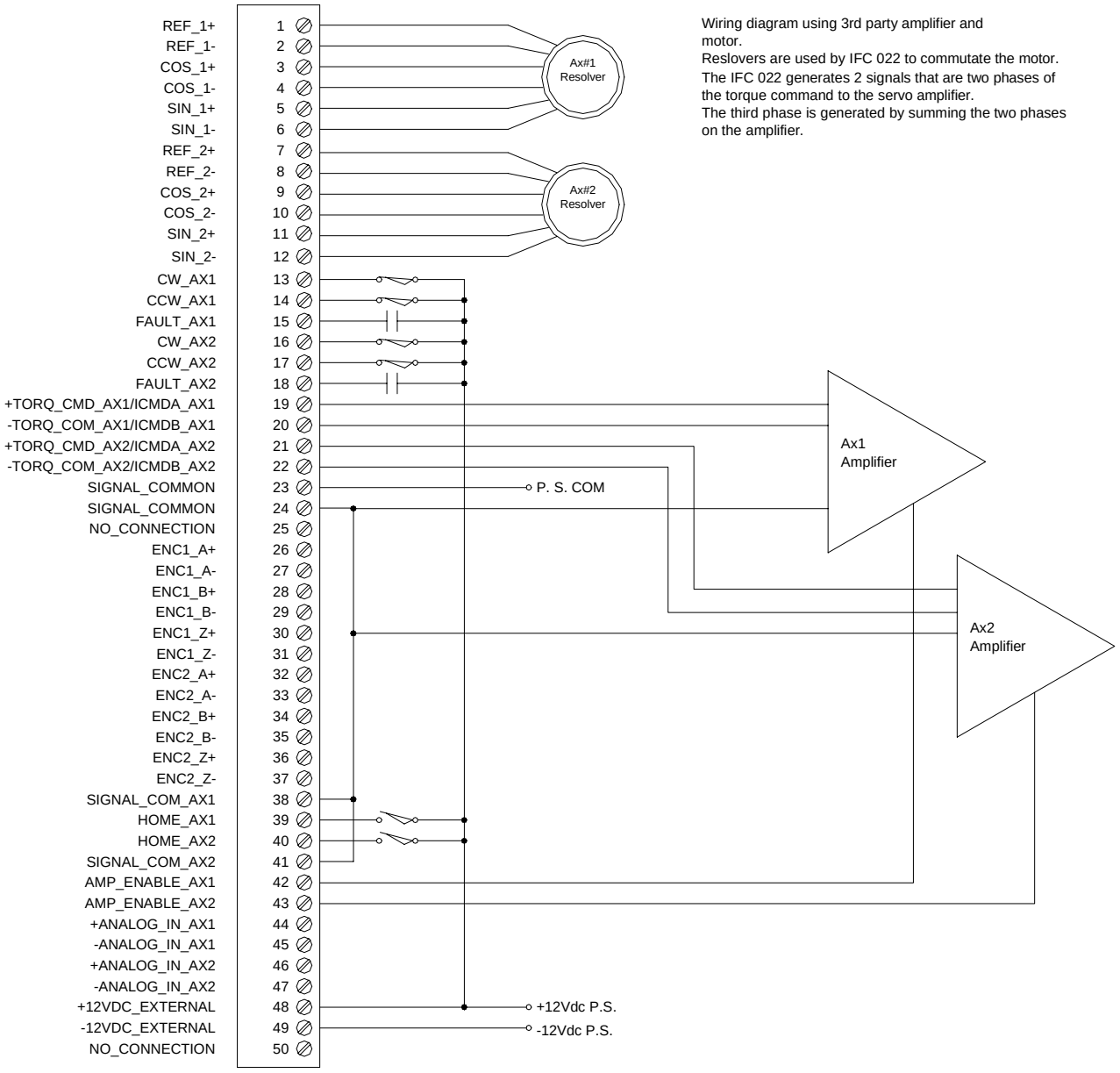


Figure B-9: 3rd Party Drive/ Motor with IFC 022 Using Resolver for Commutation

