



CUSTOM MOTORS INC

CAIF SERIES

Intelligent Programmable Motion Controllers/Drives

Installation and Operation Manual

Custom Motors, Inc.

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Version 2.0

REVISION LOG

Revision Number	Date	Description
1.0	6-17-04	Pages 14,17 & 19 Corrected encoder cable wiring.
2.0	6-29-04	Pages 14,17 & 19 Additional encoder power wires & TB2 pin 4 connection shown.
3.0	7-14-04	Pages 16,17,18,19: External fuse was shown from TB4 pin 6 to 10.
4.0	7-19-04	Pages 17 & 19: Motor thermal switch shown. Added page 19a.
5.0	10-4-04	Page 20: Corrected motor wiring. Added instructions and notations, added TB6. For details, see file.

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INTRODUCTION

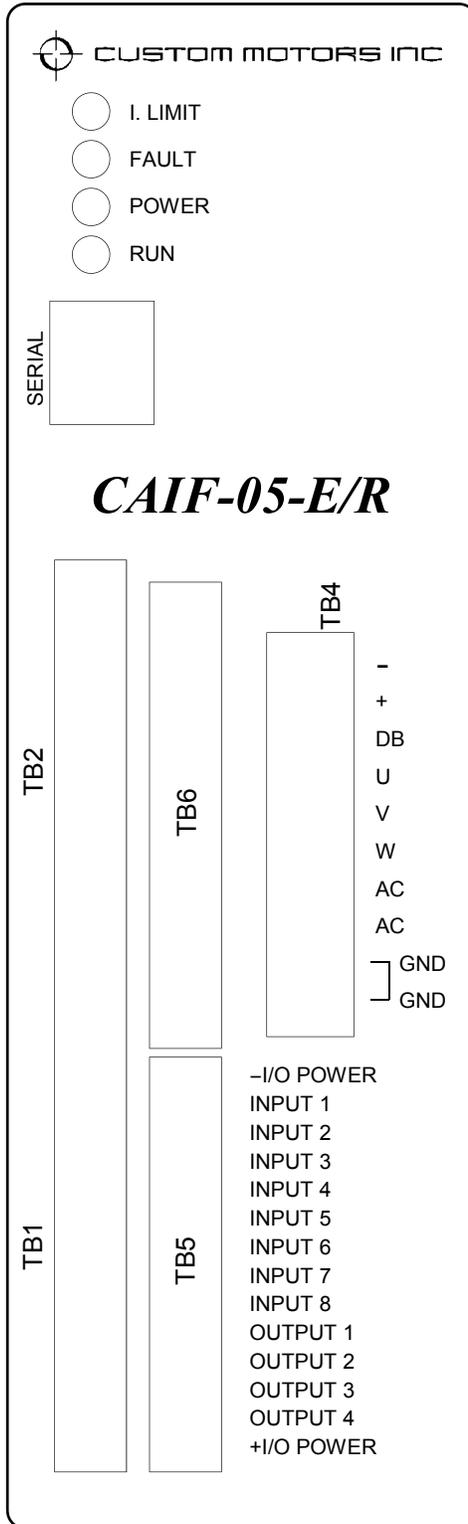
The “CAIF” Series of Digital Motor Controllers are designed to control Velocity / Torque and Position of a Single Axis Brushless DC Motor (optional DC Brush Type). These Controllers with programmable / assignable optically isolated Inputs / Outputs and Analog Inputs / Outputs can eliminate a need for an additional programmable logic controller (PLC). A Windows-based PC Software (furnished with each unit), provides a simple “drag and drop” program building environment for a stand alone or multi-axis control scheme. There is no additional controller card needed to perform motion profiles for indexing, positioning and input-output processing. The unique software and firmware development scheme allows for all the drive functions, as well as the profiling to be performed by the same processor. This translates to a very accurate torque and speed control, since there is virtually no delay in processing. Use of the same processor to perform the motion controller task and the drive function have eliminated the extra hardware needed to support the motion controller tasks and the additional I/O’s to communicate with the drive section.

In each CAIF power range, two different versions are manufactured to use either Encoder and Hall or Resolver as a motor feedback for commutation and positioning. Throughout this manual it will be referred to as part numbers ending with “E” for Encoder and Hall feedback and part numbers ending with “R” for the Resolver feedback versions. The CAIF Series of Controllers/Drives can communicate with other devices and PLC’s via their multi-drop RS485 port using Modbus RTU Protocol for programming, commands and monitoring machine functions, including I/O’s.

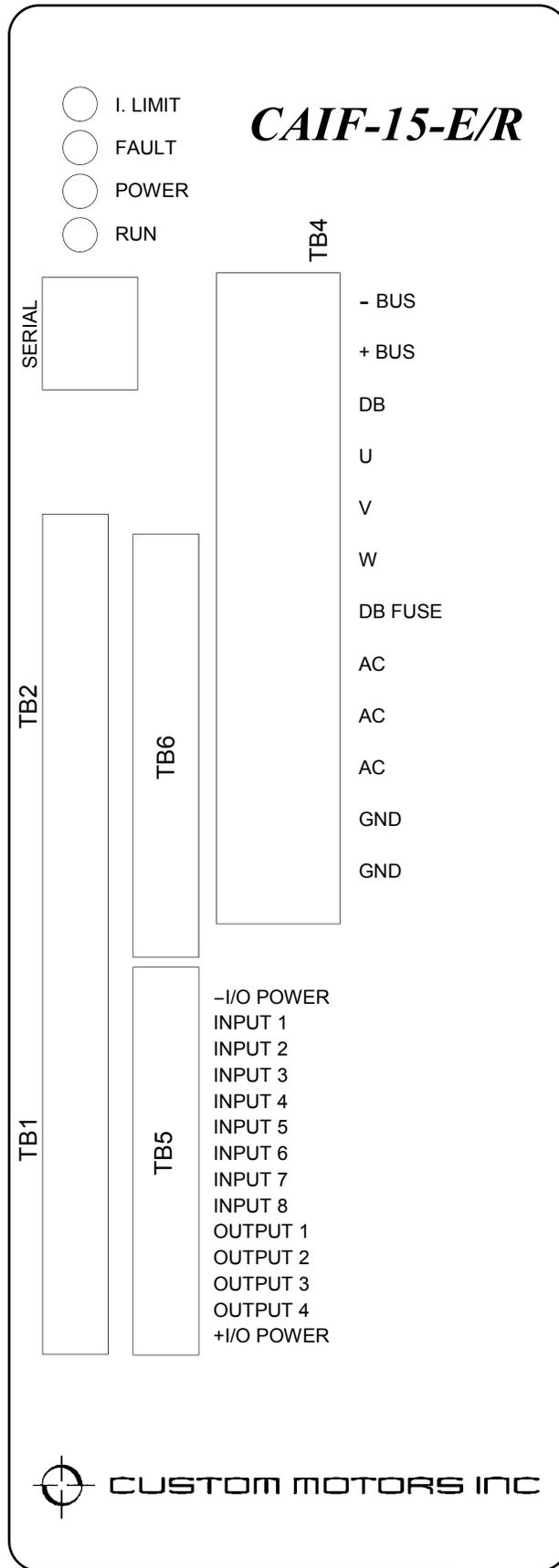
To maximize the performance and functionality, the inputs are assignable / programmable to function as a fixed assignment, such as Jog Fwd / Jog Rev, Over-travel Limits and BCD, or as a general purpose inputs.

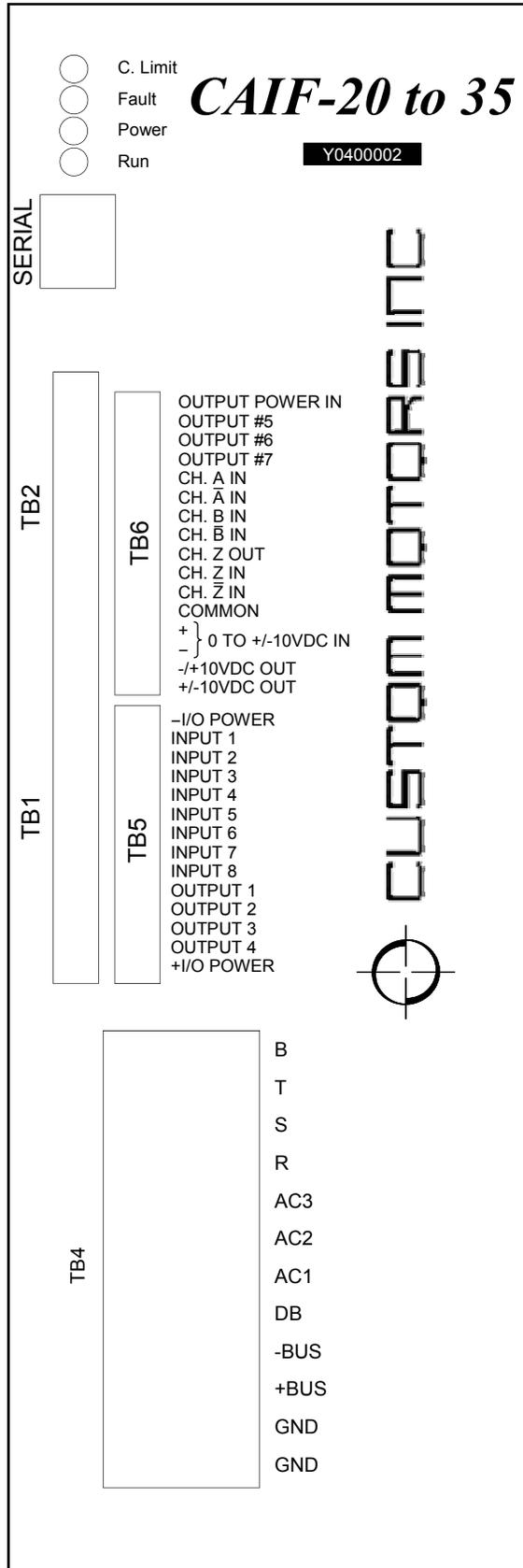
By using the provided Windows based PC Software, the controller can be tuned, configured, programmed and tailored for a particular need. Since the majority of the applications require an external source to initiate the “Start” sequence command, one of the inputs is dedicated for sequencing. Even though the sequence input is required to execute each programmed segment, provisions are provided to allow sequencing without the need for sequence input or perhaps using other inputs.

CAIF-05 Encoder and Resolver Controller Front View



CAIF-15 Encoder and Resolver Controller Front View





SPECIFICATIONS

INPUT POWER:

- CAIF-05: 70 to 250 vac single phase, 50/60 Hz. or 100 to 360 vdc, 10 Amp max.
CAIF-15: 70 to 250 vac single phase or 3 phase 50/60 Hz. or 100 to 360 vdc, 20 Amp max.
CAIF-25-50-230: 70 to 250 vac single phase or 3 phase or 100 to 360 vdc, 30 Amp max.
Output derated to 17 Amp with single phase power input.
CAIF-35-70-230: 70-250 vac single phase or 3 phase or 100 to 360 vdc, 40 Amp max.
Output derated to 17 Amp with single phase power input.
CAIF-20-40-460: 140 to 500 vac single phase or 3 phase or 200 to 700 vdc 25 Amp max.
Output derated to 8 Amp with single phase power input.

POWER ON INRUSH: Internally limited by soft start circuitry to 5 Amp. max. peak.

OUTPUT POWER: 3-Phase, sinusoidal current, +/- 360 volt max.

- CAIF-05: 5 Amp RMS continuous, 10 Amp RMS peak for two (2) seconds
CAIF-15: 15 Amp RMS continuous, 30 Amp RMS peak for two (2) seconds
CAIF-25-50-230: 20 Amp RMS continuous, 40 Amp RMS peak for two (2) seconds
CAIF-35-70-230: 25 Amp RMS continuous, 50 Amp RMS peak for two (2) seconds
CAIF-20-40-460: 35 Amp RMS continuous, 70 Amp RMS peak for two (2) seconds

MODULATION FREQUENCY: 20 kHz.

DISCRETE INPUTS: Optically isolated common cathode inputs.
(10 to 30 vdc inputs at 10 mA minimum current.)
Four (4) fixed assignment inputs
1 – Controller Enable / Disable
2 – Home limit switch or Encoder Channel Z
3 – Sequence / RUN
4 – Motor thermal switch
Seven (7) assignable / Programmable inputs can be used as general purpose inputs, or assigned as +JOG, -JOG, +Travel limit, -Travel limit and BCD inputs or mixed combinations.

DISCRETE OUTPUTS: Optically isolated common collector transistor outputs
(5 to 30 vdc outputs at 20 mA max.)
Two (2) fixed assignment outputs
1 – In-position / Ready within programmed tolerance.
2 – Controller Fault
Four (4) general purpose programmable outputs

ANALOG INPUTS: Programmable / Assignable
1) +/- 10 vdc Input, 12 bit resolution
1) 0 to +5 vdc Input, 12 bit resolution

ANALOG OUTPUT: Programmable / Assignable
1) 0 to +5vdc at 20mA Max., 8 bit resolution

SPECIFICATION (cont.)

ENCODER/HALL FEEDBACK:

ENCODER VERSION Differential line receiver with digital filtering on board +5vdc at 200 mA encoder power output.

RESOLVER FEEDBACK:

RESOLVER VERSION On-board resolver excitation with adjustable amplitude 4 kHz at 100 mA with differential sine / cosine Inputs.

SERIAL COMMUNICATION: RS485 at 19200 baud with Modbus RTU protocol to communicate with PC and furnished software or to communicate with other controllers. RJ45 type connection. (Up to 32 Controllers can be connected on a single BUS.) Alternate RS232 connection is possible using the CAIF-06CB232 cable for short term use.

OPERATING CONDITIONS: 0 Degrees to 55 Degrees Celsius – non condensing

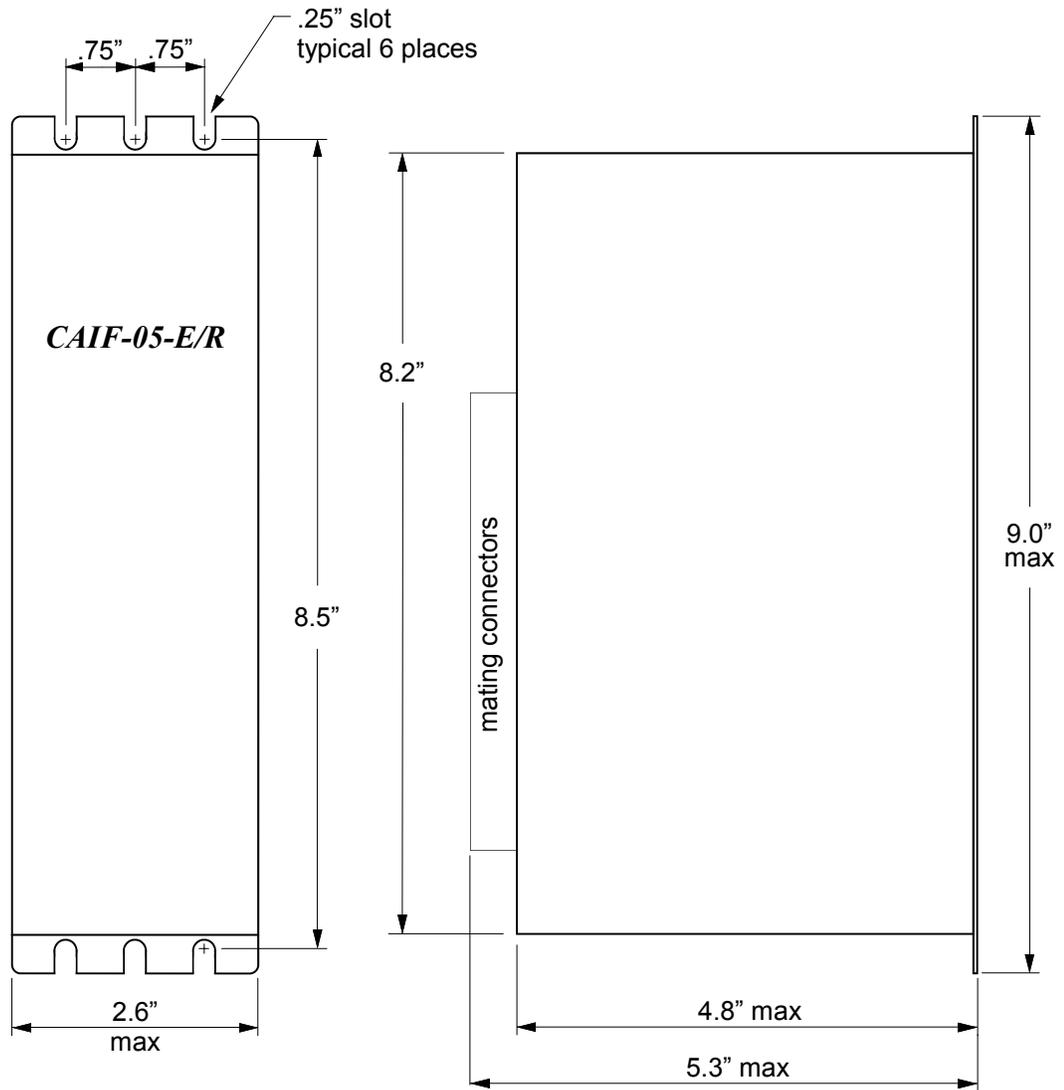
PHYSICAL DIMENSIONS:

CAIF-05:	2.6”W x 9.0”H x 4.8”D
CAIF-15:	3.4”W x 10.2”H x 6.5”D
CAIF-20:	4.5”W x 14.4”H x 8.6”D
CAIF-25:	4.5”W x 14.4”H x 8.6”D
CAIF-35:	4.5”W x 14.4”H x 8.6”D

PROGRAM STORAGE: Drive / Controller set up parameters are stored in an EEPROM (Electrically Erasable Programmable Read Only Memory).

999 Command Sequences can be stored in the controller

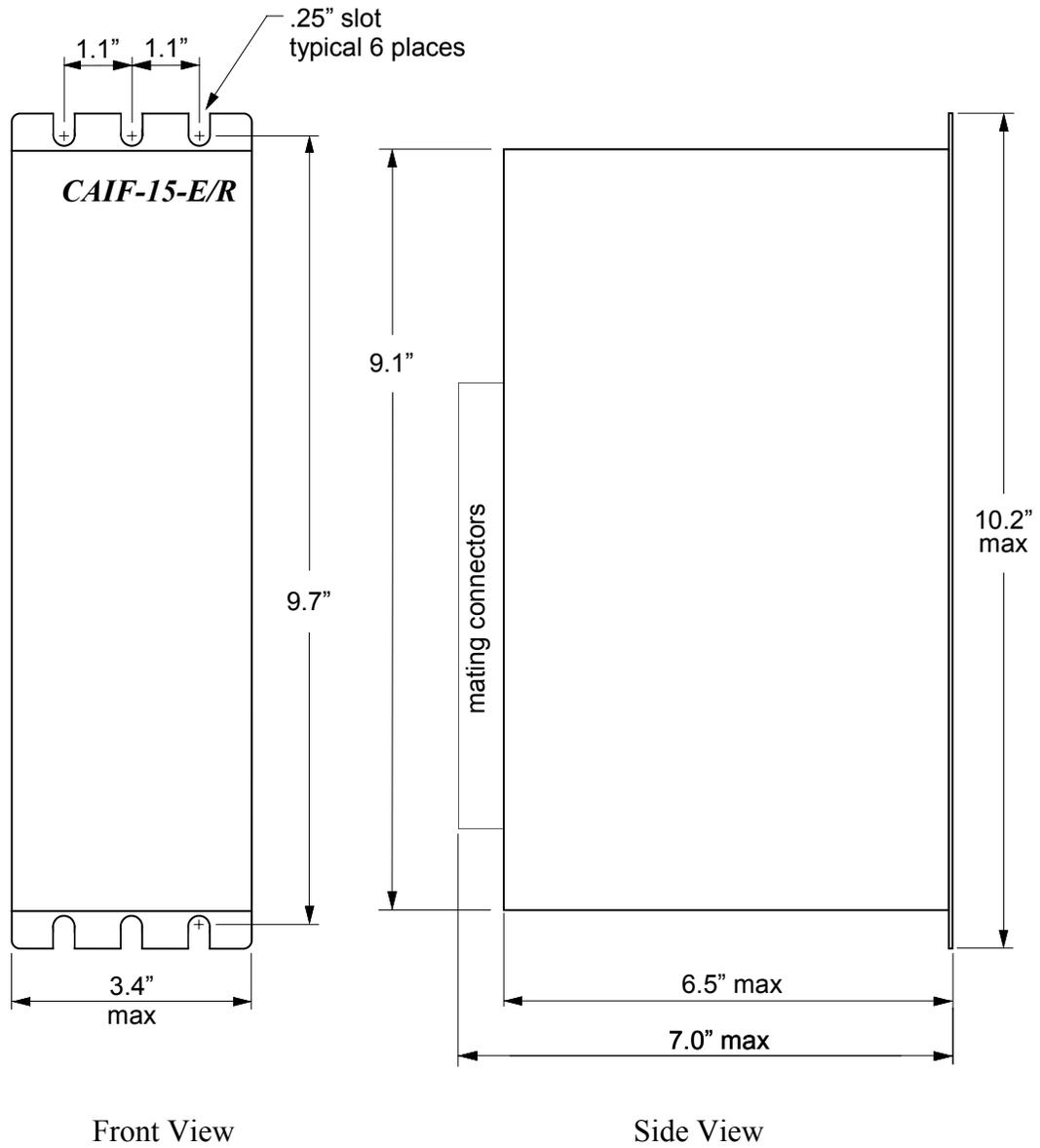
CAIF-05 Encoder and Resolver Controller Mounting Dimensions



Front View

Side View

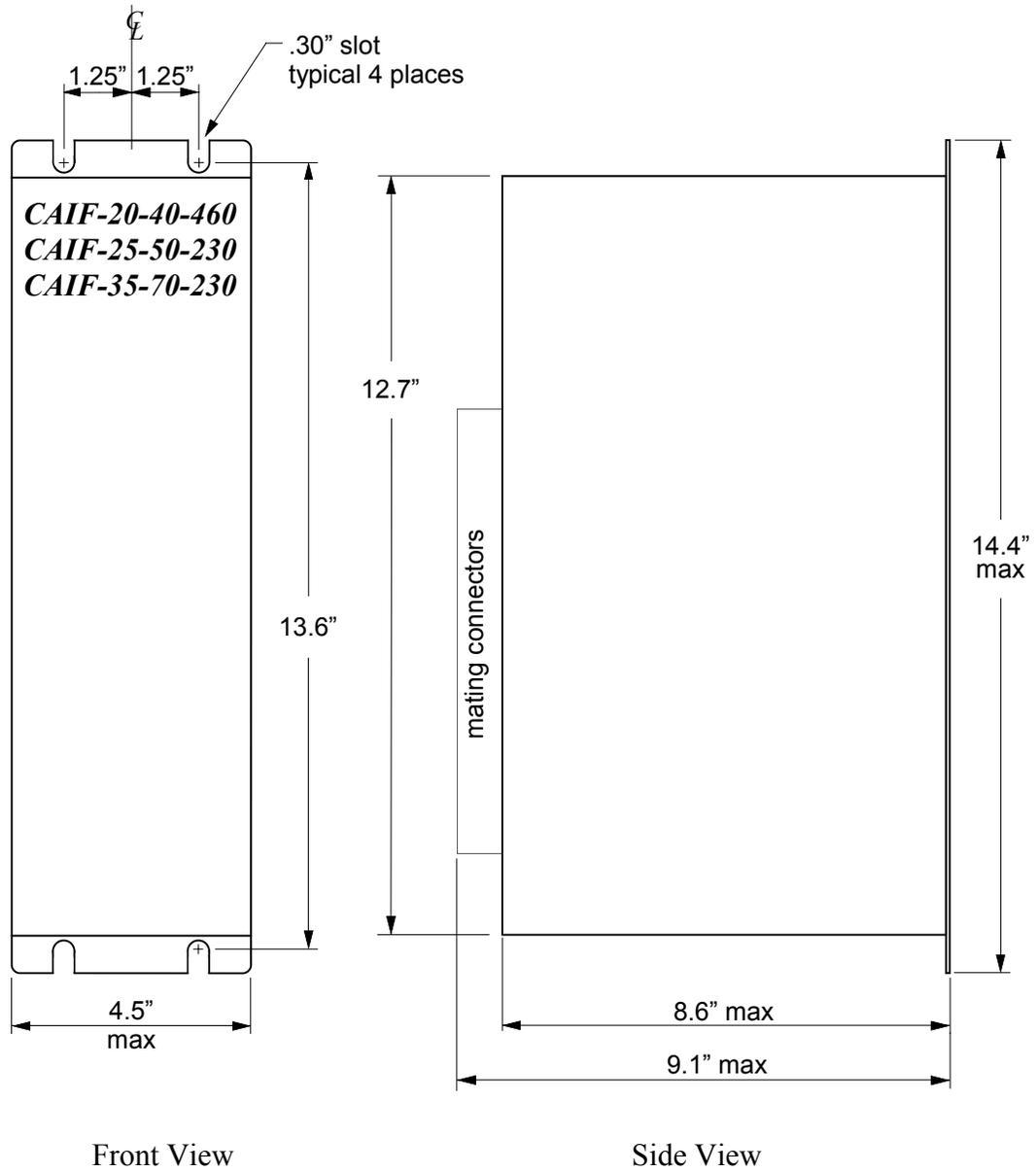
CAIF-15 Encoder and Resolver Controller Mounting Dimensions



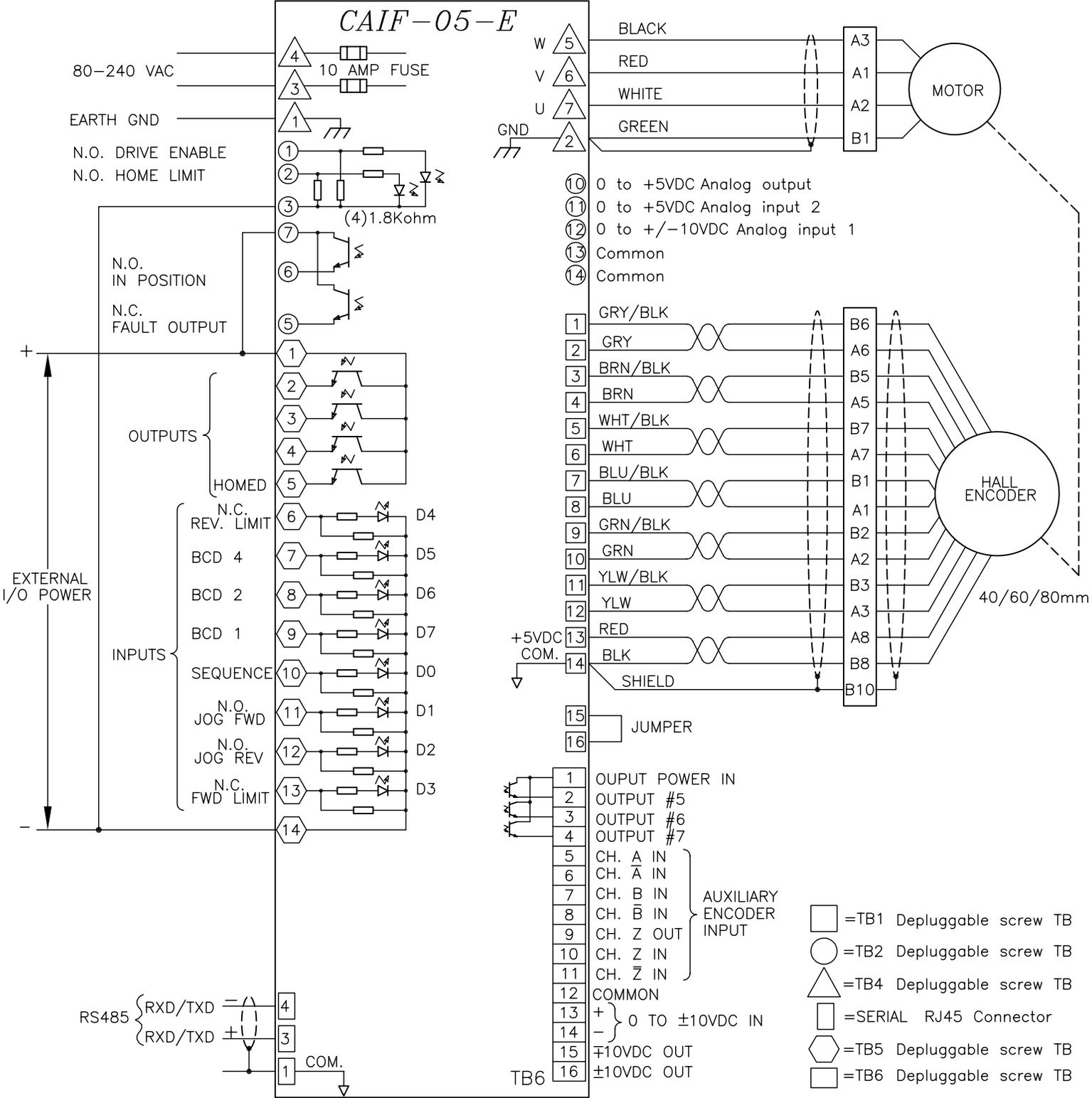
CAIF-20-40-460

CAIF-25-50-230

CAIF-35-70-230 Encoder and Resolver Version Controller Mounting Dimensions



CAIF-05-E



- E Added TB6. 10-4-04
- D BCD 1 & 4 were reversed. TB4 was TB3. 6-10-04
- C Corrected motor & encoder wire colors. 3-16-04
- B Add note for 40/60/80mm mtr. 2-24-04
- A Added analog inputs. 2-24-04
- See file. 2-17-04

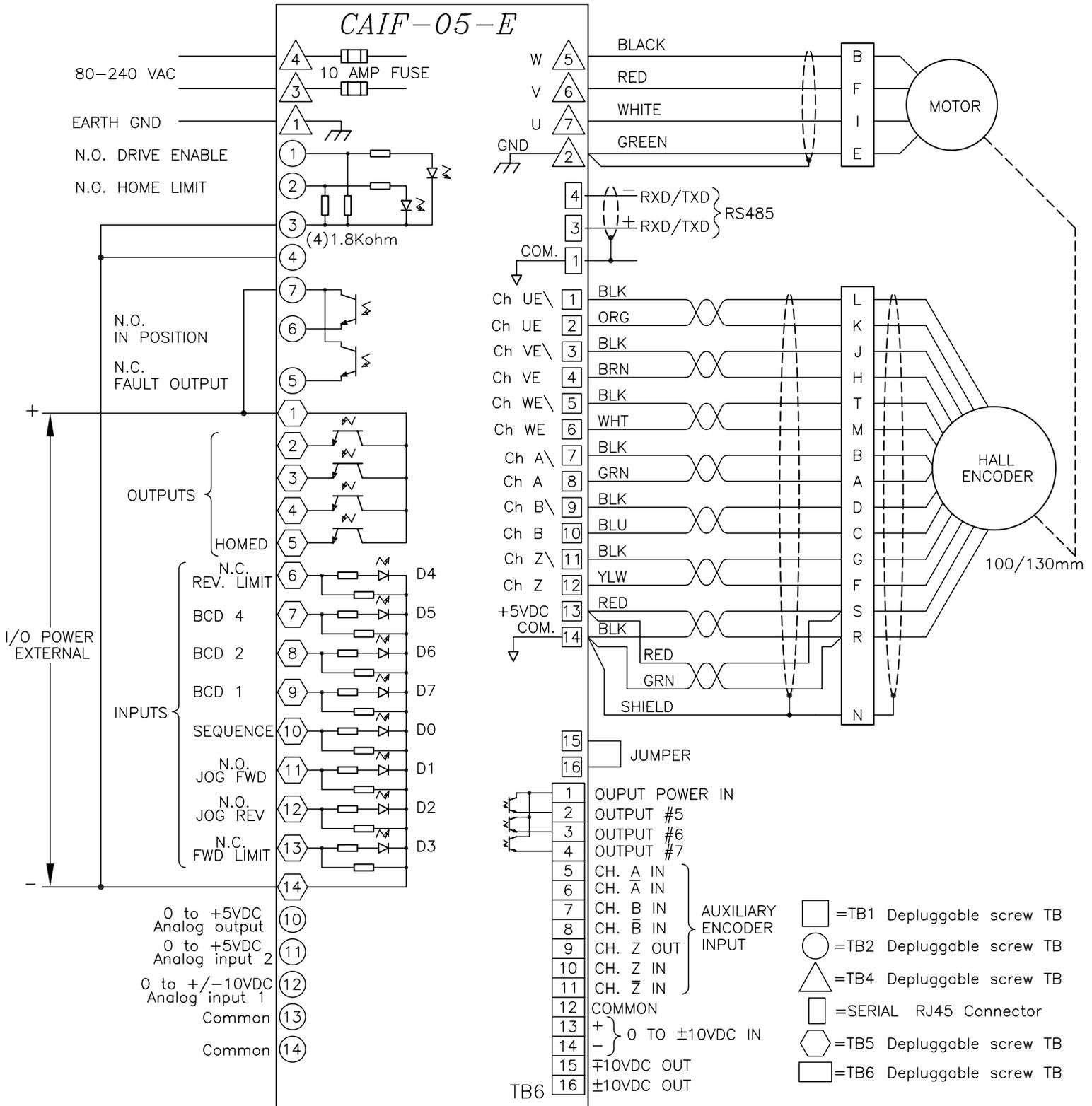
NO. 700 CC42

TITLE CAIF-05-E to 40/60/80mm Motor Encoder Feedback Connection Diagram

ERS	2-6-04	CHKD.	APPVD.
DRAWN	DATE		

DESCRIPTION	DATE	APPVD.
REVISIONS		

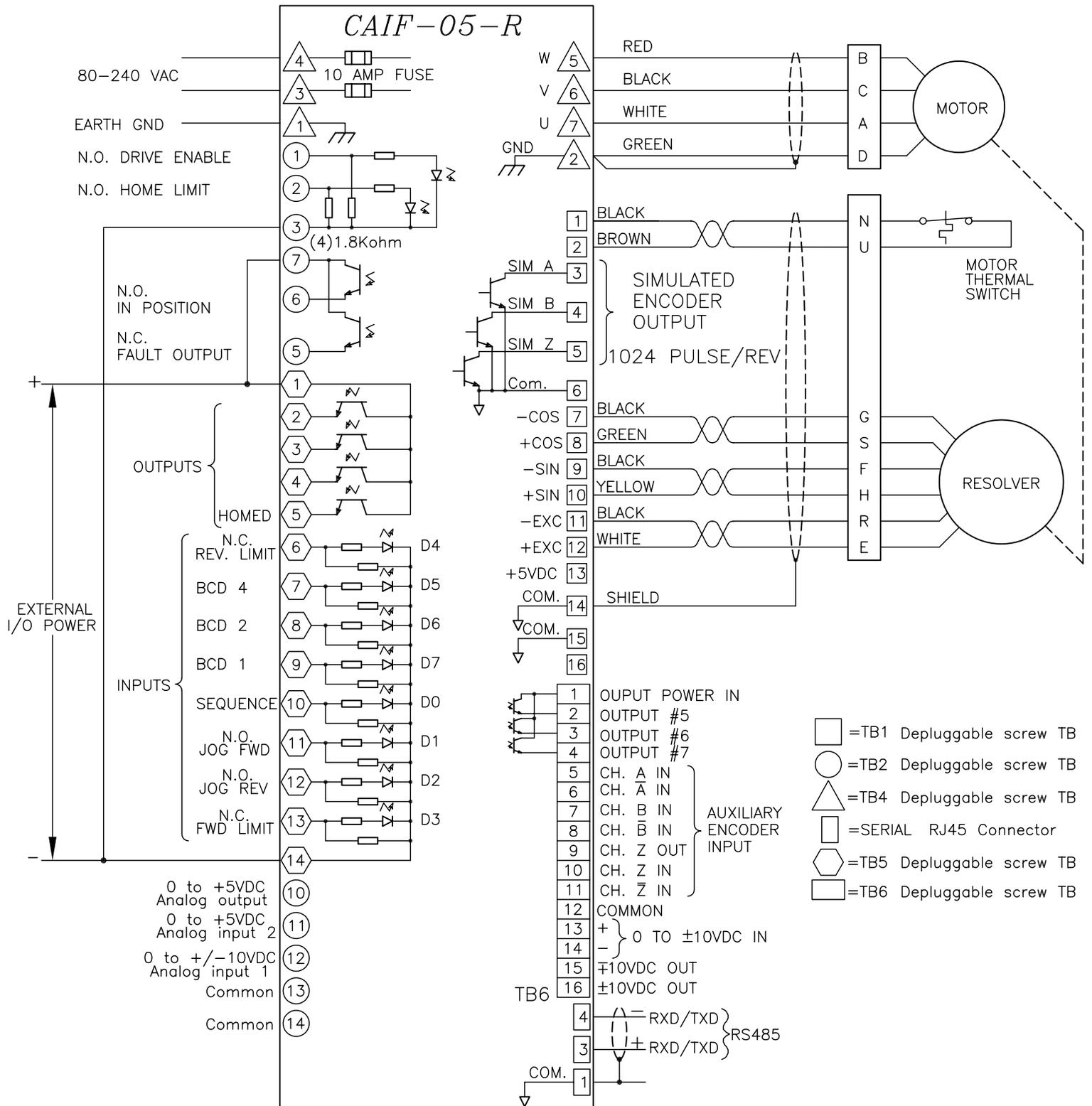
CAIF-05-E



- D Added TB6. 10-4-04
- C Additional encoder power wires & TB2 pin 4 connection shown. 6-29-04
- B Ch. A & B were reversed on Encoder. 6-17-04
- A BCD 1 & 4 were reversed. TB4 was TB3. 6-10-04
Corrected motor & encoder wire colors.

NO.	700 CC48		
TITLE	CAIF-05-E to 100/130mm Motor Encoder Feedback Connection Diagram		
ERS DRAWN	3-16-04	DATE	CHKD. APPVD.

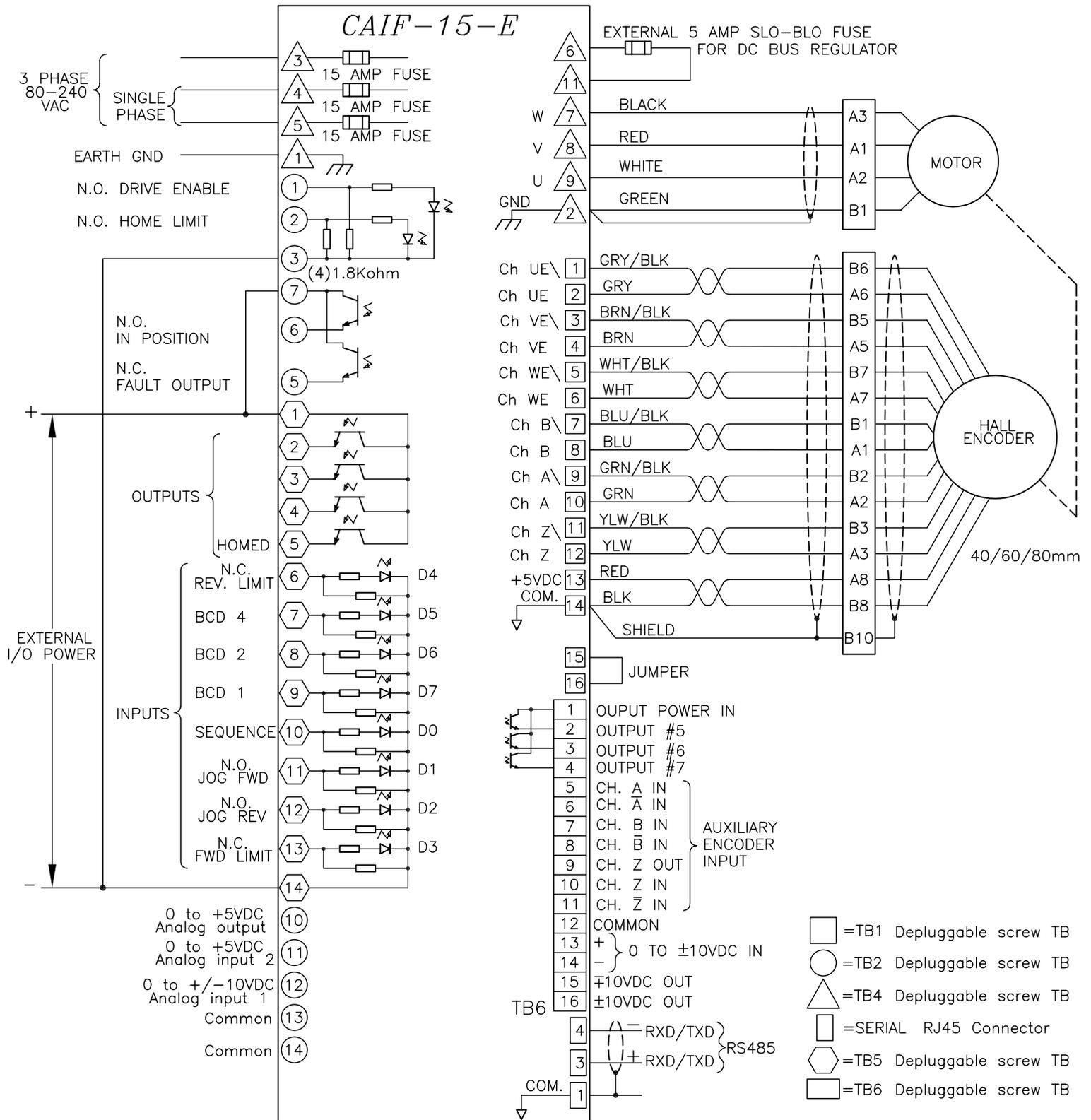
DESCRIPTION	DATE	APPVD.
REVISIONS		



- C Added TB6. 10-4-04
- B BCD 1 & 4 were reversed. TB4 was TB3. 6-10-04
- A Modified Resolver wiring; added colors. 4-28-04

NO. 700 CC44			
TITLE CAIF-05-R to Motor with Resolver Feedback Connection Diagram			
ERS	2-24-04	CHKD.	APPVD.
DRAWN	DATE		

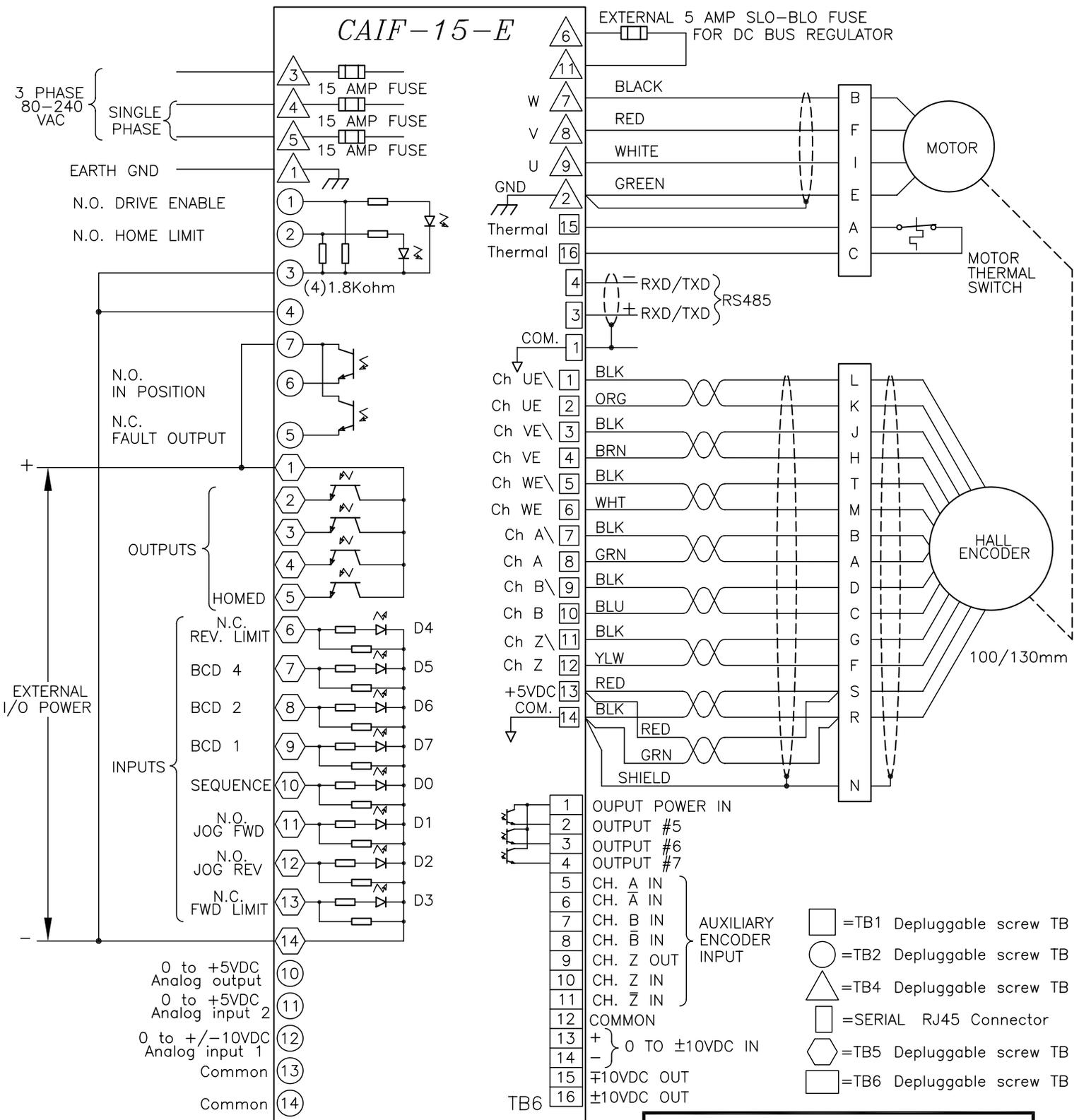
DESCRIPTION	DATE	APPVD.
REVISIONS		



- D Added TB6. 10-4-04
- C Ext. fuse was shown from TB4 pin 6 to 10.7-14-04
- B Corrected mtr & encoder wire colors 6-10-04
- A Add note for 40/60/80mm mtr. 3-16-04

NO. 700 CC45			
TITLE CAIF-15-E to 40/60/80mm Motor Encoder Feedback Connection Diagram			
DESCRIPTION	DATE	APPVD.	
REVISIONS		ERS DRAWN	3-2-04
		DATE	CHKD. APPVD.