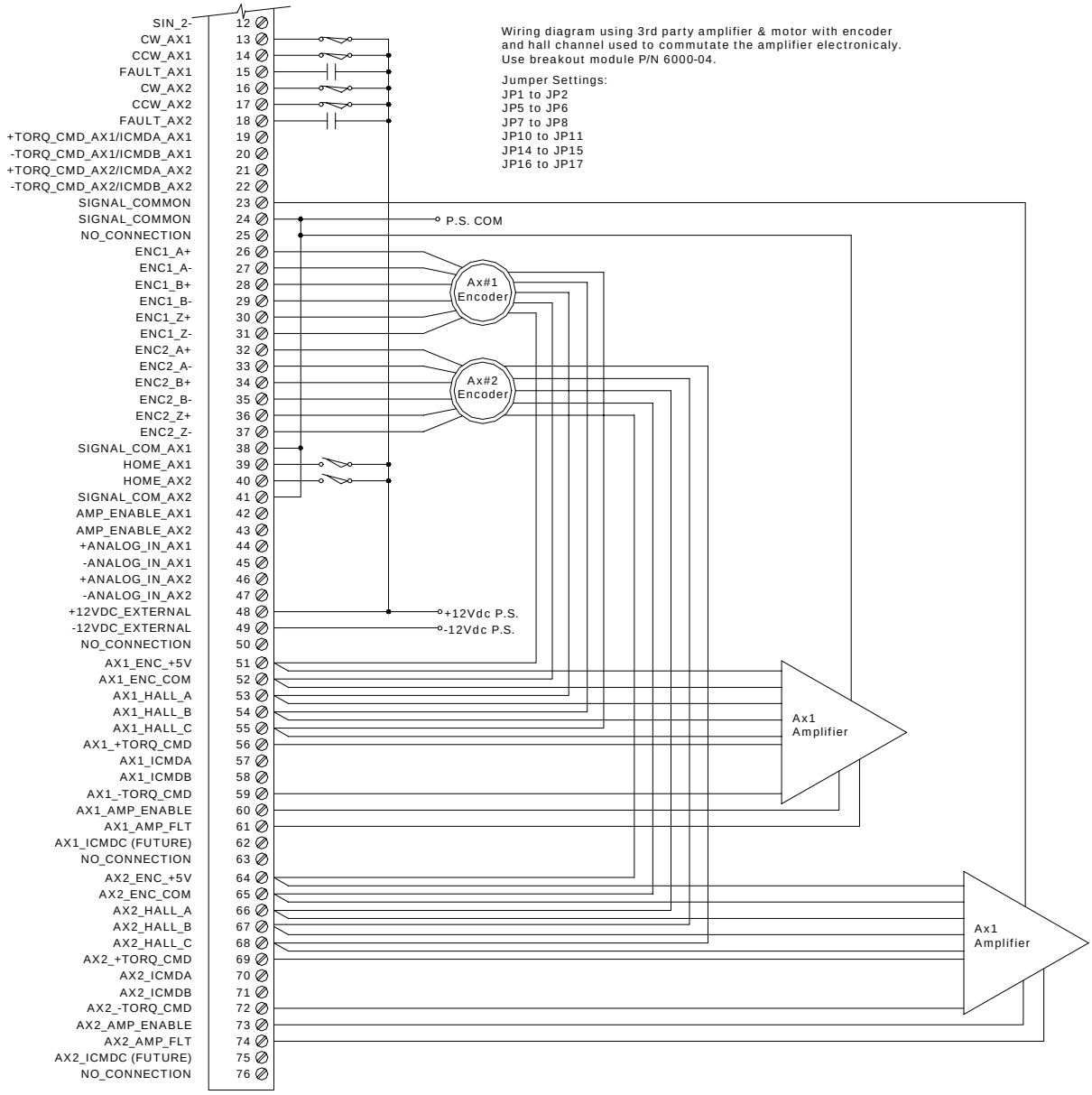


Figure B-10: 3rd Party Drive/Motor Using Halls for Commutation

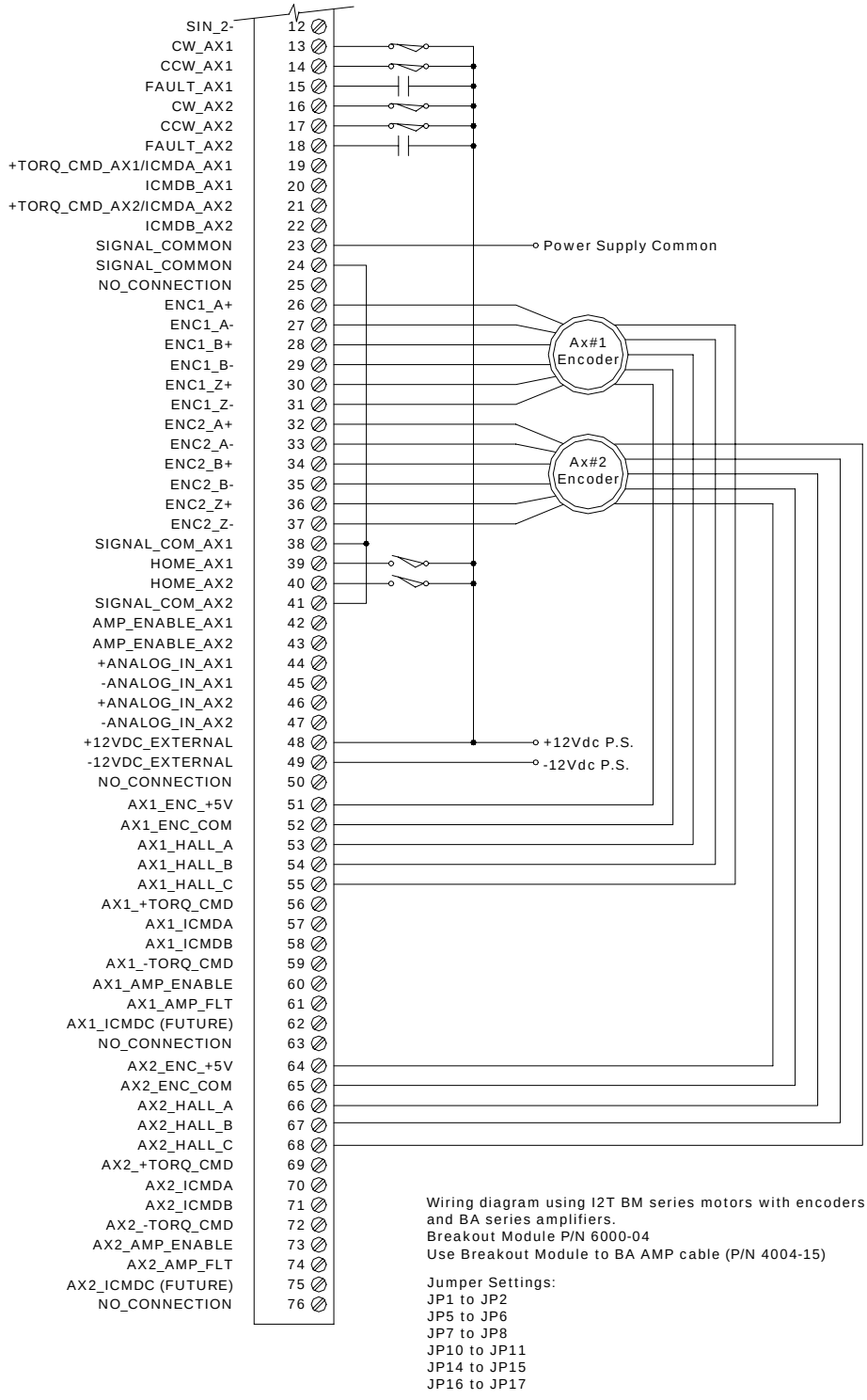