CAIF-15-E



- E Added TB6. 10-4-04
- D Ext. fuse was shown from TB4 pin 6 to 10. 7-14-04
Motor thermal switch shown.
- C Additional encoder power wires & 6-29-04
TB2 pin 4 connection shown.
- B Ch. A & B were reversed on Encoder. 6-17-04
- A Corrected motor & encoder wire colors. 6-10-04

NO. 700 CC49
TITLE CAIF-15-E to 100/1300mm Motor
Encoder Feedback
Connection Diagram

ERS	3-2-04	CHKD.	APPVD.
DRAWN	DATE		

DESCRIPTION	DATE	APPVD.
REVISIONS		

CAIF-20-40-460-E
 CAIF-25-50-230-E
 CAIF-35-70-230-E

N.O. DRIVE ENABLE

N.O. HOME LIMIT

N.O. IN POSITION

N.C. FAULT OUTPUT

OUTPUTS

HOMED

#8 BCD 8/REV. LIMIT

#7 BCD 4

#6 BCD 2

#5 BCD 1

INPUTS

#4 SEQUENCE

#3 N.O. JOG FWD

#2 N.O. JOG REV

#1 FWD LIMIT

0 to +5VDC Analog output

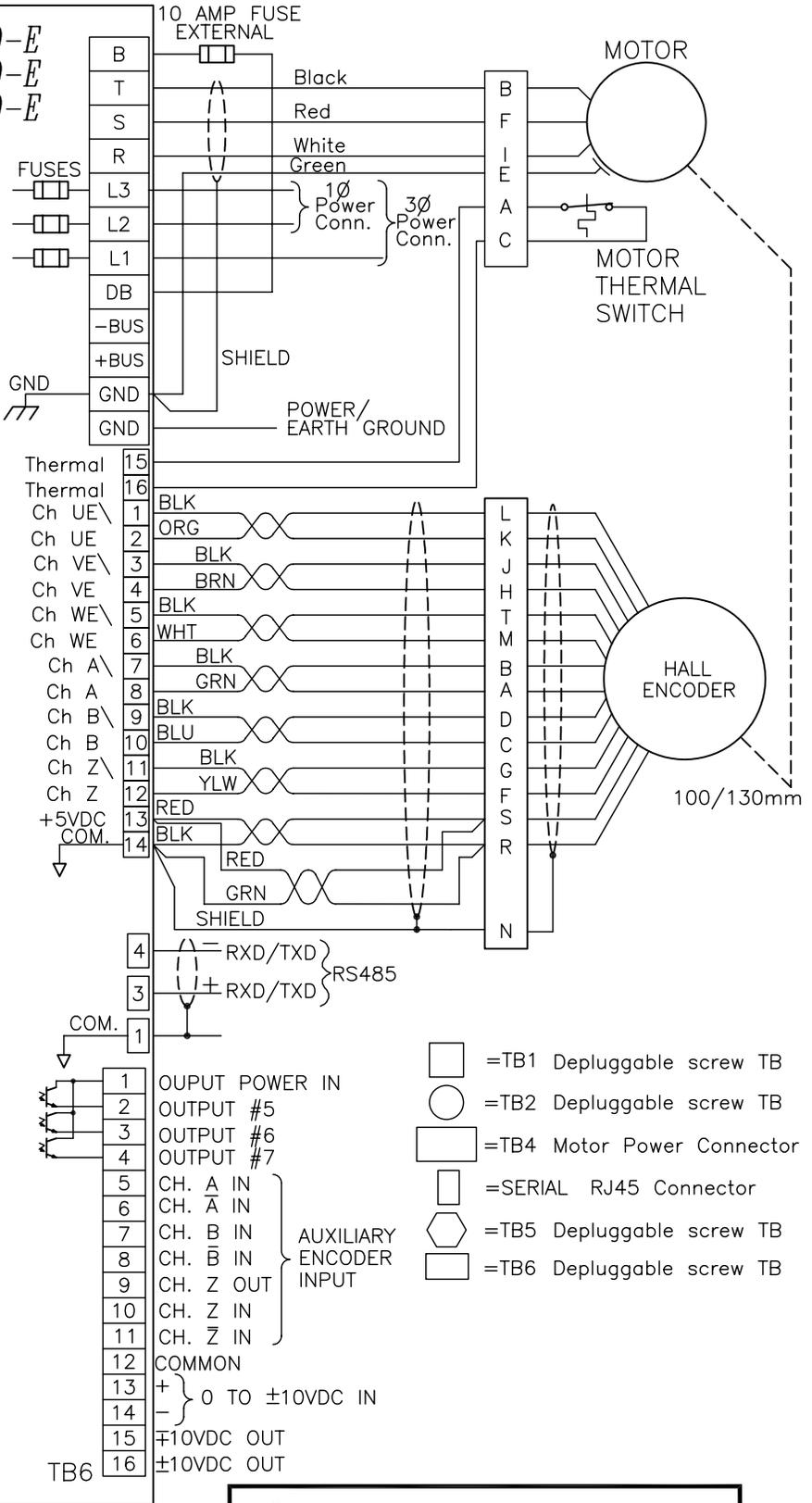
0 to +5VDC Analog input 2

0 to +/-10VDC Analog input 1

Common

Common

EXTERNAL I/O POWER



- E Added TB6. 10-4-04
- D Corrected motor wiring. Motor thermal shown. 7-13-04
- C Additional encoder power wires & TB2 pin 4 connection shown. 6-29-04
- B Ch. A & B were reversed on Encoder. 6-17-04
- A Corrected motor & encoder wire colors. 6-10-04

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NO. 700 CC55

TITLE CAIF 20 to 50 Amp Controllers to 100/130mm Motor Encoder Feedback Connection Diagram

DESCRIPTION	DATE	APPVD.	
REVISIONS			
ERS DRAWN	6-3-04	DATE	CHKD. APPVD.

CAIF-20-40-460-E
 CAIF-25-50-230-E
 CAIF-35-70-230-E

N.O. DRIVE ENABLE
 N.O. HOME LIMIT

N.O. IN POSITION
 N.C. FAULT OUTPUT

OUTPUTS

HOMED

#8 BCD 8/REV. LIMIT

#7 BCD 4

#6 BCD 2

#5 BCD 1

#4 SEQUENCE

#3 N.O. JOG FWD

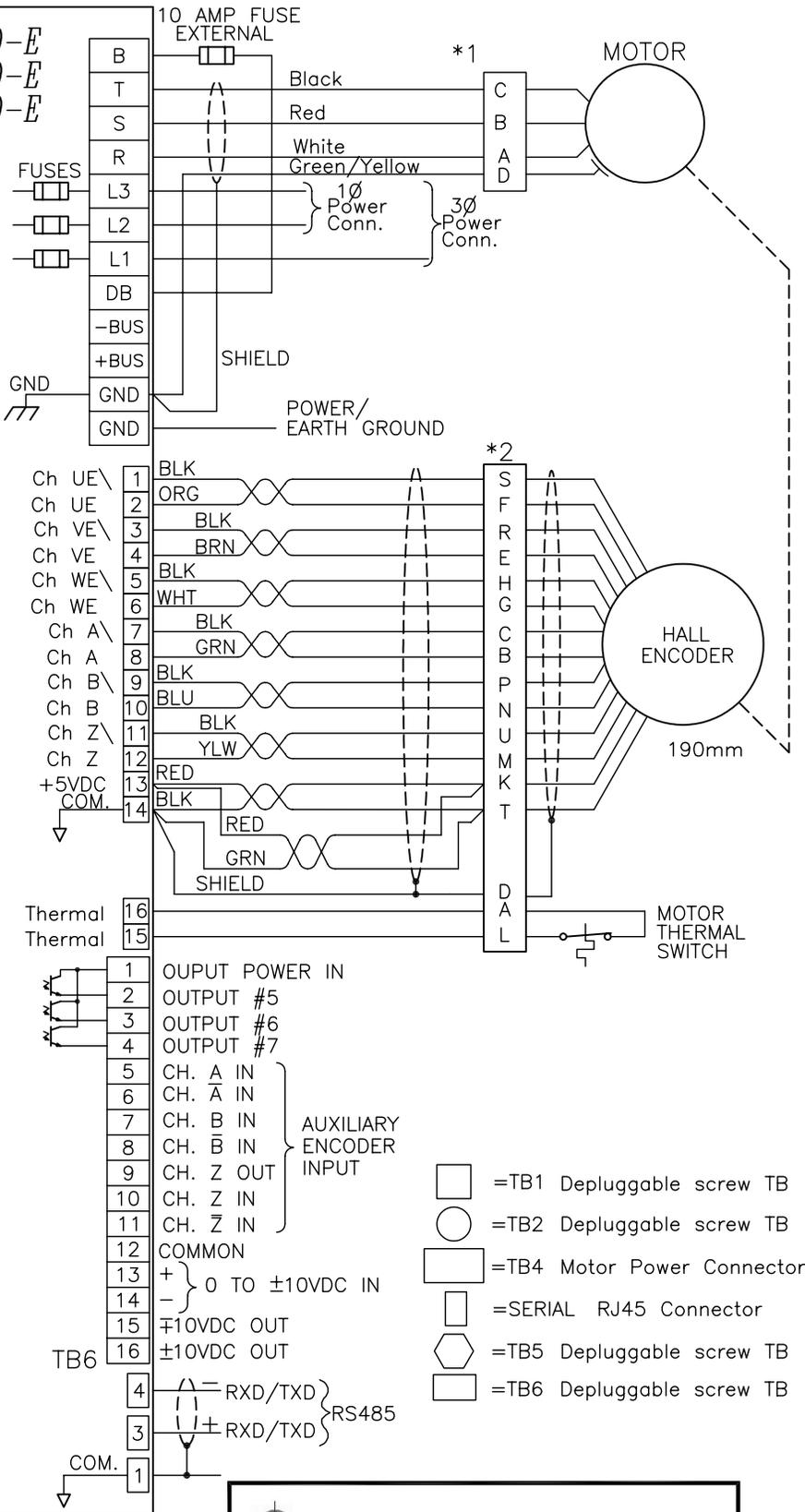
#2 N.O. JOG REV

#1 FWD LIMIT

0 to +5VDC Analog output
 0 to +5VDC Analog input 2

0 to +/-10VDC Analog input 1
 Common

Common



- =TB1 Depluggable screw TB
- =TB2 Depluggable screw TB
- =TB4 Motor Power Connector
- =SERIAL RJ45 Connector
- =TB5 Depluggable screw TB
- =TB6 Depluggable screw TB

*1 Motor cable Part No. CMPxxM-10C
 *2 Encoder cable Part No. CMExxM-CL

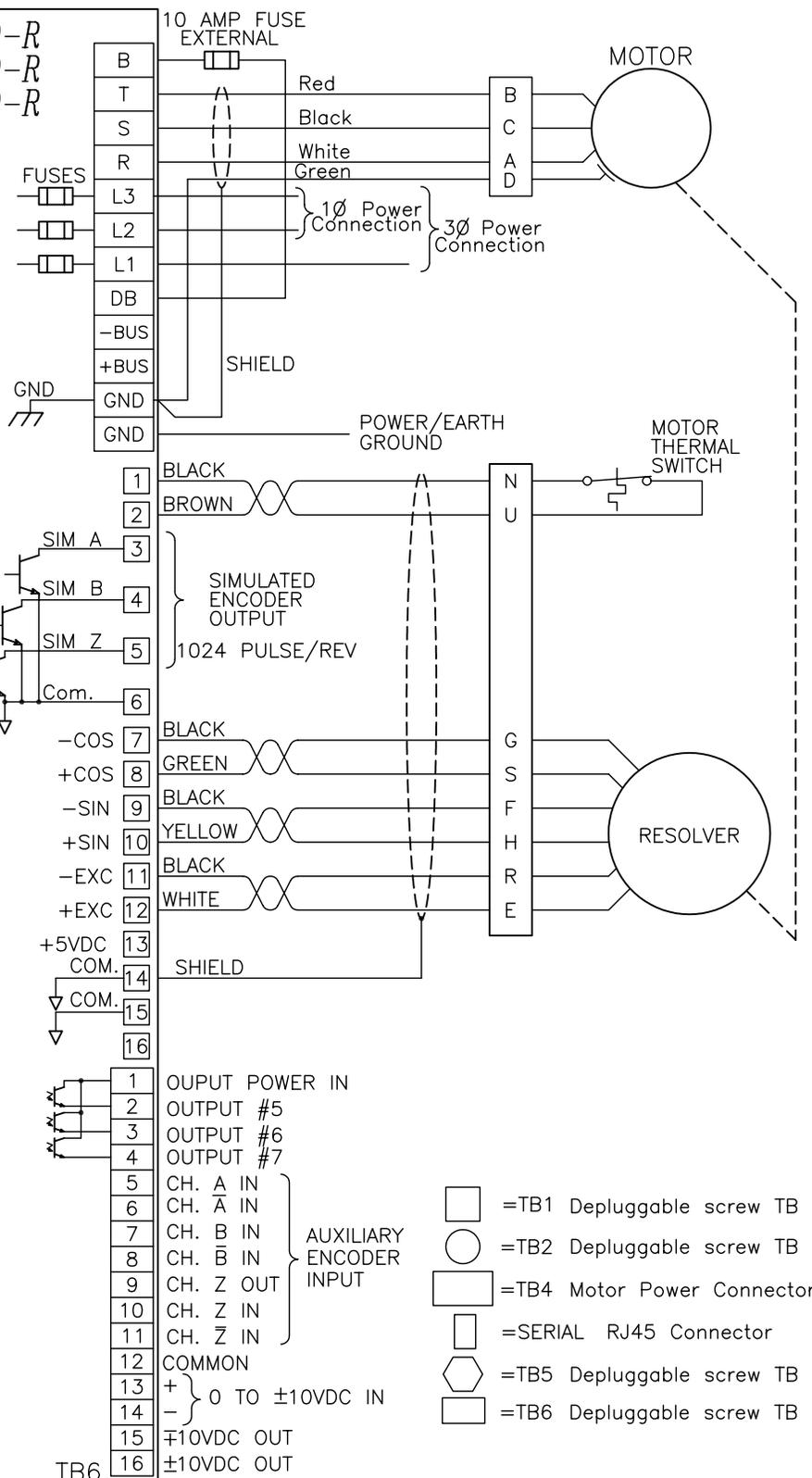
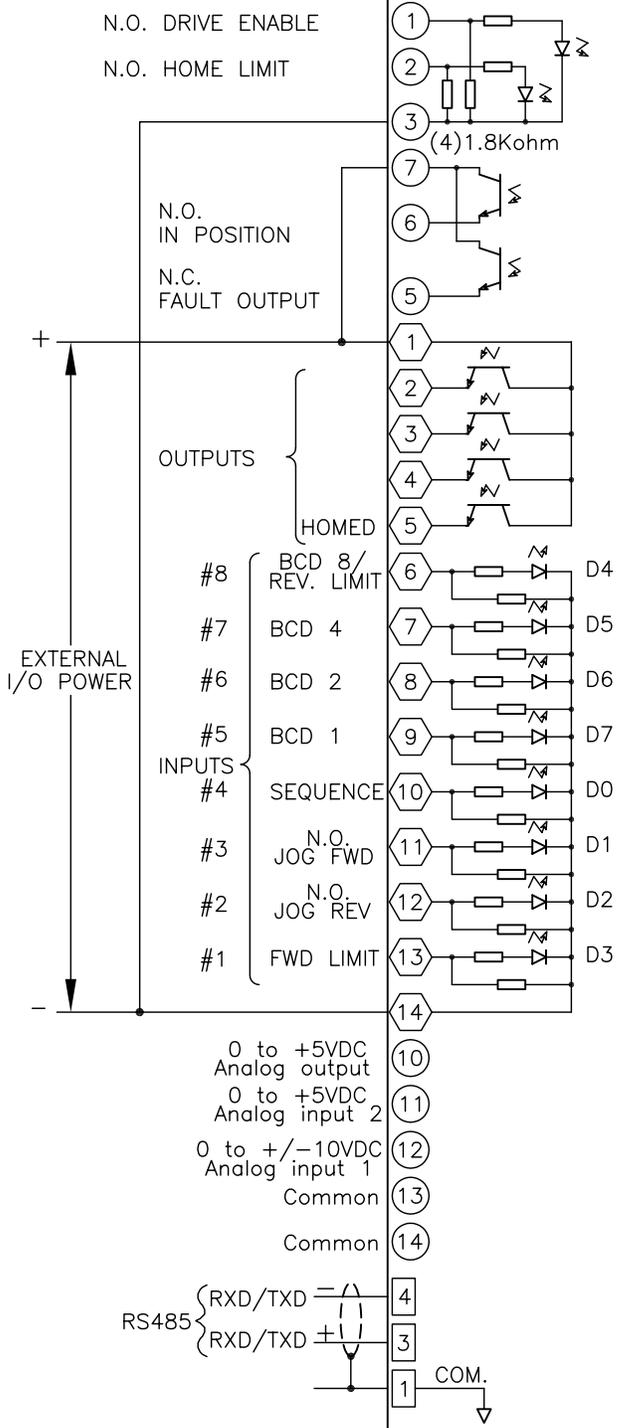
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NO. 700 CC57
 TITLE CAIF 20 to 50 Amp Controllers to 190mm Motor Encoder Feedback Connection Diagram

ERS	7-13-04	CHKD.	APPVD.
DRAWN	DATE		

A Added TB6.	10-4-04
DESCRIPTION	DATE APPVD.
REVISIONS	

CAIF-20-40-460-R
 CAIF-25-50-230-R
 CAIF-35-70-230-R



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NO. 700 CC54

TITLE CAIF 20 to 50 Amp Controllers to Motor with Resolver Feedback Connection Diagram

DESCRIPTION	DATE	APPVD.	ERS	6-3-04	CHKD.	APPVD.
REVISIONS			DRAWN	DATE		

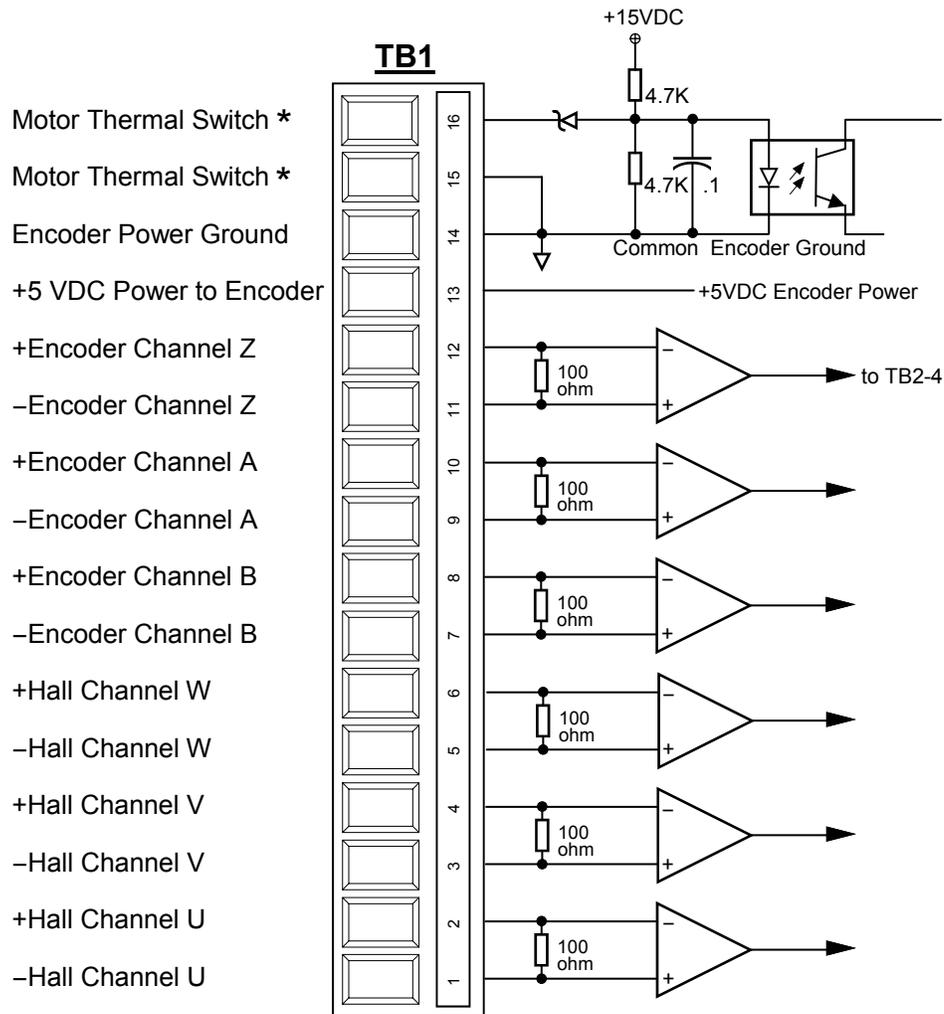
B Corrected motor wiring.	10-4-04	
A Corrected motor wiring.	7-19-04	

HARDWARE OVERVIEW

All CAIF Series of controllers are furnished with depluggable connectors where the wires are connected to a screw terminal and then plugged into their appropriate locations. The purpose of this section is to provide enough information regarding the internal circuitry that connects to the terminals to interface to user wiring.