Figure B-11: I^2T BA Series Amplifier to BM Series Motor Wiring

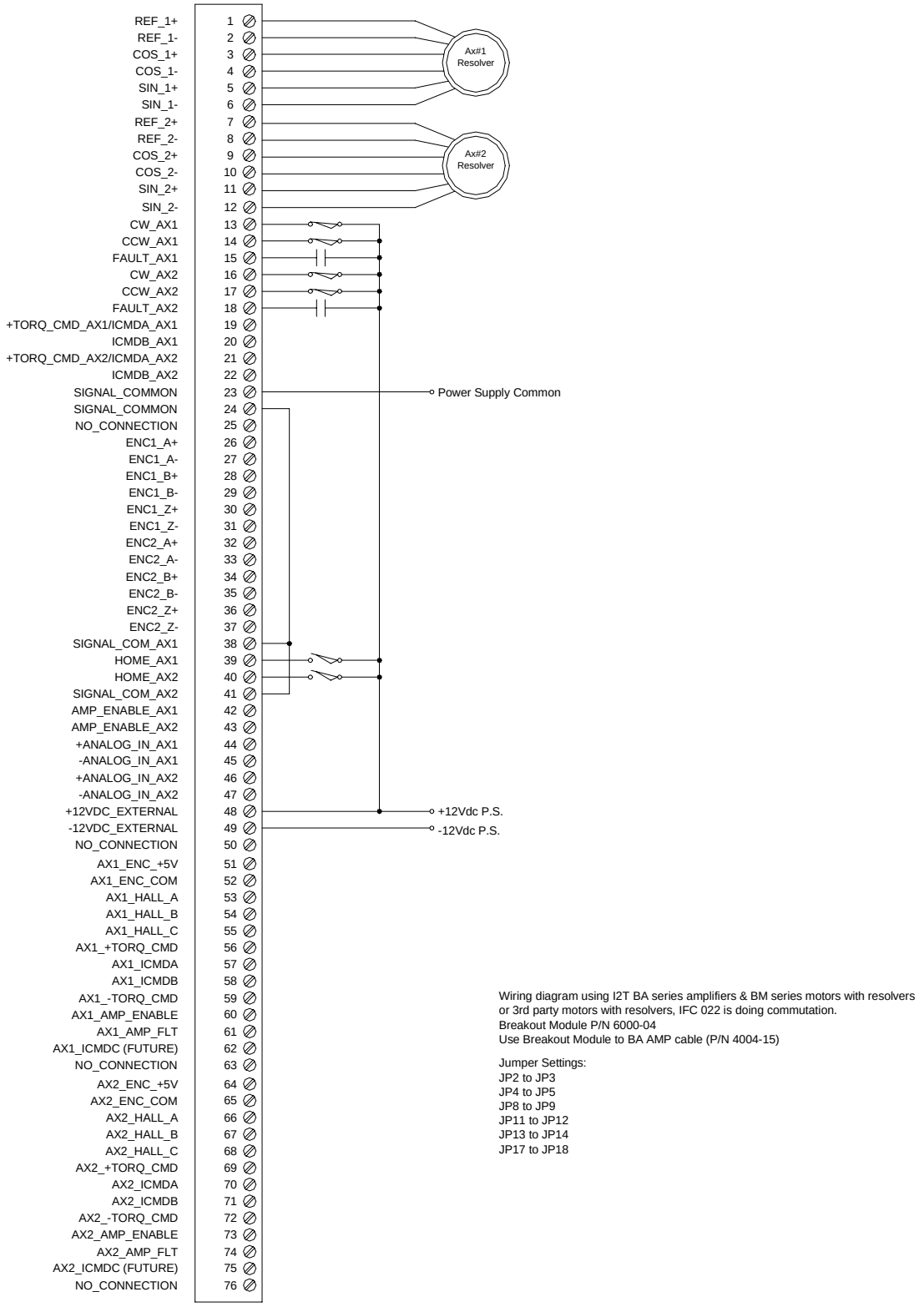


Figure B-12: I^2T BA