Terminal Block 1 (TB1) for CAIF-xx-xx-xxx-E Encoder Feedback Version

The CAIF Series Controllers with a letter designation “E” at the end of the part number, are designed to accept differentials signals from the motor-mounted encoder and Hall feedback devices.



* If motor thermal switch is not used or provided by the motor, terminals 15 & 16 must be connected together.

Fig. 1.0

Terminal Block 1 (TB1) for CAIF-xx-xx-xxx-E Encoder Feedback Version (cont.)

Terminals TB1-1 through TB1-12 are for the primary feedback devices mounted on the motor. The motor mounted Encoder provides information to the drive section for commutation and speed regulation, as well as providing information to the controller section for accurate speed and position. It is important to connect the feedback device in proper phasing, otherwise motor run-away (overspeed) and/or motor shaft lock-up can occur.

Terminal Block 1 (TB1) for CAIF-xx-xx-xxx-R Resolver Feedback Version

The CAIF Series with the letter designation “R” at the end of the part number, is designed to accept a resolver feedback which is a device mounted on the motor shaft instead of the encoder. Mostly the resolvers are used in applications where the motor is subjected to high ambient temperature, vibration and shock. The feedback allows the drive to commutate the motor winding to produce rotation, therefore, it is necessary for the drive to receive proper information from the feedback device.

The resolver is excited with a sinusoidal signal by the drive and two (2) feedback signals, sine & cosine are modulated by the relative position of the resolver rotor to its stator. These signals are filtered by the drive circuitry and then converted to digital data representing the motor shaft position and deviations.

The excitation signal is factory adjusted for proper signal levels and should not need further adjustment.

All CAIF Series (resolver version) units have a resolver excitation voltage potentiometer, physically located between TB1 and TB2 to accommodate various transformation ratios. The majority of motor manufacturers use resolvers with 0.5 transformation ratio, which is used as standard at the factory. In some instances, it may be necessary to adjust the excitation voltage potentiometer to achieve proper sine & cosine signal levels.

To verify the signal levels, an oscilloscope or an RMS Voltmeter with frequency range of at least 4 KHz is used. With the power ON and the drive disabled, while monitoring -Sine to +Sine, rotate the motor shaft until the maximum reading is encountered. The reading should be about 0.8 volt RMS (1.12 Volt Peak). The potentiometer now can be adjusted to achieve 0.8 volt RMS reading.

Terminal Block 1 (TB1) for CAIF-xx-xx-xxx-R Resolver Feedback Version (cont.)

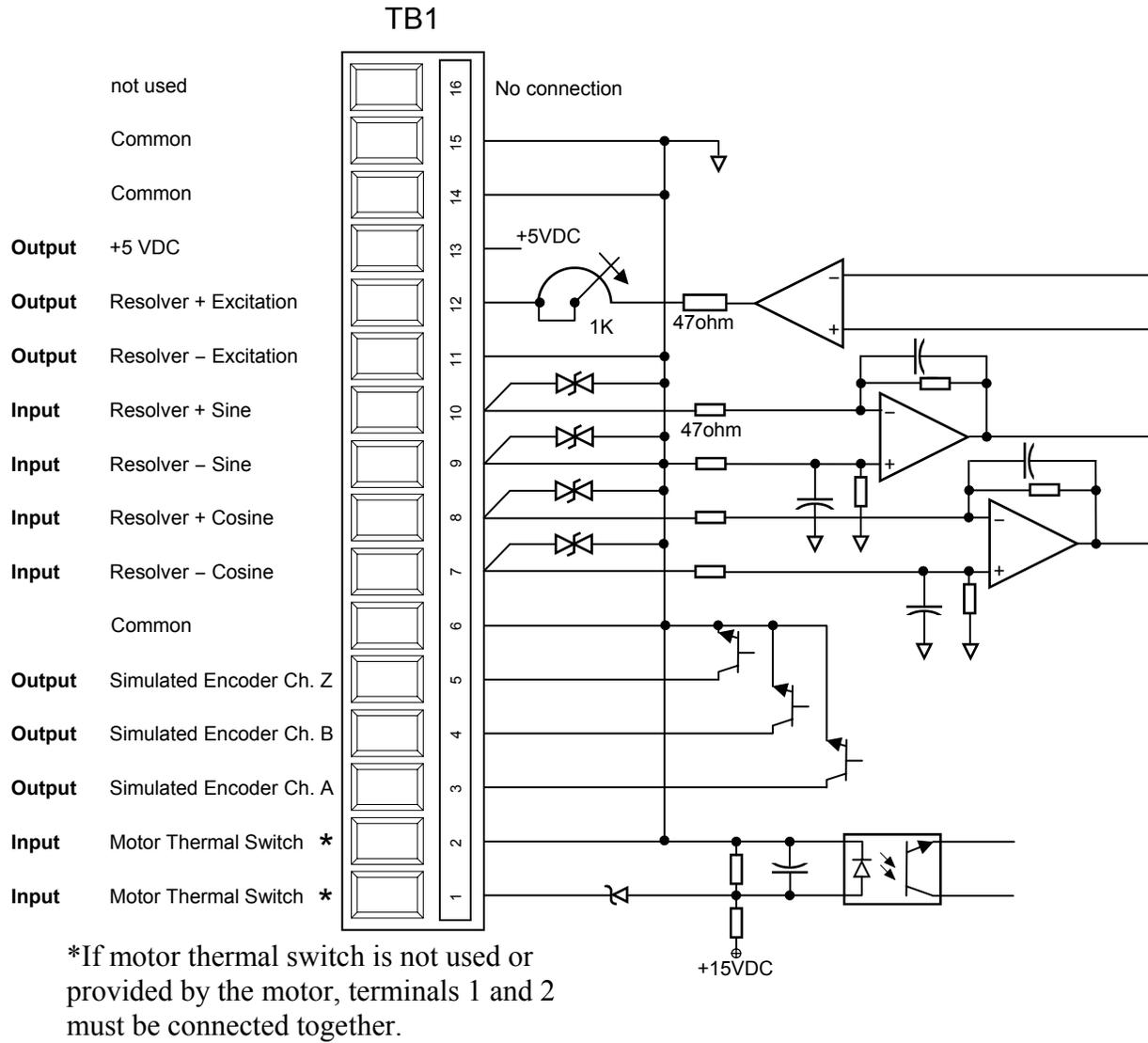


Fig. 1.1

SIMULATED ENCODER OUTPUTS TB1-3, 4, 5

After the resolver signals are filtered, they are fed into a resolver to digital converter, in which it will also generate simulated encoder signals.

The Encoder Signal channels A and B are phase shifted by 90 degrees electrical and each provides 1024 counts (cycles) per one revolution of the resolver (two pole resolver). The encoder signal channel Z is a one pulse per revolution, which normally is used for homing and machine alignments.

All simulated encoder signals are brought out using three (3) open collector transistors without pull up resistors, so they can be connected to different signal level inputs. If TTL level signals are required, 470 ohm, ½ watt resistors can be used as pull up from Sim.A, Sim.B, and Sim.Z to +5vdc at the TB1 terminal block.

Terminal Block 2 (TB2)

TB2 provides some of the main necessary interface signals between the operator station or PLC to the drive.

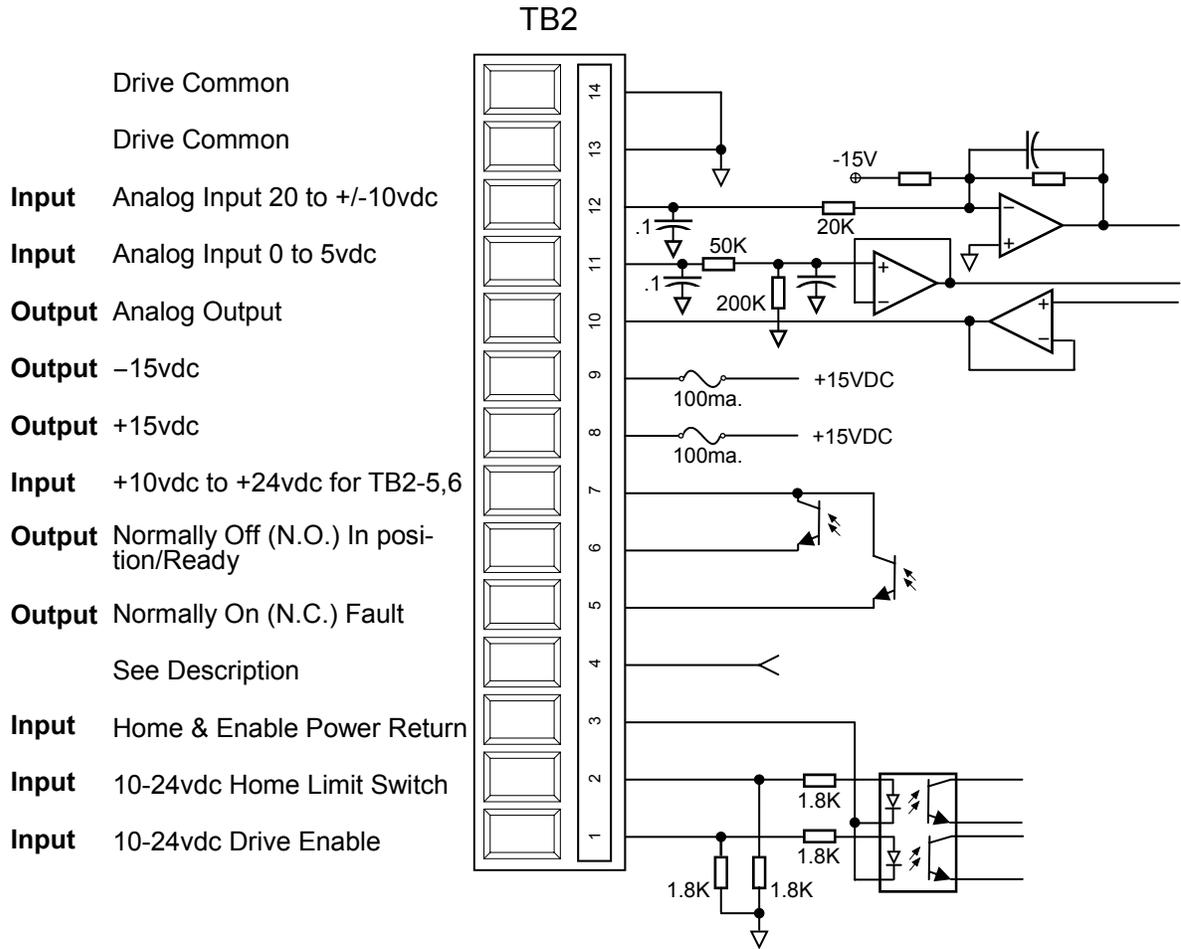


Fig. 2.0

TB2 – 1 (Input) Drive Enable

Applying a minimum +10 vdc, with respect to TB2-3 (0 vdc), will enable the output power transistor and also illuminate the green LED (RUN) on the face of the controller.

TB2-2 (Input) Home Limit Switch

This input is used in applications that require the controller to drive the motor in a given direction until a Home (zero reference) position switch is activated; mostly used in linear actuator type applications to establish a zero reference point after each power up. In some applications, the channel Z or reference marker signal generated from the motor mounted encoder or a resolver can be used to establish a zero reference point within one revolution of the motor. This input requires a minimum of +10 vdc with respect to TB2-3, in order to be recognized as an active level.

Terminal Block 2 (TB2)

TB2-3 (Input) Power Return for Enable and Home Limit Switch

If using an external power source for the Home limit switch and Drive enable inputs, this terminal should connect to the external power supply ground. If using the power from TB2-8, +15 vdc output, then this terminal should be connected to any of the drives Common (Ground) terminals.

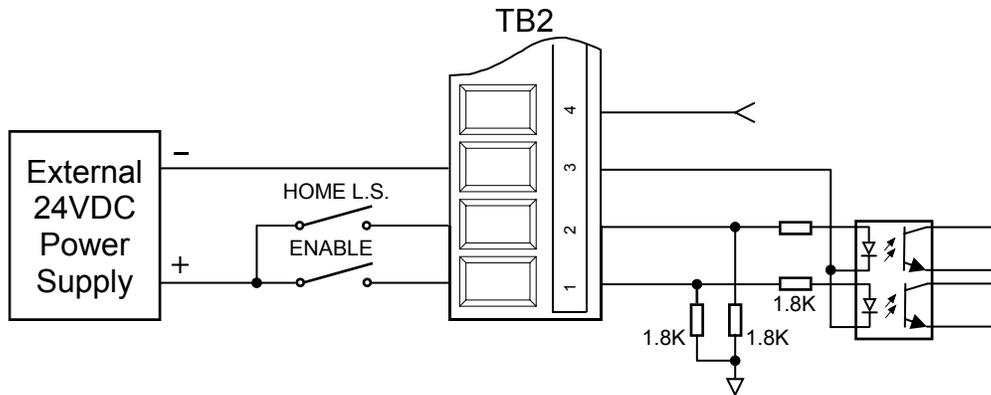


Fig. 2.1 – Using External Power for Drive Enable and Home Limit Switch Inputs.

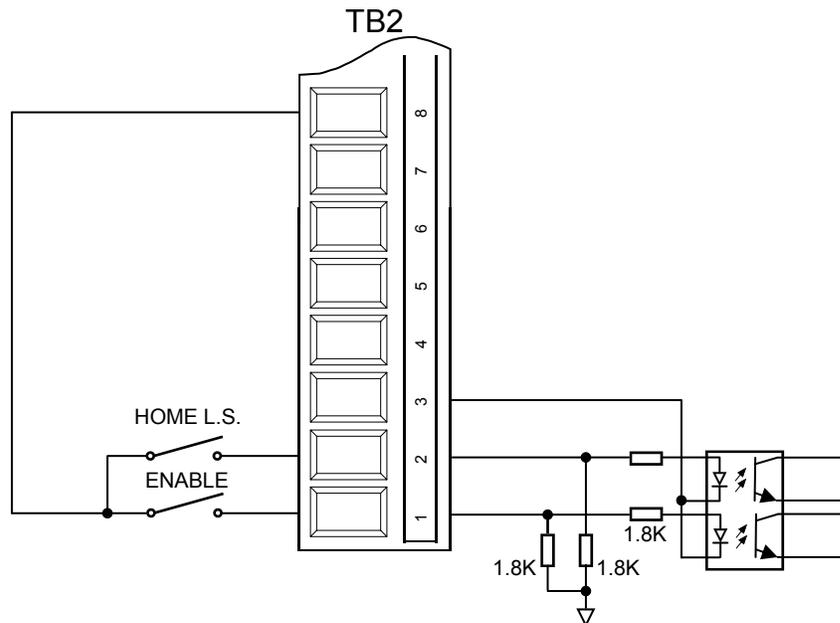


Fig. 2.2 – Using Drive +15 vdc to Power Drive Enable and Home Limit Switch.

TB2-4 (Output)

In the resolver feedback version, this terminal is internally connected to the drive common and can be used as common (ground).

TB2-5 (Output) Fault

This terminal is an open emitter photo transistor output. It provides a signal regarding the drives health. Under normal conditions, after power up, this output will be ON which will pass through the voltage level present at TB2-7 terminal. If a Fault Condition is detected by the drive, this output will turn OFF (Blocking the voltage from TB2-7).

There are several fault conditions that will cause the fault output to turn OFF.

- 1-Power Interrupt
- 2-Low DC bus voltage, less than 60vdc
- 3-High DC bus voltage, greater than 400 vdc
- 4-Motor output short.
- 5-Motor Over-temperature switch

TB2-6 (Output) In-Position / READY

This output can also be called tolerance. After each move, the controller will compare the actual position to the command position and only if the actual position is within the programmed tolerance, will it turn on this output, signaling that it is within tolerance. This output turns OFF on beginning of all moves and jogs.

This output also uses the voltage applied at TB2-7 to pass through or block.

TB2-7 (Input)

10 to 24 vdc Power for Fault and In-position Output.

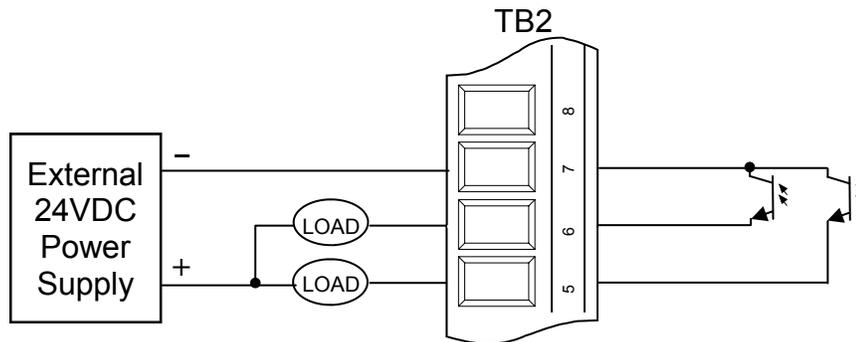


Fig. 2.3 - Using External Power for In-Position and Fault Outputs

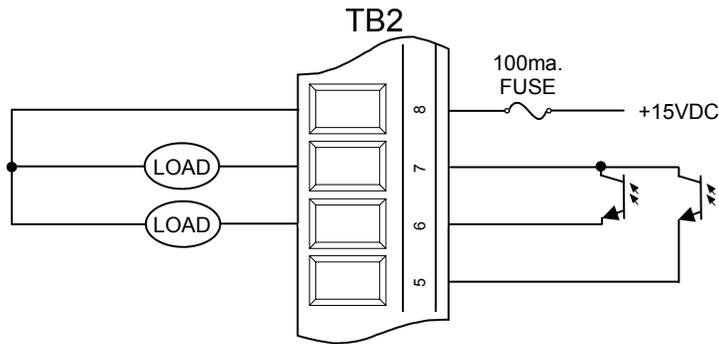


Fig. 2.4 - Using Power from the Drive for In-Position and Fault Outputs

TB2-8 (Output) +15 vdc

This terminal provides a +15 vdc with reference to any common terminal. It can be used to power the isolated I/O's. The +15 vdc contains an on-board 100 mA fuse for protection. The fuse will open if a short circuit or excessive current draw is detected, and will self-reset once the short circuit condition is removed.

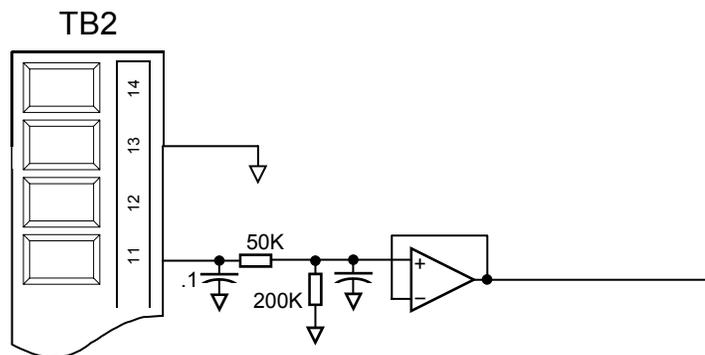
TB2-9 (Output) -15 vdc

Same as TB2-8, but -15 vdc.

TB2-10 (Output) Analog Output

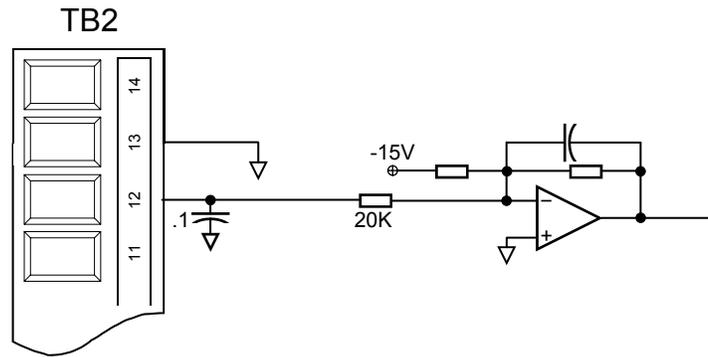
Presently the analog output is a 0 to 5 vdc output, proportional to the motor current. If the drive is rated for 5 amps rms, the Analog Output of 0 to 5 volts is proportional to 0 to 10 amps rms, and if the drive rating is 15 amps, then 0 to 5 volts is equivalent to 0 to 30 amps rms. This output can drive up to 20 mA load.

TB2-11 (Input) Analog Input 1



This input can accept an analog signal level of 0 to +5 vdc, which is intended to be used as a transducer feed input or a general purpose analog input.