Series Amplifier w/ Resolver Feedback for Commutation

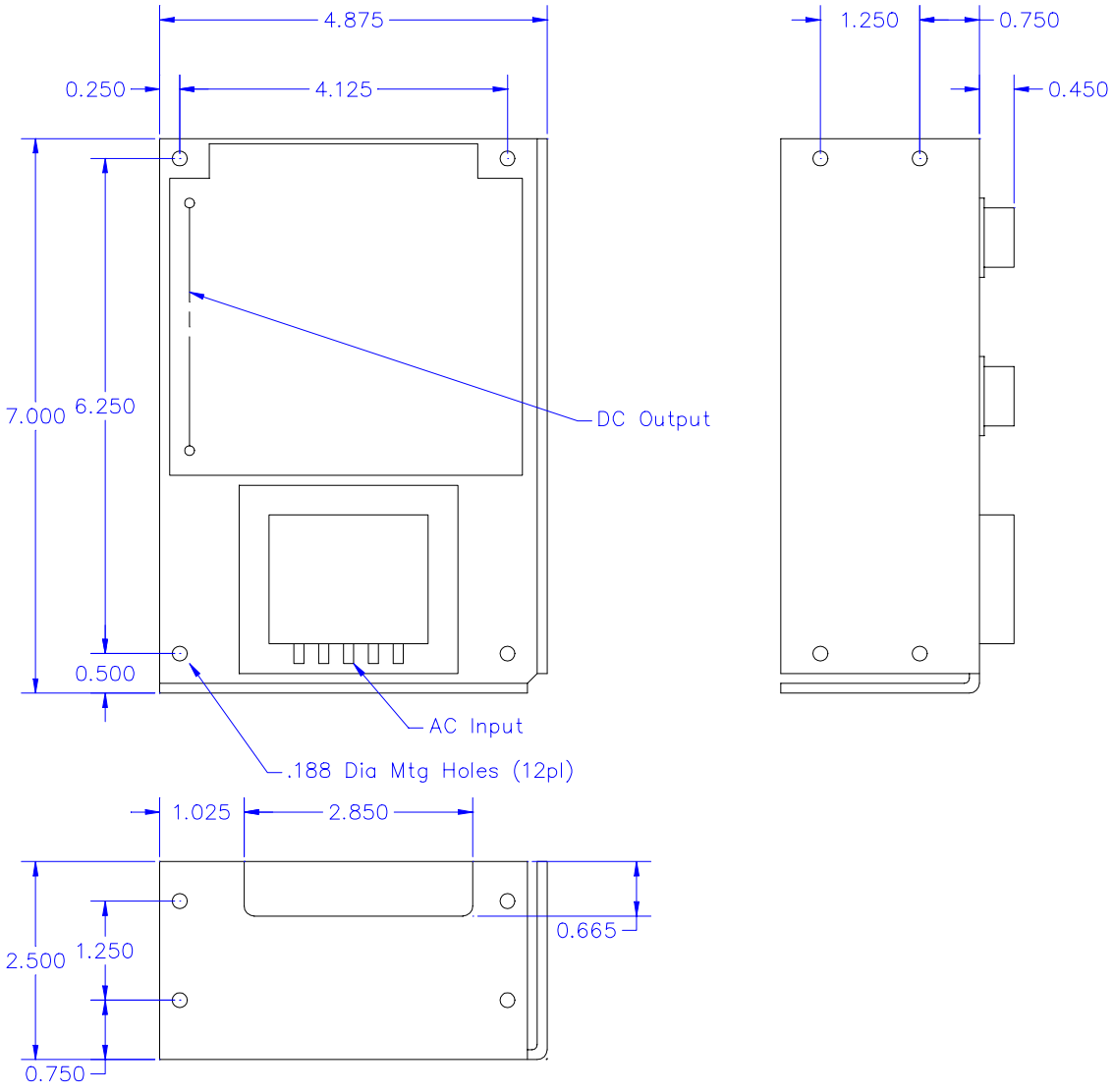


Figure B-13: ±12Vdc Power Supply Dimensions (6000-02)

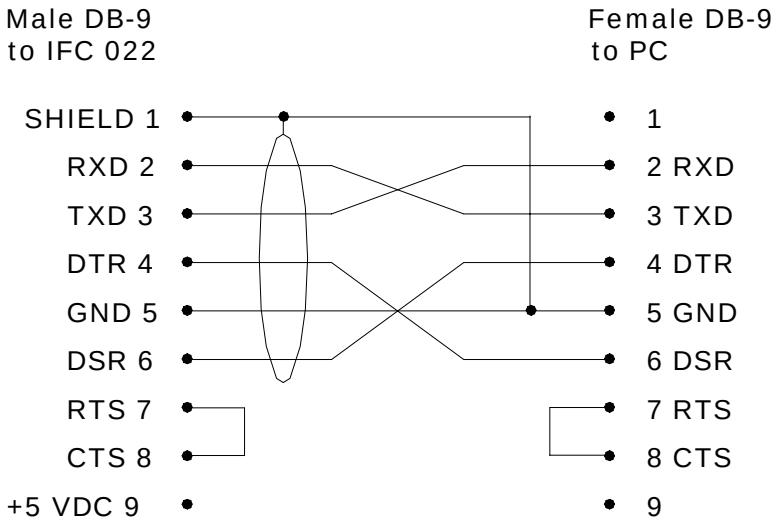


Figure B-14: Programming Cable Wiring for 10 or 25 Ft. Lengths (P/N 4001-XX)