TB2-12 (Input) Analog Input 2



This input can accept an analog signal level of -10 to +10 vdc, which is intended to be used as a speed reference or a current command. It can also be utilized as a programmable analog input.

TB2-13 and TB2-14

These two (2) terminals are the Drive common, or the +/- 15 vdc power supply commons.

SERIAL COMMUNICATION INTERFACE RS485

The controller is furnished with a RS485 2-wire communication channel intended to interface to PLC's and PC's capable of communications using ModBus RTU protocol (using cable part number CAIF-06CB485.) As an alternate method, an RS232 3-wire device can be connected to this port using the RS232 cable (part number CAIF-06CB232).

Please Note: Use of RS232 cable while the controller is running (enabled) is not recommended, once the controller programming is completed, the cable must be disconnected from the controller.

The communication baud rate has been set to 19200 with 8 data bits and one stop bit, with no parity. The internal circuitry is shown below along with both RS232 and RS485 Cables.

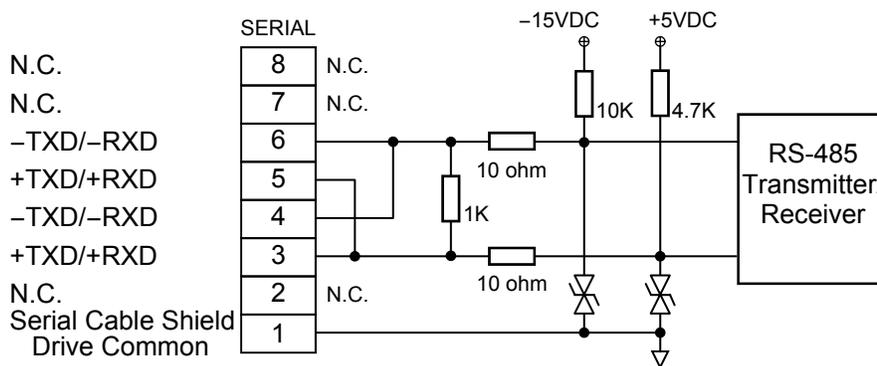


Fig. 3.0 - Serial Interface through RJ45 Connector

9 pin D-SUB Female Amphenol
Connector #40-9709-S with 9 pin
D-SUB Shell Amphenol # MPS-520-9

8 position RJ45 Modular Plug
Amp # 5-569532-2 with 8 position
Strain Relief Amp #
558527-1



Pin 1 - N.C.
Pin 2 - White/Brown & Cathode of 1N914
Pin 3 - Anode of 1N914
Pin 4 - N.C.
Pin 5 - Brown
Pin 6 - N.C.
Pin 7 - N.C.
Pin 8 - N.C.
Pin 9 - N.C.

Wire 1 - White/Blue
Wire 2 - Blue
Wire 3 - White/Orange
Wire 4 - Orange
Wire 5 - White/Brown
Wire 6 - Brown
Wire 7 - White/Green
Wire 8 - Green

Fig. 3.1 - CAIF-06CB232 Recommended Cable to connect directly to PC with RS232.

9 pin D-SUB Female Amphenol
 Connector #40-9709-S with 9 pin
 D-SUB Shell Amphenol # MPS-520-9

8 position RJ45 Modular Plug
 Amp # 5-569532-2 with 8 position
 Strain Relief Amp # 558527-1

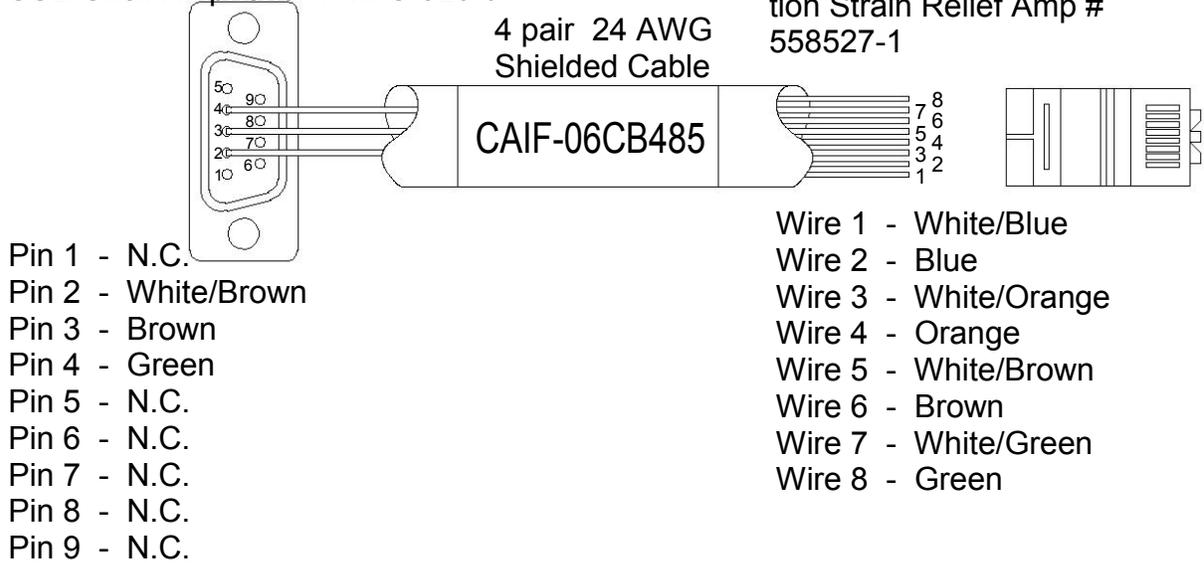


Fig. 3.2 - CAIF-06CB485 Recommended Cable for RS485.

Please Note: Use of the RS485 cable and connection is highly recommended for applications that need a direct serial link to the controller. To connect an RS232 device to the drive, an RS232 to RS485 converter is required, such as B&B Electronics Model# 485SD9R or similar.

TB5 DIGITAL INPUTS / OUTPUTS

The CAIF Series of programmable motion controllers currently are furnished with 8 programmable inputs and 4 programmable outputs which can be accessed through this terminal block. All the inputs are optically isolated and will require a 10 to 24 vdc to be recognized as a valid ON State.

All outputs are also isolated from the controller circuitry, which can source 5 to 24 volt DC applied at terminal TB5-1 when they are turned ON.

To maintain isolation, an external power source should be used to connect to TB5-14, 0 volt, and TB5-1, 10 to 24 vdc, otherwise the +15 vdc power from TB2-8 can be used.

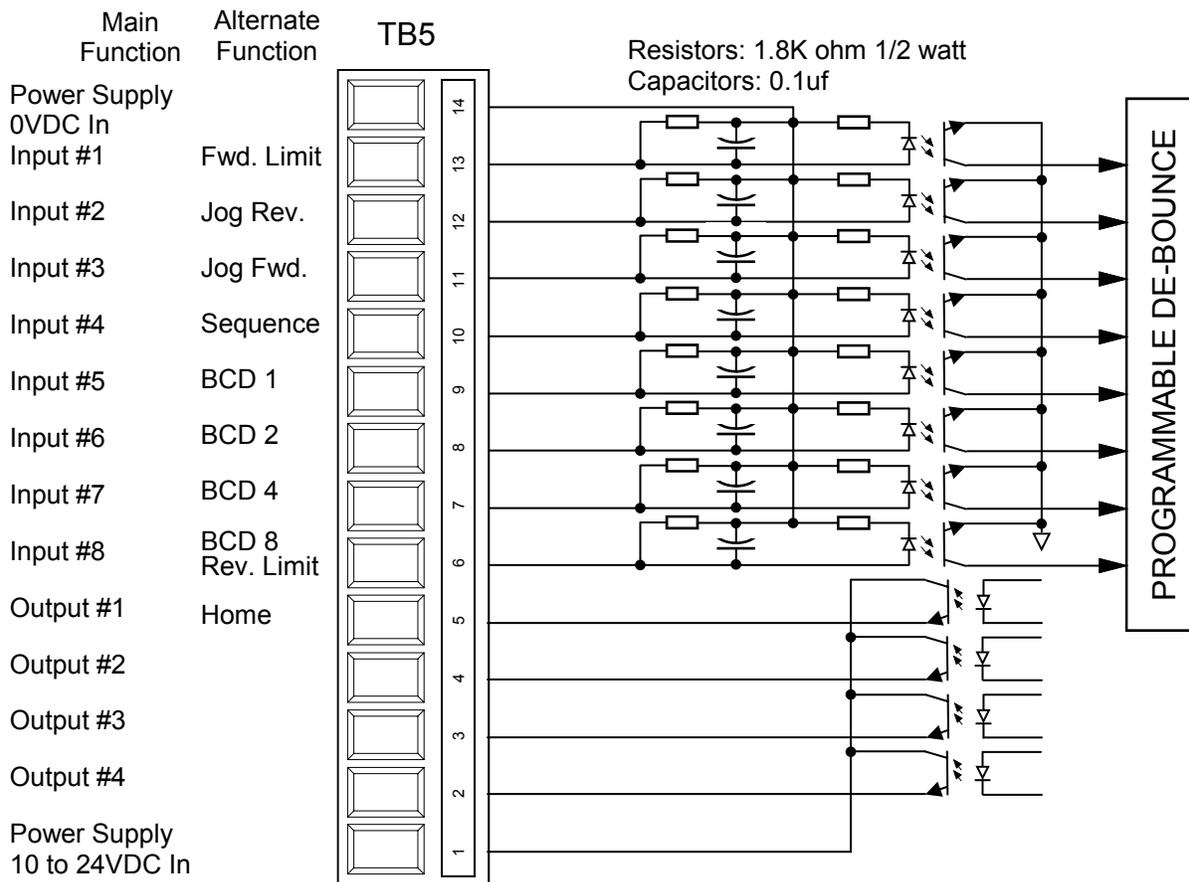


Fig. 4.0 - TB5, Fully Isolated Digital Inputs and Outputs.

The Inputs will require at least 10 mA if +10 vdc power is used and maximum of 26 mA, if +24 vdc power is used.

TB5 DIGITAL INPUTS / OUTPUTS (cont.)

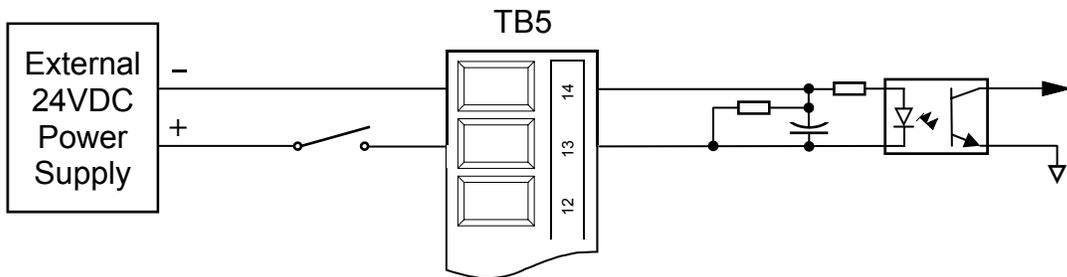


Fig. 4.1 - Connecting Inputs to External Power. One input shown.

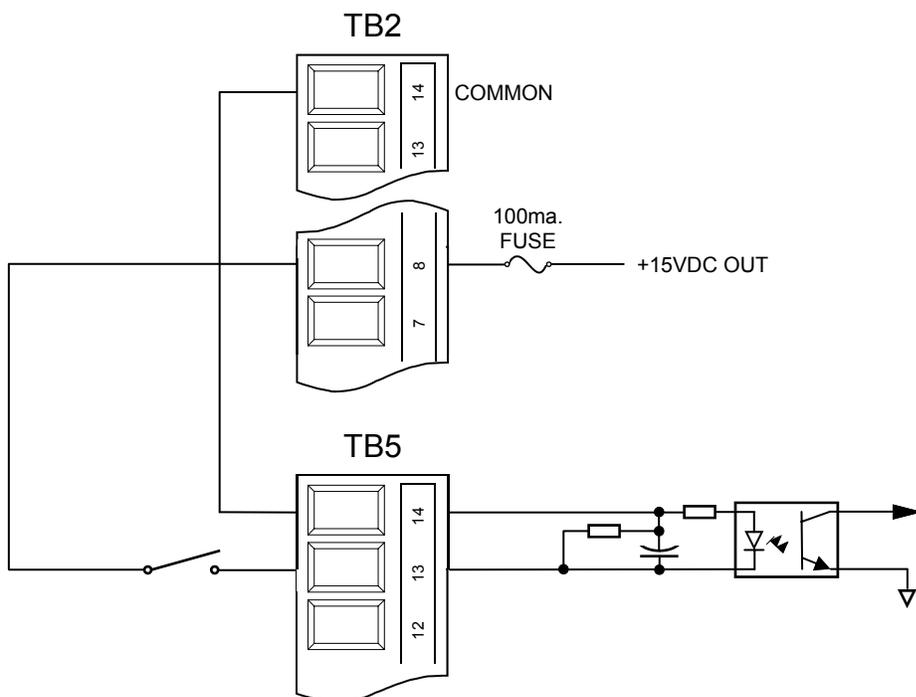


Fig. 4.2 - Connecting Inputs using +15vdc from the Drive. TB2-8 One input shown.

The outputs are sourcing photo transistor outputs and they can source up to 20 mA and up to 24 vdc power from TB5-1. Since the outputs are open emitter output (they supply + volt when they are ON), for applications requiring TTL Level signals, a pull down resistor can be used. A good value for the pull down resistor with 5 vdc power applied at TB5-1 is about 1000 ohm and should be installed on the receiving end.

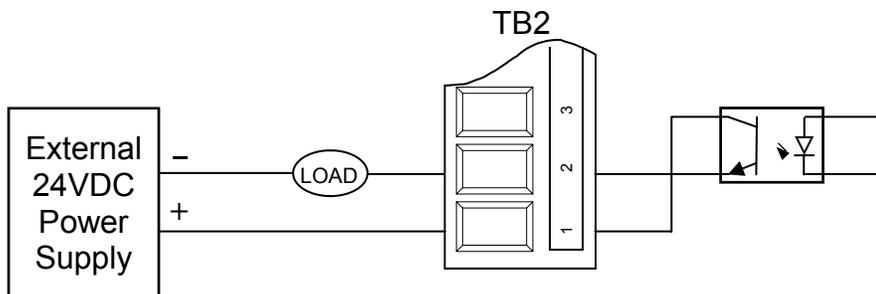


Fig. 4.3 - Using External Power for the Outputs. One input shown.

TB5 DIGITAL INPUTS / OUTPUTS (cont.)

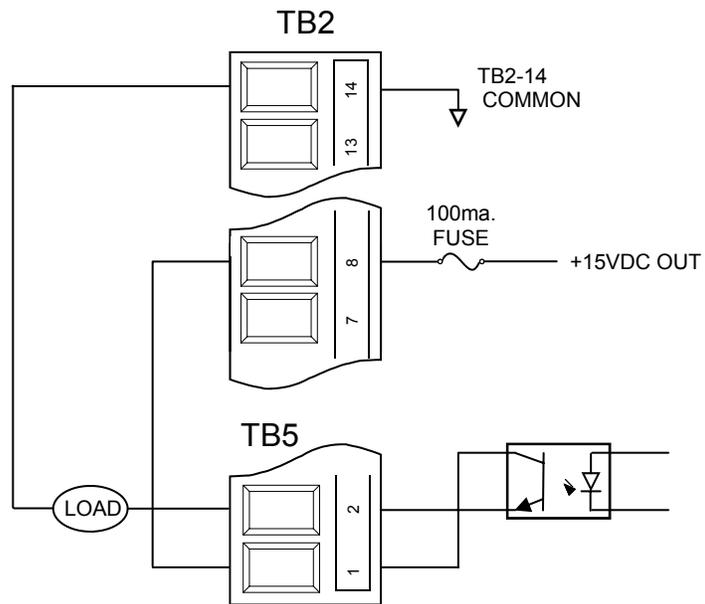
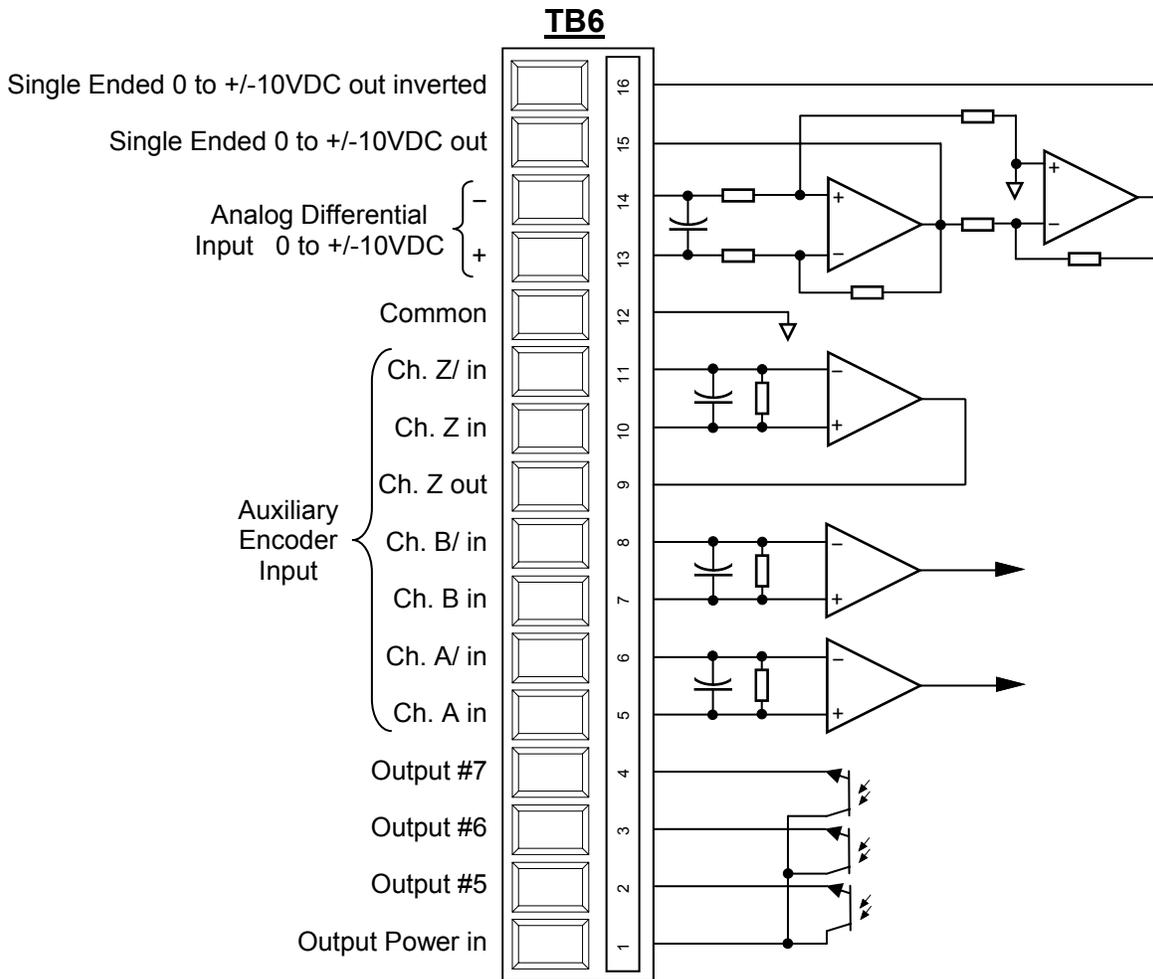


Fig. 4.4 - Using power from drive for outputs. One output shown.

TB6 AUXILIARY ENCODER INPUTS AND ADDITIONAL 3 OUTPUTS AND DIFFERENTIAL ANALOG INPUT

This terminal block adds additional features and enhancement to the original CAI series of controllers, converting it to CAIF Controller. The new feature allows for an electronic gearing control with a programmable set ratio. In addition to an auxiliary encoder channel input, three (3) additional programmable outputs and a differential analog input have been added.



TB4 POWER AND MOTOR CONNECTION

The TB4 Terminal Block of the CAIF Series is electrically isolated from the controller circuitry. This terminal block is intended for the high current, high voltage power input and power output to the motor.

All CAIF Series Controllers/Drives are furnished with on-board shunt regulator circuitry to prevent excessive potential during the regeneration, due to the braking of a rotating mass to a stop; which is also accessible through this terminal. During motoring acceleration, the energy is provided from the drive to the motor to bring the load up to a speed and during braking deceleration, the kinetic energy translates to electrical energy through the motor charging the buss capacitors.

Without the shunt regulator circuitry, the potential on the capacitor banks can exceed a safe level for the capacitors and the power transistors, which can cause capacitor overheating and possibly an explosion, as well as the power transistor failure. The shunt regulator circuitries consist of a voltage comparator, measuring the buss voltage against a preset value, a power transistor, acting as a switch to turn on when the comparator has sensed the voltage in excess of preset value, and a load resistor, which will act as a load to dissipate the excess energy that is causing the capacitor over-charge.

It is also recommended to include a fuse in series with the load resistor, to prevent damage to the shunt regulator transistor and to protect the load resistor from melting down, in case of the shunt regulators transistor failure.

Presently, three (3) different frame size drives and controllers have been introduced:

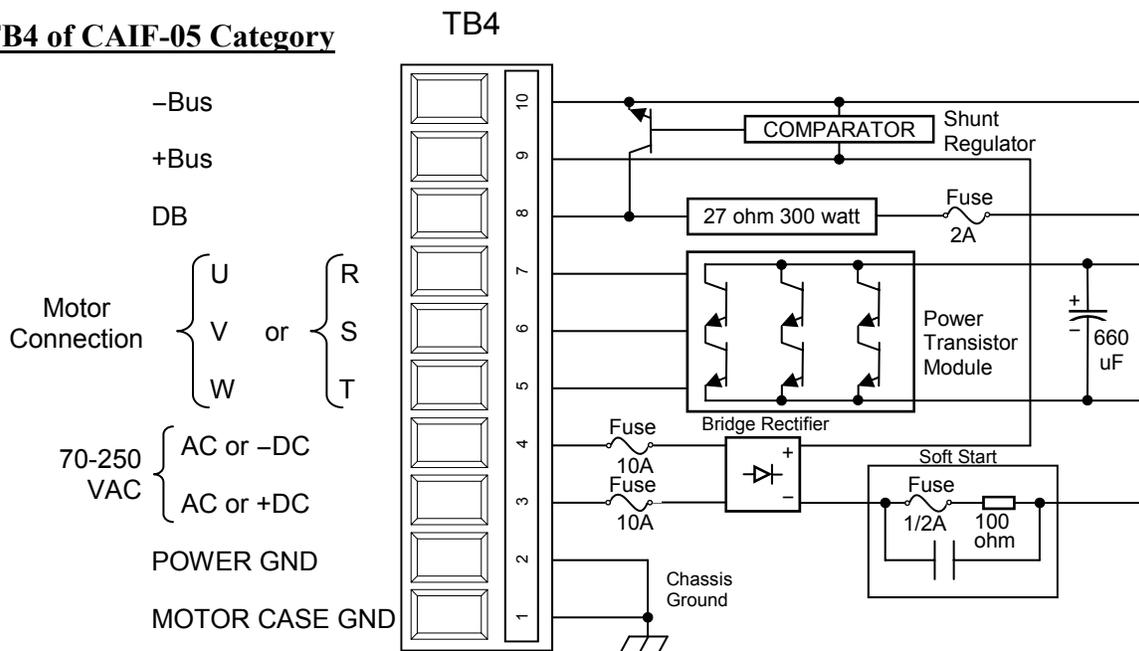
CAIF-05 Category

CAIF-15 Category

CAIF-20 to CA-35 Category

The intent of this section is to describe the function of each terminal for each category.

TB4 of CAIF-05 Category



NOTE 1: TB4-3 and 4, can accept 70 to 250 vac single phase input or 100 to 360 vdc. When using a DC Power Input to the drive, the (+) polarity must connect to TB4-3 and (-) polarity to TB4-4.

NOTE 2: TB4-8 is the collector of the shunt regulator power transistor with its emitter connected to negative DC Bus. CAIF-05 contains a 27 ohm, 300 Watt shunt load in series with a 2 Amp slow-blow fuse connecting from +Bus to TB4-8 (Collector of the Shunt Regulator Transistor). To add additional shunt load, connect an appropriate size resistor in series with a fuse between TB4-9 (+Bus) and TB4-8 (DB) Terminals.

INSTALLATION AND SET-UP

THE INSTALLATION OF THIS DRIVE SHOULD BE PERFORMED BY QUALIFIED ELECTRICAL PERSONNEL AND SHOULD CONFORM WITH LOCAL AND NATIONAL ELECTRICAL CODES WHERE APPLICABLE.

1. Before installing the drive, check for any physical damage that may have occurred during shipping. ***DO NOT INSTALL A DAMAGED DRIVE. RETURN FOR REPAIR OR REPLACEMENT.***
2. Choose a location to install the drive. An ideal location would be free of dust and moisture, away from high current carrying buss bars and away from wiring that is susceptible to electrical noise. Allow at least 2” clearance on the top and bottom to allow for air movement.
3. Mount the drive through the slotted holes on the base of the drive, vertically.
4. Refer to the connection diagram provided, for the appropriate drive model number.
5. For motor currents of less than 5 Amps Continuous and less than 50 Ft. Distance, use minimum 16 AWG wire. Connect the 3 motor wires, motor case ground and shield to TB4 terminal block. Refer to chart below for wire sizes

Current Rating	Wire Size
up to 5 Amp	16 AWG
5 to 10 Amp	16 AWG
10 to 15 Amp	14 AWG
15 to 20 Amp	12 AWG
20 to 35 Amp	10 AWG

6. Connect power. ***DO NOT FORGET TO CONNECT EARTH GROUND.*** All CAIF Series of Controller/Drives, are furnished with on-board line fuses. Because the drive is a high voltage and high current fast switching PWM device, switching power into an inductive load (which also is capacitive considering shielded motor cable), it may be required by the installation to install a line filter on power input to the drive. The line filter will minimize the radiated noise (EMI) through the power wiring. It is important to install the line filter as close as possible to the drive and use short wires from the filter to power input of the drive.
NOTE: FOR CE COMPLIANCE THE LINE FILTER IS A MUST.
7. Connect feedback to the drive using a good quality foil shielded cable. Use of minimum 20 AWG twisted pair shielded cable is preferred. Increase the wire size for cable length of greater than 200 ft.
8. A normally ON Opto-transistor output is provided to indicate drive fault for:
 - a. DC Buss Under Voltage
 - b. DC Buss Over Voltage
 - c. Motor Over Current
 - d. Motor Short
 - e. Loss of Power
 - f. Motor Over TemperatureThe Output is OFF (0 Volt) to initiate Fault.

INSTALLATION AND SET-UP (cont.)

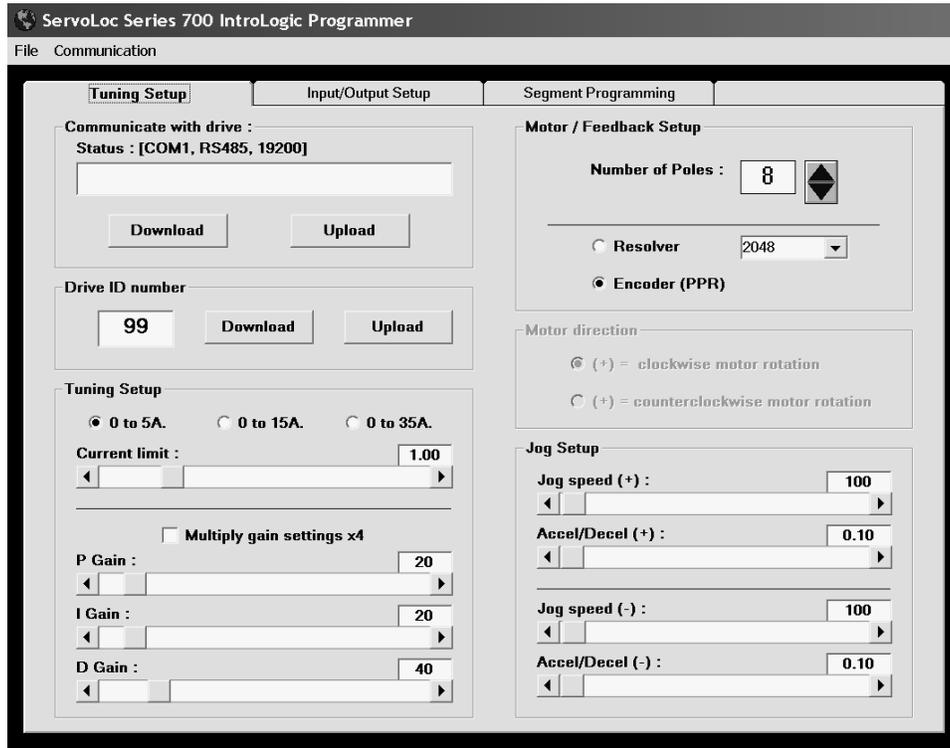
9. Connect appropriate inputs to the controller to ENABLE/DISABLE and all other Inputs/Outputs as required by your particular application needs.

NOTE: All Inputs/Outputs are optically isolated and they will require an external power, (10 to 24vdc) or power from TB2 terminal of the drive for proper operation.

10. **WARNING: Before applying power for the first time, please RECHECK all wiring for proper and correct connection and please remember that all terminals are connected with Terminal #1 toward the bottom. Also, to avoid possible problems, make sure the drive is disabled prior to power up for the initial set-up.**
11. Apply Power. Now the yellow "POWER ON" LED on the face of the drive will illuminate. During the power up, a clicking sound may be heard which indicates that the soft start circuitry has timed out and the drive is ready to operate.
12. Boot up the furnished PC Software after it is installed and "click" on the "TUNING SET-UP" tab on top, if it is not already there; follow the procedure below to set up and get ready to run. If this is the first time you have launched the programmer software, it may be necessary to set up the communication port and connection type (RS232 or RS485), through the drop-down menu bar labeled "Communication".

TAB #1 – TUNING SET-UP PAGE

Starting from Top Left and going Down –



COMMUNICATE WITH DRIVE

Status:

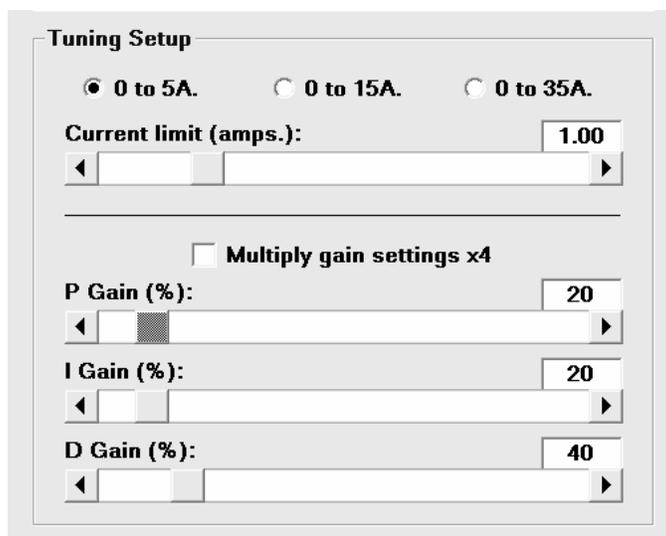
This is to indicate the communication parameters as well as displaying activities and error messages in the text box field right below it.



Download / Upload buttons are used to send information from the PC to the Drive (Download), or to get information from the Drive and display on the PC (Upload). Each time parameters are changed on the PC, it must be downloaded to the drive, in order to take effect.

TUNING SET-UP

This field contains settings to match the drive to a particular motor and tune the system behavior for a desired performance. There are three (3) current range selections. Based on the drive's continuous current rating, select the appropriate current range.



The screenshot shows a 'Tuning Setup' window with three radio buttons for current range selection: '0 to 5A.' (selected), '0 to 15A.', and '0 to 35A.'. Below these are three sliders for gain settings: 'Current limit (amps.)' set to 1.00, 'P Gain (%)' set to 20, 'I Gain (%)' set to 20, and 'D Gain (%)' set to 40. A checkbox labeled 'Multiply gain settings x4' is currently unchecked.

Current Limit:

Adjust the slide bar to match the motor continuous rated current.

WARNING: DO NOT SET THE CURRENT LIMIT TO MORE THAN THE MOTOR'S CONTINUOUS CURRENT RATINGS. Operating the motor in excess of its continuous rating will damage the motor and could cause drive failure.

Multiply Gain Settings x 4:

It is possible in some instances, with a very low torque and high speed motors, all or some of the PID settings will reach their maximum setting during tuning. Selecting this Option will multiply the PID result by 4.

Proportional Gain (P GAIN)

The Controller / Drive constantly monitors the feedback and calculates the difference between its intended position versus its current position. The result of this calculation (the difference) is called "position error" or "following error". The drive will produce current into the motor in proportion to the position error multiplied by the P GAIN. Obviously, the greater the P GAIN, the lower the position error; however, if the P GAIN is too high, the system can become unstable, and excessive current will be delivered to the motor and cause motor over-heating.

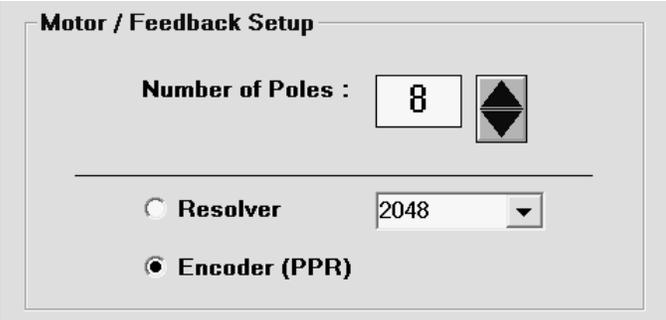
Integral Gain (I GAIN)

Since a high P GAIN causes an unstable control and a low setting causes a large position error, the Integral GAIN control corrects and compensates the output current to the motor by integrating the positional error deviations over time, so that eventually the positional error deviations are brought to zero. The I GAIN setting determines how quickly the error is brought to zero. The higher the I GAIN, the faster the positional error is brought to zero. Excessive I GAIN will cause system instability and oscillation, which will require higher Derivative Gain.

Derivative Gain (D GAIN)

Since the control loop always suffers from delay in processing the error instantaneously, the D GAIN will compensate for this problem by using the rate of change of the error and anticipating the future error. D GAIN compensates and corrects for sudden changes in position / velocity and load disturbances, by calculating the rate of change of error and multiplying this rate by the D GAIN setting to achieve stability. Excessive D GAIN will cause longer setting time and excessive motor current.

MOTOR / FEEDBACK SET UP



The screenshot shows a configuration window titled "Motor / Feedback Setup". It contains the following elements:

- A label "Number of Poles :" followed by a text box containing the value "8" and a vertical double-headed arrow button.
- A horizontal separator line.
- Two radio button options: "Resolver" (unselected) and "Encoder (PPR)" (selected).
- A dropdown menu next to the "Resolver" option, which currently displays the value "2048".

Number of Motor Poles:

Brushless servo motors are designed similar to 3 Phase AC motors with the exception of having permanent magnet rotor poles. Based on the motor design, they could be 4, 6, 8, ... etc. pole counts and contain an integral feedback device which is used by the drive to commutate the motor and produce a motor rotation as well as using it as a velocity feedback. This field allows the drive to properly commutate the selected motor.

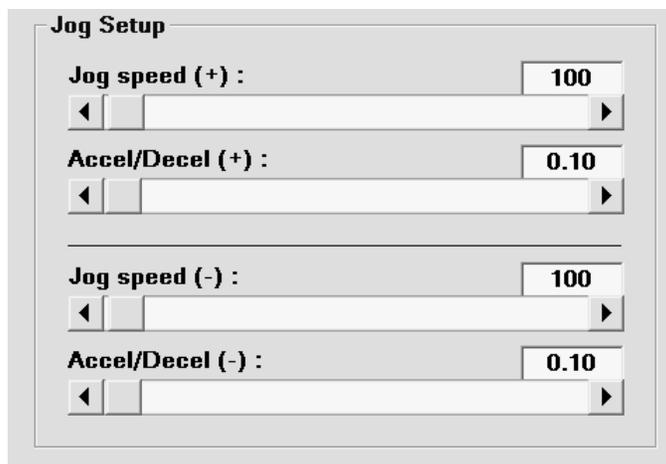
RESOLVER / ENCODER

Based on the type of motor, the motor may have a resolver or an encoder with hall effects as a primary feedback. Selecting "Resolver" will disable the selection for "Encoder" and also will disregard the setting for "Encoder PPR".

NOTE: In Resolver Mode, the feedback PPR (pulses per revolution) of the motor is 1024 Pulses.

Selecting "Encoder" will disable the "Resolver" and will allow for the selection of the Encoder resolution on the motor.

JOG SET-UP

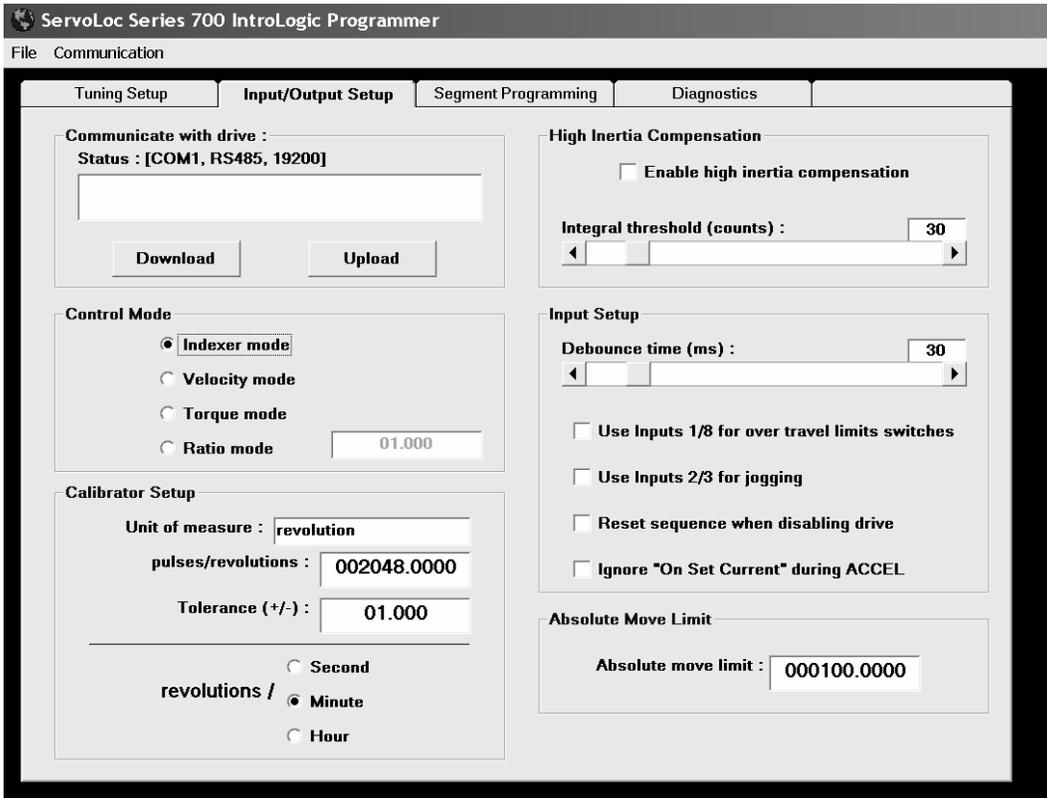


The screenshot shows a 'Jog Setup' dialog box with four parameter rows. Each row consists of a label, a numerical value in a small box, and a horizontal slider with arrowheads at both ends. The parameters are:

Parameter	Value
Jog speed (+) :	100
Accel/Decel (+) :	0.10
Jog speed (-) :	100
Accel/Decel (-) :	0.10

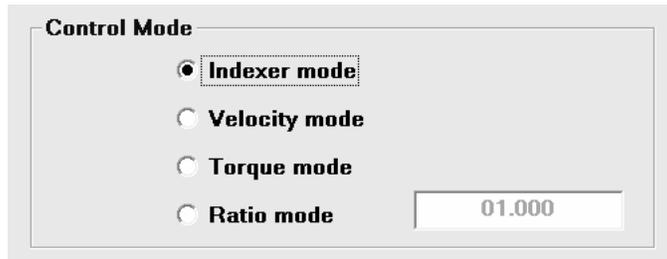
This portion is to set up the JOG speeds and Acceleration / Deceleration times for forward and reverse directions. As was mentioned earlier, some of the inputs are assignable as well as being programmable. Two of the general purpose inputs can be assigned to be used as JOG FWD / REV inputs and here (their speeds and Accel / Decel times) can be programmed. **(Please note that the speeds are programmed in a designated unit of measure such as Revolutions per Minute (RPM), Feet per Minute (FPM), Inches per Minute (IPM) etc., which will be explained under the next tab, “Input / Output Set-Up” and calibration) .**

TAB# 2 - INPUT / OUTPUT SET-UP



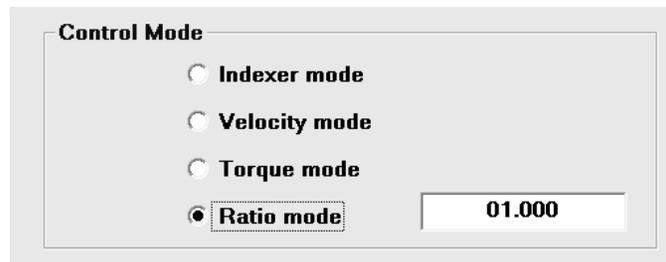
Starting again from upper left side: The Upload / Download is the same as the previous tab to write and read the set up parameters to and from the Controller / Drive.

CONTROL MODE



This portion will configure the controller to operate as an Indexer / Positioner, or as a dumb drive in velocity mode, or as Current / Torque mode controller, using an analog signal input.

RATIO MODE



The screenshot shows a control panel titled "Control Mode". It contains four radio button options: "Indexer mode", "Velocity mode", "Torque mode", and "Ratio mode". The "Ratio mode" option is selected, indicated by a filled circle. To the right of the "Ratio mode" option is a text input field containing the value "01.000".

When ratio mode is selected, a ratio programming field will become active. The ratio programming range is 00.001 to 09.999. This is the pulse ratio of the auxiliary encoder input at TB6 to the primary feedback (resolver or encoder). Programming the value 1.000 means that for each one encoder count received through TB6, the primary feedback will move by an equal amount.

CALIBRATOR SET-UP

The screenshot shows a 'Calibrator Setup' window with the following fields and options:

- Unit of measure : revolution
- pulses/revolutions : 002048.0000
- Tolerance (+/-) : 01.000
- revisions / Second
- Minute
- Hour

Unit of Measure:

This field, in conjunction with the unit setup Second/Minute/Hour will allow the user to define a unit of measure for the particular application. Once the unit of measure is selected and programmed, all the programming fields will adjust and display the unit of measures.

Example: If the unit of measure was programmed as inches and Second was selected, all speeds would be displayed as inches/second.

Calibrator PPU (Pulses per Unit of Measure):

This setting defines and sets the calibration of how many counts of the primary feedback from the motor equates to one unit of desired measure. Please Note that all position, indexing and speed commands will be calibrated using this setting. As an example, if the motor is coupled to a linear actuator with a 3:1 belt ratio and the screw lead is 0.2 inches (5 revolutions of screw to one linear inch motion), using a resolver feedback motor, one would program the calibrator as follows:

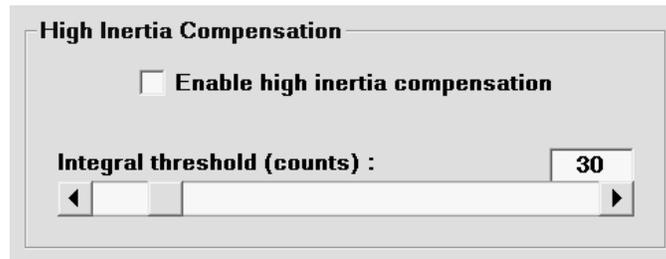
$$\text{Calibrator} = 1024 (\text{feedback counts}) \times 3 \times 5 = 15360 \text{ counts.}$$

TOLERANCE (+ / -) :

This is also known as the acceptance window. After each move, the controller will check to see if the actual position is within the programmed limits at this entry, before it initiates the Move Complete / In-Position output signal. This is programmed in user defined calibrated units of measure, revolutions, inches, etc.

HIGH INERTIA COMPENSATION

To further enhance and tailor the PID for stability, these settings have been implemented.



ENABLE HIGH INERTIAL COMPENSATION:

With a high inertial load (reflecting back 20:1 mismatch and higher), this selection will enable the high inertial compensation by disabling the Integral Gain of the PID loop until the move profile is completed, at which time, the Integral Gain is activated to bring the load within the programmed tolerance. With high inertia mismatch, enabling this function will prevent motor overshoot by critically damping the PID loop to avoid overshoot during deceleration and allows faster deceleration and reduces cycle time.

INTEGRAL THRESHOLD (COUNTS):

Based on the nature of the application, the impact from the Integral Gain can be limited to achieve a non-linear response. The integral threshold is programmed in unit of counts received from the resolver / encoder. As an example:

If a load disturbance has occurred, in which the error has exceeded the limit set by this entry, the Integral Gain will only use the limit set here on each calculation until the error has fallen below this limit.

This setting will prevent over integration and system instability, especially in high inertia mismatch situations. Entering a zero for this setting will disable the integral term of the PID loop.

INPUT SET-UP

Input Setup

Debounce time (ms) : 30

Use Inputs 1/8 for over travel limits switches

Use Inputs 2/3 for jogging

Reset sequence when disabling drive

Ignore "On Set Current" during ACCEL

DEBOUNCE TIME (ms):

All inputs are debounce / filtered. This setting will set the amount of time that an input must maintain a valid state (High / Low or On / Off), without changing state before it is realized. The time is programmed in milliseconds (ms).

NOTE: Individual input debounce times are being implemented to satisfy the applications requiring a mix of fast response inputs used as an interrupt generated via a solid state device and high debounce time for inputs in noisy environments with dry contacts.

Use Input 1 and 8 for over-travel limit switch input.

Inputs 1 and 8 can be assigned as a hardware over-travel limit switch to prevent end crashes in limited travel applications. During homing, or any other move types, if either over-travel limit switches are dropped out, (over-travel limits are ON, providing inputs to indicate safe zone, normally closed), the controller will decelerate to stop and also will reset the programmed segment execution to the 1st segment (line).

If the Jogs are enabled (and during a jog, the over-travel limit switch is detected), the controller can be jogged only in the opposite direction to clear the over-travel limit.

Note: Care must be taken when utilizing the over-travel limit switch to allow for a safe deceleration distance to stop, to avoid end crashes on ball screw or linear actuator type applications.

Here is an example to assist with calculating a deceleration distance when over-travel limits switch is detected.

Example: If the motion speed is 500 inches / minute with accel / decel of 0.5 seconds, if the actuator reaches the over-travel switch, it will travel:

$$\text{Decel distance} = 1/2 \frac{\text{Speed (inches/min)} \times \text{accel/decel time (sec)}}{60 \text{ (sec/min)}}$$

$$\text{Decel distance} = 1/2 \frac{500 \text{ (inches/min)} \times 0.5 \text{ (sec)}}{60 \text{ (sec/min)}}$$

(One should allow for more than the calculated numbers.)

Use Input 2 and 3 for Jogging.

Inputs 2 and 3 can be assigned to be used as “Jog +” and “Jog -” Inputs. Using the speeds and acceleration / deceleration programmed in the first “TAB” (Tuning Set-Up), while the Drive/Controller is not executing any motion profiles, it can be commanded to move in either direction at the programmed speed. The motor will move at the programmed speed as long as the particular Jog Input is active. Once the Input is de-activated, the motor will decelerate to a stop and then it will turn On the in-position output.

Reset Sequence when Disabling Drive

Based on the application, it may be preferred to restart the program execution from the beginning of the program. Checking this option will reset the programs execution to line (segment) #1 anytime the controller is disabled.

NOTE: Even though the controller is disabled, it remembers the actual position, even if the motor is rotated by other means. Care must be taken in selection of this option and the program segments should include either a HOME command or a RESET Actual Position, to discard the positional data.

Ignore “On Set Current” during Accel.

This option will be explained in using “ON SET Current / Go To” program command.

In some versions, this option may be embedded and allowed when the “ON SET Current / Go To” instruction is selected from the command list.

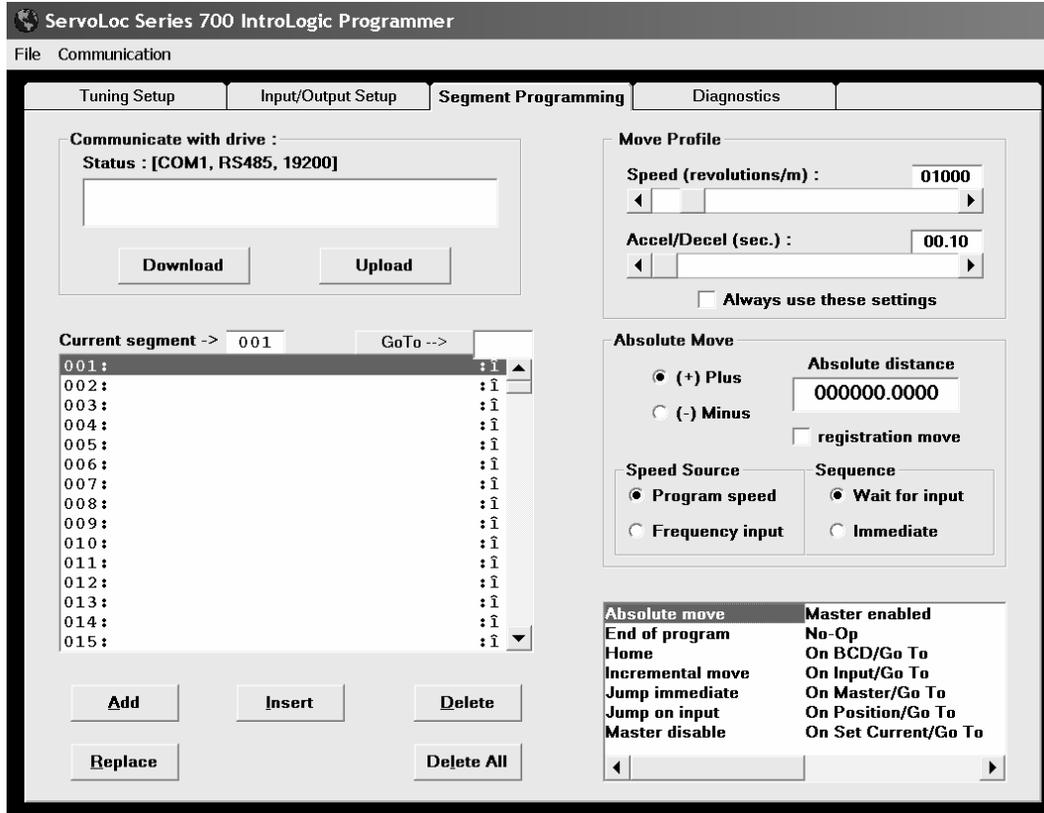
ABSOLUTE MOVE LIMITS



This is a software programmed limit to confine the moves within the “0” Home and the entry made here. This is in the calibrated unit of measure. Programming a zero, will disable this function and allows jogging and motion without limits.

TAB #3 - SEGMENT PROGRAMMING TAB

This section allows the user to program the controller to perform the functions required by the application. There are program commands displayed in the lower right field and they can be selected and added to the segment list on the left side. Each time a command is selected, additional options become visible to allow for more information to be



programmed pertaining to the selected command. Once the selected command is tailored to each need, clicking on the “ADD” will transfer the information to the left field, adding it to the list as a program segment.

Each programmed segment can also be edited by “double clicking” on the segment, to allow for the alteration and “clicking” on the “REPLACE” will replace the selected segment with the modified command on the right field.

A program segment can also be inserted by selecting a location for insertion of the new segment, and selecting a command from the command list, and then “clicking” on the “INSERT”.

ABSOLUTE MOVE

Absolute move or a relative move finds its use mostly in linear actuator type applications where move commands are referenced to a starting point. Usually one extreme end of the actuator is referred to as a zero or reference point or home and all moves are programmed relative to that point. When an Absolute Move is executed, the controller compares the commanded position to its actual (present) position to calculate the amount of motion and direction required to satisfy the commanded position relative to the reference point (Home).

When an absolute move command is selected an additional programming field regarding absolute move will appear directly above the command list to allow for programming the position command, direction, speed, and acceleration / deceleration.

The speed is programmed in the calibrated units of measure established by the programmed calibrator under the TAB #2 (Input/Output Setup).

NOTE 1: Remember that every move command (Incremental, Absolute & Home) normally requires a sequence input command. If it is desired to perform multiple moves without requiring additional sequence input commands, a selection is provided to self-sequence the next move by selecting the immediate option. Otherwise, wait for input will require the preceding move to wait for a sequence command input.

NOTE 2: All instructions other than move commands in between the move segments will be executed regardless of wait for input or immediate selection option.

Move Profile

Speed (revolutions/m) :

Accel/Decel (sec.) :

Always use these settings

Absolute Move

(+) Plus Absolute distance
 (-) Minus

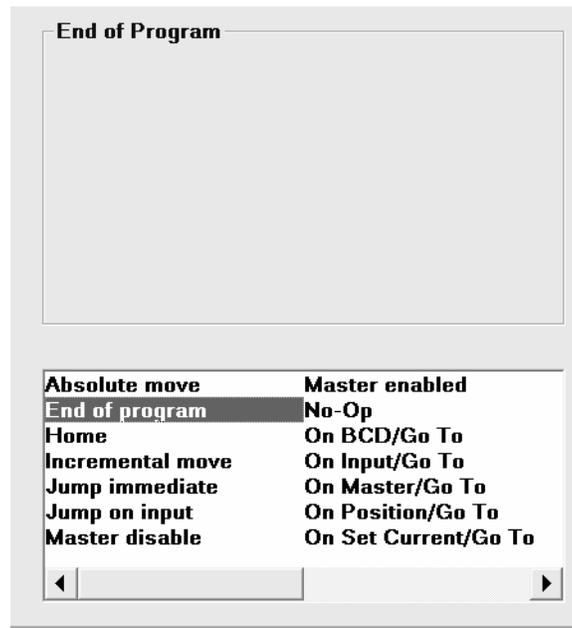
registration move

Speed Source **Sequence**
 Program speed Wait for input
 Frequency input Immediate

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

NOTE 3: The controller always keeps track of its position relative to the Home or Zero position, even if the controller is disabled, as long as the power is applied. If the controller would have been disabled and the position was deviated by other means, upon re-enabling the controller and execution of an Absolute Move command, the controller will move to a commanded position relative to Home or Zero Reference point.

END OF PROGRAM



After all desired commands are programmed, it is necessary to include the “END OF PROGRAM” command, after the last programmed segment in order for the PC software to process and download only the programmed segments.

NOTE 1: If the program consists of many sub-programs at various different locations, The “END OF PROGRAM” command should be placed after the very end of the last sub-program.

NOTE 2: Only one “END OF PROGRAM” should be used. If a program contains more than one “END OF PROGRAM” command, the program will only be processed up to the first “END OF PROGRAM” command line.

HOME

Home instruction will command a motion in the commanded direction with the programmed speed and Acceleration/Deceleration time. The speed is programmed in the calibrated unit of measure established by the programmed calibrator under the TAB #2 (Input/Output Setup). Once the HOME Command is executed, the status of the Home limit switch will be examined.

A)- If the Home limit switch Input is not active, the motor will run in the commanded direction until the leading edge of the Home limit switch is detected. At this point, the motor will decelerate to a stop while measuring the distance from the sensed point. After a complete stop, the motor will reverse direction and move to the leading edge point.

B)- If at the time of execution of the homing sequence, the Home Limit Switch is Active, the motor will move in the opposite direction of the programmed direction until the limit switch is cleared and then starts the homing sequence as described in 1.1

The screenshot displays a configuration window for the HOME function. It is divided into three main sections:

- Move Profile:** Contains two numeric input fields. The first is labeled "Speed (revolutions/m) :" with a value of "01000". The second is labeled "Accel/Decel (sec.) :" with a value of "00.10". Below these is a checkbox labeled "Always use these settings".
- Home Move:** Features two radio buttons: "(+) Plus" (selected) and "(-) Minus". To the right is a "Home offset distance" field with the value "+00000.0000". Below this are two sub-sections: "Speed Source" with radio buttons for "Program speed" (selected) and "Frequency input"; and "Sequence" with radio buttons for "Wait for input" (selected) and "Immediate".
- Move Type List:** A table with two columns. The first column lists move types, and the second column lists their corresponding actions. The "Home" row is highlighted.

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

NOTE: The homing can be done to a limit switch or to channel Z or marker of the encoder or both.

CAUTION: Be aware if using a Home limit switch, the actual position is NOT beyond the position of the Home limit switch. If such a condition can exist, provisions must be made to insure that the limit switch will remain active anywhere beyond the Home position.

NOTE: So far, the description for Homing assumes the leading edge of the limit switch is the Zero position, however, there are two (2) ways to introduce an offset (meaning, to assign a value for the Home position).

- 1.) Program the offset directly in the position field of the Home Command. This can be a (+) or (-) value in the calibrated measurement.
- 2.) Program a second segment, to reset the present position, using the set location command (will be described later in this chapter) to reset the position after homing to the programmed position.

INCREMENTAL MOVE

Incremental Move or an Index command is used to move a programmed amount from the present position. Once the Incremental Move is selected, additional fields regarding the incremental move will appear directly above the command list, to allow for programming the amount of movement, direction, speed, and acceleration / deceleration time. The speed is programmed in the calibrated unit of measure established by the programmed calibrator under the TAB #2 (Input/Output Setup).

Additional options have been incorporated to allow for registration move indexing and also to select the velocity source. Registration move is ideal for applications where the feed distance must occur from a point of interest, rather than from the starting point. For instance, in a feed-to-length application where the product is pre-printed with a repeat pattern of about 24 inches, the registration move allows for accurate feed and cut.

To make full use of the registration move, a repeat pattern move must be programmed (see repeat pattern move). The repeat pattern will allow the indexer to start the motion and try to move the repeat pattern distance. Once the registration mark from the product is detected, the distance to move is recalculated and the final move would be the incremental index programmed here after the detection of the registration point.

Example: For a preprinted product with a print repeat of 24 inches, with the photo eye positioned 17 inches from the seal and cut mechanism, the repeat pattern move will be programmed as 24 inches and the incremental index would be programmed as 17 inches. In the event that the photo eye malfunctions or in the absence of a registration mark, the repeat move will be executed, which should be close to where it should be.

Move Profile

Speed (revolutions/m) :

Accel/Decel (sec.) :

Always use these settings

Incremental Index

(+) Plus Incremental distance
 (-) Minus

registration move

Speed Source **Sequence**
 Program speed Wait for input
 Frequency input Immediate

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

Speed Source: The velocity can be programmed in the unit of measure or it can be selected to follow the auxiliary encoder input (master speed). In order to utilize this option, the master encoder channel must be enabled (see master enable) and an appropriate ratio must be programmed (see set ratio).

The indexing with external frequency input is very useful in applications where the feed speed must be the same as the line speed, such as label feeders. Combination of indexing to match external frequency and registration indexing is ideally suited for label dispensing for packaging machinery.

NOTE 1: Remember that every move command (Incremental, Absolute & Home) normally requires a sequence input command. If it is desired to perform multiple moves without requiring additional sequence input commands, a selection is provided to self-sequence the next move by selecting the immediate option. Otherwise, wait for input will require the preceding move to wait for a sequence command input.

NOTE 2: All instructions other than move commands in between the move segments will be executed regardless of wait for input or immediate selection option.

NOTE 3: Even though the Incremental Move is a point-to-point move, the controller keeps track of its relative position to the starting point since the last reset instruction either at power-up, home initiate, or position reset.

NOTE 4: If the controller is disabled and the position is deviated by other means, upon re-enabling, the controller will lock in at its present position and waits for a sequence command to continue the program execution. While disabled, the controller will continue to keep track of the actual position.

JUMP IMMEDIATE

This command allows the program execution sequence to branch and continue from the programmed segment (line number).

Jump Immediate

Jump immediate to segment :

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

JUMP ON INPUT

This instruction allows a conditional jump only if the specified inputs are active prior to the execution of this instruction. Jump to the specified sequence step number will only be taken, if and only if, the specified inputs are active when the program execution sequence has reached such an instruction, otherwise the next instruction following this step number will be executed.

Jump on input

Jump to segment no. : n input :

#1 (TB5 - 13) #5 (TB5 - 9)
 #2 (TB5 - 12) #6 (TB5 - 8)
 #3 (TB5 - 11) #7 (TB5 - 7)
 #4 (TB5 - 10) #8 (TB5 - 6)

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

MASTER DISABLE

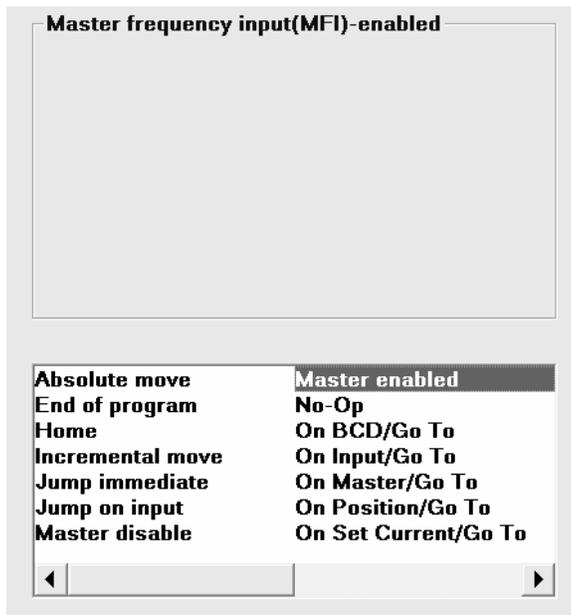
When this instruction is executed, the auxiliary encoder channel input is shut off. The content of the accumulated master pulses are held at the count prior to the execution master disable instruction.

Master frequency input(MFI)-disable

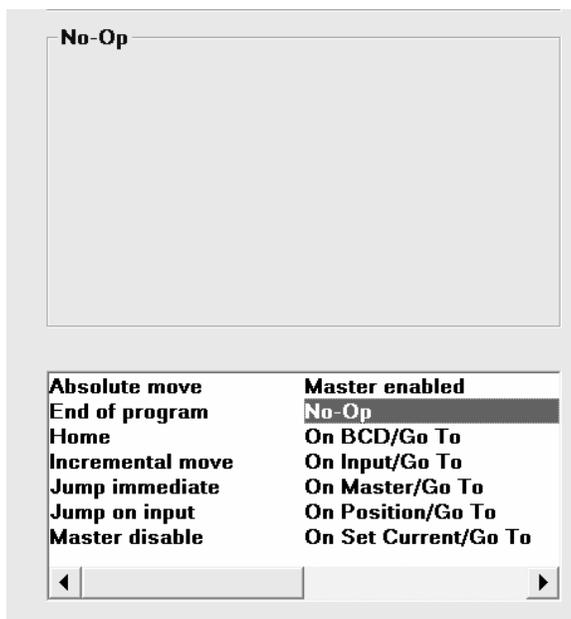
Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

MASTER ENABLE

This instruction will open the auxiliary encoder input channels for counting and ratio follower mode operation.



NO-OP



Just as it sounds, this is a no operation command or skip. When program execution sequence detects this command, it will ignore and execute the next line. No Operation can be used as a filler or when deleting a command from a previously programmed segment. Rather than deleting a line of command in a large size program with many jump to line numbers, the line of command can be replaced with "NO-OP" commands, to preserve the jump to line numbering.

ON BCD GO TO (BRANCH TO)

This feature is very useful for applications where the machine has to operate in several different modes, or to execute different programs that have been loaded into the memory of the controller.

What is BCD?

It is a abbreviation of the term “Binary Coded Decimal”. By using 4 Bit input (4 Input lines), 15 different combinations of the 4 Bit inputs are possible by Binary Selection of the designated inputs. Therefore, it would be possible to create 15 different programs or sub-programs and select which to be executed using the particular input combinations. Other inputs can also be used to increase the BCD selectability to up to 127 combinations by using “On Input Jump To” or “Jump On Input” commands.

The ON BCD commands must be loaded to and program execution sequence must already have gone through the command before they can be selected and executed. Usually, all the ON BCD commands reside at the beginning of the program, so once the drive is enabled and the very first sequence command is initiated, the controller will read and remember which line number it should branch to based on the binary selected inputs. The controller only needs to read the ON BDC commands once and does not need to be reminded or constantly looped through.

To force an execution and branch to a line number:

- 1– Binary select the desired inputs that correspond to the programmed ON BCD command that is loaded into the controller.
- 2– Initiate a sequence command. At this point, the branch to the designated line number is taken.
- 3– Remove the selection on all binary selected inputs.

Once the binary selected input lines are removed (turned off), the program execution will resume from the branched line number.

NOTE: To efficiently utilize the inputs, the inputs can be configured for three (3) BCD lines or four (4) input BCD lines based on the selection made under the Input Setup portion of TAB #2. If “Use inputs 1/8 for overtravel limits switches” is checked, then only three (3) BCD lines are available.

On BCD/Go To	
On BCD input value :	<input type="text"/>
Go To segment number :	<input type="text"/>
Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

Here is a simple BCD programming and assignment example:
 On an assembly line, four (4) different size products are placed on a conveyor which requires the conveyor to index different amounts based on the product; the desired index amounts are 6", 12", 18" and 24". Program segment as follows:

```

Current segment -> 020 GoTo -->
001:ON BCD:001:GOTO:008      :
002:ON BCD:002:GOTO:010      :
003:ON BCD:003:GOTO:012      :
004:INC:+000006.0000:00500:00.60:ÿÿ:
005:JMIMD:004                :
006:                          :î
007:                          :î
008:INC:+000012.0000:00500:00.60:ÿÿ:
009:JMIMD:008                :
010:INC:+000018.0000:00500:00.60:ÿÿ:
011:JMIMD:010                :
012:INC:+000024.0000:00500:00.60:ÿÿ:
013:JMIMD:012                :
014:END OF PROGRAM:          :ÿ
015:                          :î
  
```

* ON INPUT/GO TO

On Input/Go to

Jump to segment no. : n input :

#1 (TB5 - 13) #5 (TB5 - 9)
 #2 (TB5 - 12) #6 (TB5 - 8)
 #3 (TB5 - 11) #7 (TB5 - 7)
 #4 (TB5 - 10) #8 (TB5 - 6)

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

This command allows for the program sequence execution to be interrupted and forced to a programmed line number once the selected input lines become active. The unselected inputs are ignored regardless of their state.

Since this is an interrupt and does not need an additional sequence command, it will branch and continue the execution of the program from the designated line number.

NOTE 1: Once the branch has been taken, the command for the particular “ON INPUT/GO TO” will expire and if it needs to remain active, it should be reloaded somewhere within the branched program sequence or after returning to the main program sequence loop.

NOTE 2: In order for the interrupt and branch to take effect, the program execution sequence must have passed through the command.

NOTE 3: If a branch is taken during any move (Home, Incremental, Absolute), in order to interrupt the motion, two different types of stopping commands are available, Fast Stop and Ramp To Stop. Remember that the controller is still tracking the actual position and if an Absolute Move command is initiated, the controller will move to the correct position.

ON MASTER/GO TO

There are six (6) programmable medium speed counters that can be assigned to jump to a programmed line number. These counters will compare the actual position or the accumulated master count received from the auxiliary encoder. When any of the six counters are assigned to compare to the master count, it should be noted that the internal pulse count is four (4) times the encoder count and the accumulated count is counted up and down. When the master (auxiliary encoder) count is equal to or greater than the programmed amount here, the jump to the segment (program line number) is executed.

Please note that no polarity is programmed and if the controller is disabled prior to the count and the reset sequence when disabled option is selected (see Input Setup), the jump to segment instruction will not take place.

On Master count/Go To

+000000000 counts

Set counter no : Go to segment :

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

ON POSITION/GO TO

There are six (6) programmable medium speed counters that can be assigned to jump to a program line number once the programmed limit is reached or exceeded. This instructions will compare the actual position to the programmed position and once the actual position exceeds the programmed limit, the jump to program line number is executed.

Please note that no polarity is programmed and if the controller is disabled prior to the count and the reset sequence when disabled option is selected (see Input Setup), the jump to segment instruction will not take place.

On actual position/Go To

00000.0000 position

Set counter no : Go to segment :

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

ON SET CURRENT/GO TO:

This instruction allows for the program sequence execution to branch to a specified step number, based on the programmed current threshold level. When this instruction is selected, a programming field will appear, to allow for programming the current threshold level at which point the interrupt will be initiated, as well as, the Branch/Jump to the Step/Program Line number.

On Set Current/Go To

Go to segment number :

On current threshold :

Delay before Go to :

Absolute move	Master enabled
End of program	No-Op
Home	On BCD/Go To
Incremental move	On Input/Go To
Jump immediate	On Master/Go To
Jump on input	On Position/Go To
Master disable	On Set Current/Go To

Also, a programmable time delay is included as a debounce or override, to ignore current spikes with a duration less than the programmed time.

To further refine the use of this function, additional selections are made available to ignore current threshold processing during the acceleration, which usually demands more current to accelerate the load to the speed. Please see the Ignore On Current During Accel in TAB #2 (Input/Output Section).

PLEASE NOTE THAT:

In order for this instruction to take effect, the program execution must have passed through this instruction. This instruction is a single shot, meaning that, once the Branch/Jump has occurred, it will not re-trigger unless it is reloaded with a new instruction again.

Following is a simple example:

```

Current segment -> 020      GoTo -->
001:ONI:01.50:GOTO:007:DELAY:00.010:[]
002:INC:+000005.0000:00500:00.60:ÿÿ:[]
003:OUTPUTS:OFF:1          [] :[]
004:JMIMD:002              :[]
005:                        :î
006:                        :î
007:FAST STOP:             :[]
008:OUTPUTS: ON:1         [] :[]
009:JMIMD:001              :[]
010:END OF PROGRAM:       :ÿ
011:                        :î
012:                        :î
013:                        :î
014:                        :î
015:                        :î

```

EXAMPLE

Once the controller is enabled and the sequence command is initiated, in 001 the On Set Current is loaded. If at anytime here after, the current level exceeds 1.5 amp level for more that 0.010 second, the program execution will be forced to line number 007, otherwise +5 inch index will be completed without interruption and output #1 will clear regardless.

Once the current level and time is detected, at line number 007, fast stop (without ramp) is executed and also output #1 will turn ON Output #1 (may be used to indicate or alarm a jam up or dull tooling). After the output is turned ON, the Jump Immediate Command to line 001 will reload the ON SET Current instruction and waits for sequence input command.

OUTPUT OFF

Any of the programmable outputs can be turned OFF using this instruction, when the program sequence has reached such an instruction. One (1) or all outputs can be turned OFF with a single instruction. Commanding to turn OFF an output that is already off will have no effect on the specified output. Selecting the Output Off command will open a programming field to allow selection as to which outputs should be turned OFF.

Output(s) Off

Select output(s) to turn off :

Output 1 (TB5-5) Output 5 (TB6-5)

Output 2 (TB5-4) Output 6 (TB6-6)

Output 3 (TB5-3) Output 7 (TB6-7)

Output 4 (TB5-2)

Master enabled	Output off
No-Op	Output on
On BCD/Go To	Ratio disable
On Input/Go To	Ratio enabled
On Master/Go To	Repeat pattern move
On Position/Go To	Reset actual position
On Set Current/Go To	Reset/preset MRC

OUTPUT ON

The controller presently includes (7) seven programmable outputs which can be turned ON or OFF via a programmed segment when the program execution sequence has reached such an instruction. Selecting the Output ON command will open a programming field to allow selection of which outputs should be turned ON, in addition to the ones that may have already been turned ON through previous instructions.

NOTE: You do not need to re-specify the outputs that have already been turned ON to keep them ON, on each Output ON instruction. You may specify the output that needs to be turned ON in addition to the existing ones.

Output(s) On

Select output(s) to turn on :

Output 1 (TB5-5) Output 5 (TB6-5)

Output 2 (TB5-4) Output 6 (TB6-6)

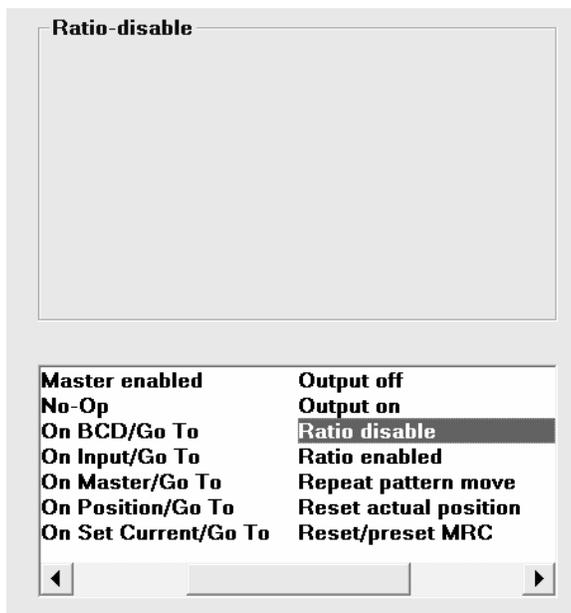
Output 3 (TB5-3) Output 7 (TB6-7)

Output 4 (TB5-2)

Master enabled	Output off
No-Op	Output on
On BCD/Go To	Ratio disable
On Input/Go To	Ratio enabled
On Master/Go To	Repeat pattern move
On Position/Go To	Reset actual position
On Set Current/Go To	Reset/preset MRC

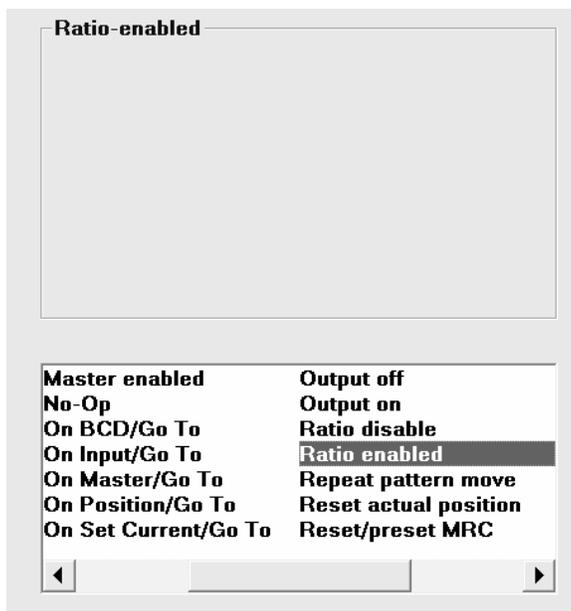
RATIO DISABLE

This instruction will stop the ratioed follower mode, but it will still continue on sampling auxiliary master encoder input.



RATIO ENABLED

If auxiliary encoder input channel is enabled (see Master Enable instruction), by execution of ratio enable, the master pulses are multiplied by the programmed ratio (see Set Ratio instruction) and then summed with the primary feedback pulses to generate position error. The error then passes through internal processing algorithm and PID to generate a current command to the motor.



REPEAT PATTERN MOVE

This instruction is intended to be used in conjunction with the Incremental Move when Registration Move option is selected. For example, if a pre-printed material with a repeat pattern of 24 inches is to be fed into a seal and cut station, with a photo eye detecting a registration point on the material itself, and after which the detection of the registration point the material must feed exactly 17 inches, two segments of program are required. One segment to program the 24 inch repeat pattern and one segment to program the incremental move with registration and 17 inches if index. Please note that if the registration signal is missed for any reason, the repeat move of 24 inches will take place, avoiding undesirable double feeds and machine jam-ups.

Registration repeat pattern	
Repeat move	
000000.0000	

Master enabled	Output off
No-Op	Output on
On BCD/Go To	Ratio disable
On Input/Go To	Ratio enabled
On Master/Go To	Repeat pattern move
On Position/Go To	Reset actual position
On Set Current/Go To	Reset/preset MRC

RESET ACTUAL POSITION

Reset actual position	
Reset position to	
+00000.0000	

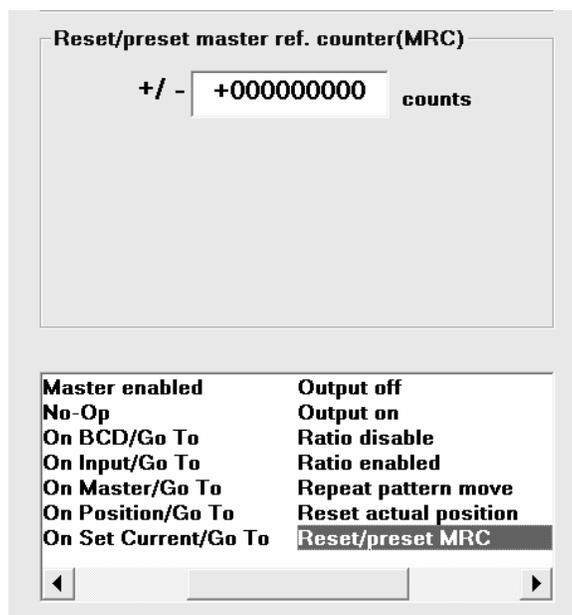
Master enabled	Output off
No-Op	Output on
On BCD/Go To	Ratio disable
On Input/Go To	Ratio enabled
On Master/Go To	Repeat pattern move
On Position/Go To	Reset actual position
On Set Current/Go To	Reset/preset MRC

Since the controller is always keeping track of the actual position based on the nature of the application, it may be necessary to clear or fool the controller by resetting its position memory to a desired position. This command is useful in absolute positioning applications and creating a home offset, where the Home limit switch is not actually mounted at zero position. Also in ap-

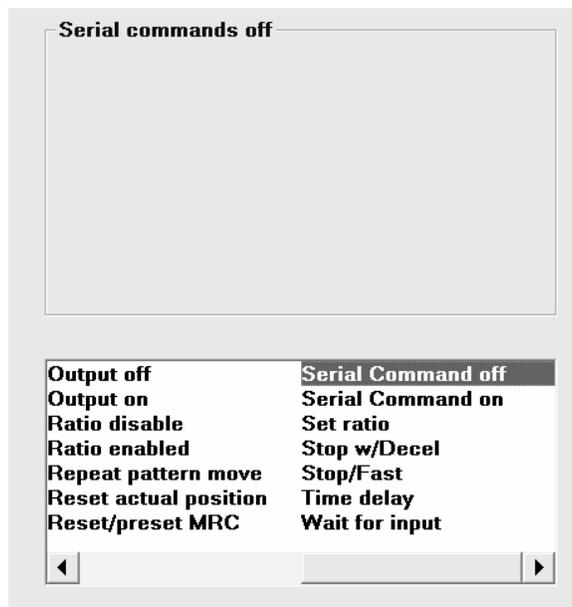
plications where the actual home is the stalled position at either end of a linear actuator, the Reset Actual Position command after the execution of an On Set Current and Move command and Stop, can be used as a Home To Stall command. The programmed position is in the specified unit of measure established by the programmed calibrator under TAB #2 (Input/Output Setup).

RESET/PRESET MASTER REFERENCE COUNT

This instruction is used to preset a starting count value in to the auxiliary encoder input counter that is used to compare to the programmable limits (see On Master Count instruction).

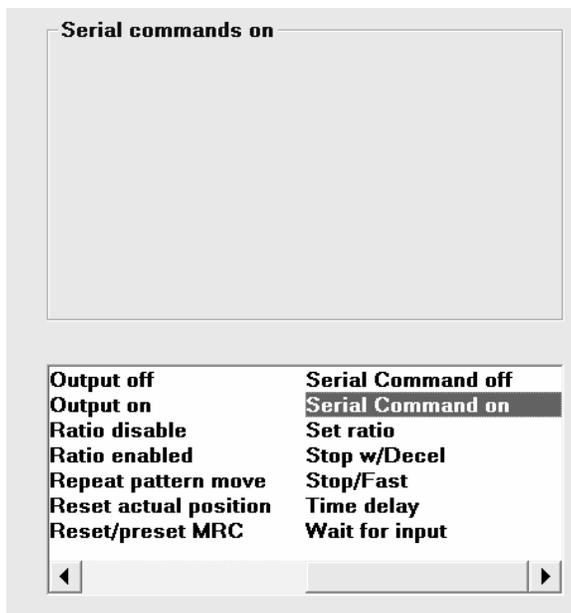


SERIAL COMMAND OFF



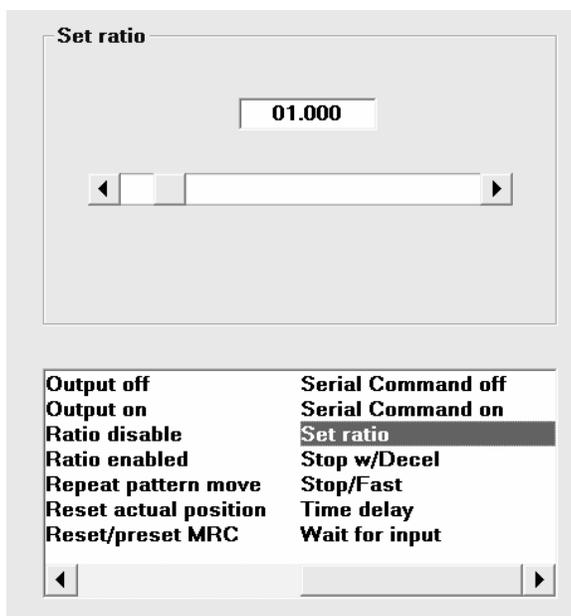
Using this command in the programmed sequence will disable any Modbus commands for motion or Input/Output alteration. The monitoring through Modbus remains active, regardless of this command.

SERIAL COMMAND ON



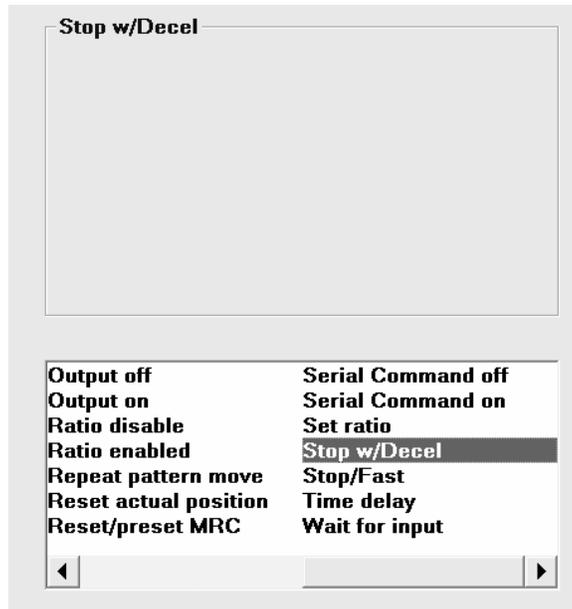
Using this command in the programmed sequence will enable any Modbus commands for motion or Input/Output alteration. The monitoring through Modbus remains active, regardless of this command.

SET RATIO



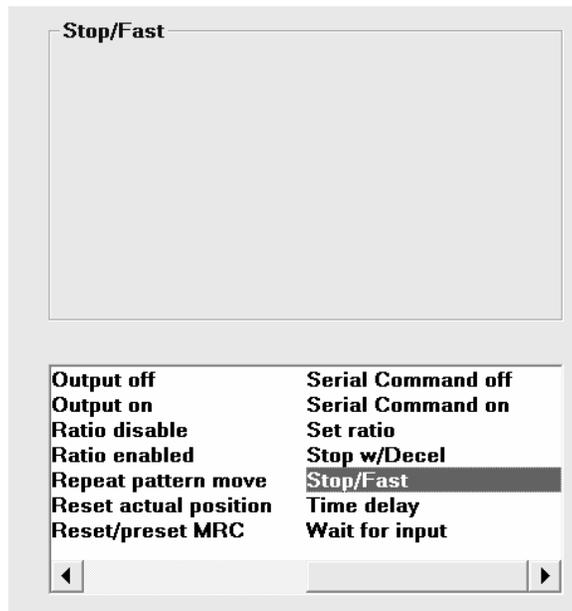
The ratio between the master reference encoder (auxiliary encoder) and the primary feedback (resolver or encoder) can be programmed using this instruction. The ratio range is 0.000 to 9.999. Even though the ratio mode is activated, the controller will continue to keep track of the actual position and all other instructions are still allowed. This means that, while in ratio/follower mode, the controller can still execute an incremental/absolute move command, as well as the I/O processing and counting operations.

STOP WITH DECEL



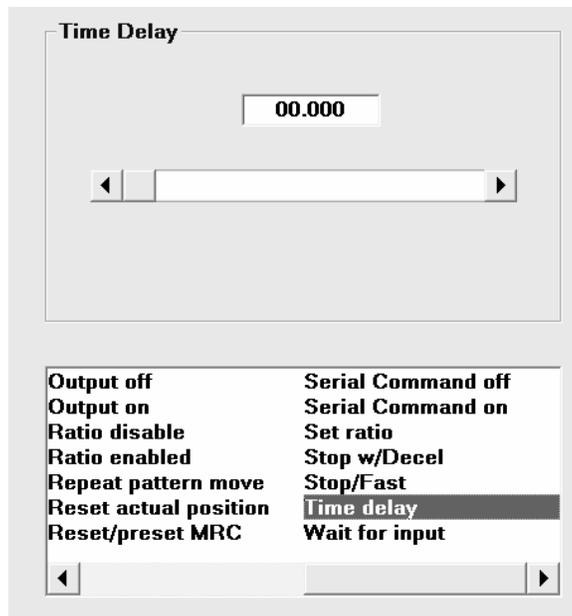
This command is intended for use with the commands that can interrupt motions, such as On Set Current and On Input/Go To commands. Placing this command at the branched line will cause the motor to decelerate to stop, only if it was in motion. The deceleration time would be the normal deceleration time. If no motion was detected, or the motor was already decelerating, this command would be ignored.

STOP/FAST



This command is the same as the Stop With Decel command, except with zero deceleration time and if it occurs during deceleration, it will interrupt and stop immediately.

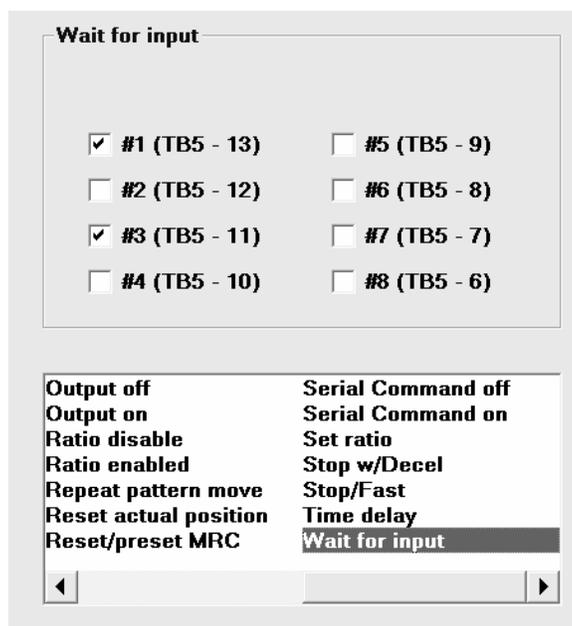
TIME DELAY



Program execution sequence can be halted for a period of time, using this command and will resume once the time has expired. This is also useful in creating a timed output pulse where an output can be turned on, then time delayed and then turned off.

WAIT FOR INPUT

Anytime the program execution sequence reaches such an instruction, the programming sequence will be halted until the specified Inputs are active before the program execution is continued.



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