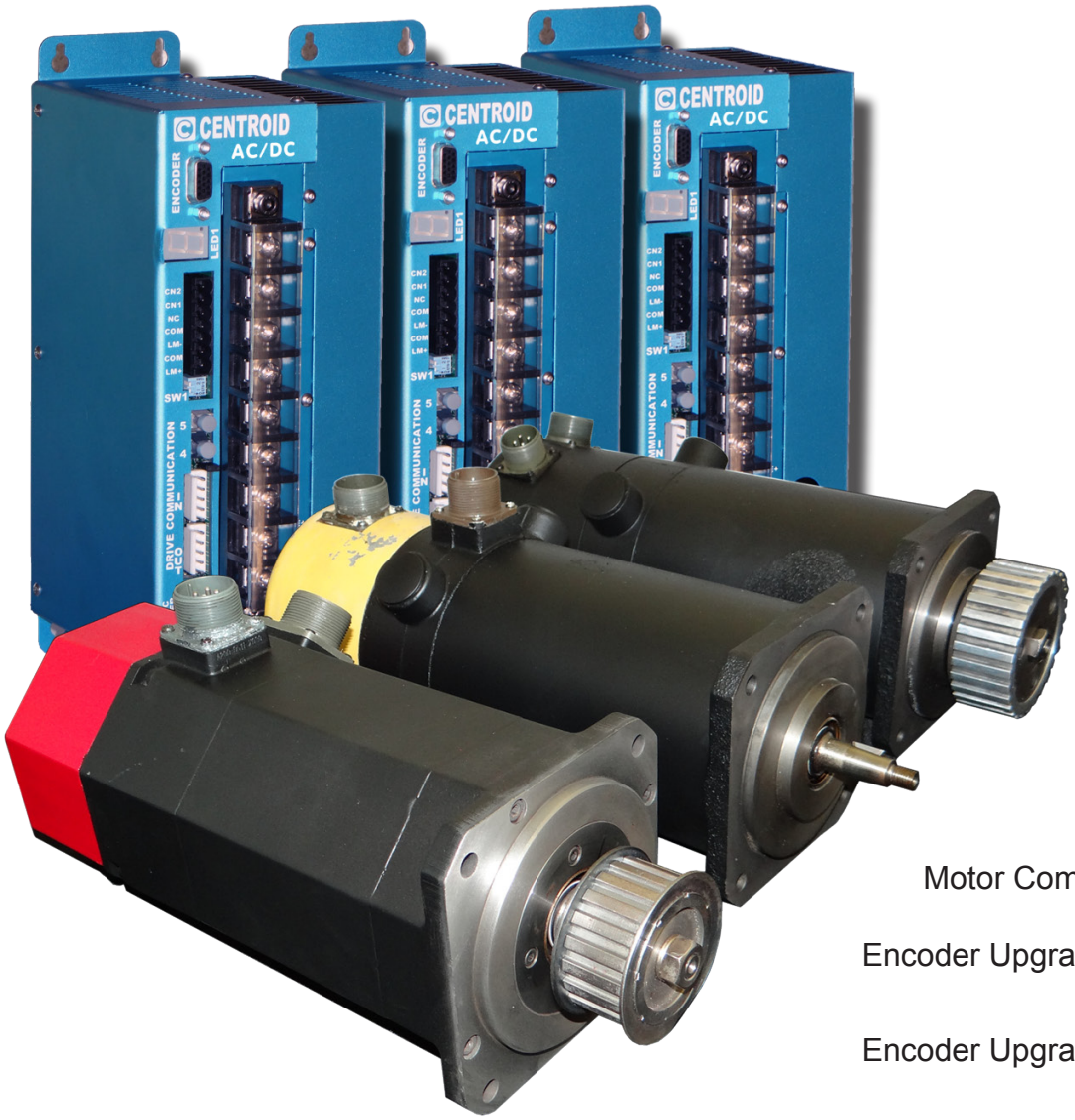
CENTROID™ FANUC CNC Retrofits

Centroid Fanuc CNC Retrofit Installation Manual

Models: AC/DC-30, AC/DC-60



READ YOUR CNC11 OPERATORS MANUAL AND AC/DC USERS GUIDE **BEFORE** PERFORMING A FANUC RETROFIT. FAILURE TO FOLLOW THE INSTRUCTIONS AND SAFETY PRECAUSTIONS IN THOSE MANUALS COULD RESULT IN SERIOUS INJURY OR DEATH.

DRIVE WARRANTY DOES **NOT** COVER DAMAGE BY FAULTY MOTORS OR WIRING.

The information provided by CENTROID relating to wiring, installation, and operation of CNC components is intended only as a guide, and in all cases a qualified technician and all applicable local codes and laws must be consulted. CENTROID makes no claims about the completeness or accuracy of the information provided, as it may apply to an infinite number of field conditions.

As CNC control products from CENTROID can be installed on a wide variety of machine tools NOT sold or support by CENTROID, **you MUST consult and follow all safety instructions provided by your machine tool manufacture regarding the safe operation of your machine and unique application.**

The procedures detailed in this manual are designed to be used by someone familiar with the AC/DC drive and MPU11 software. This documentation is designed to be used in correlation with the available manuals and technical bulletins, and is not intended to replace any pre-existing documentation.

Only Fanuc motor handling safety procedures are described in this procedure. Additional safety information can be found in the CNC 11 Operators Manual and the AC/DC Users guide.

Servo Motor Handling

When working with servo motors**:**

- **NEVER pick up or carry the motor by the cables or the shaft. (Always carry by the frame.) Use a crane or lift to move the motor when necessary.**
- **NEVER drop or subject the motor to impact. The servo motor is a precision device.**
- **NEVER set heavy or sharp objects on the motor or cables. Do not step or sit on the motor or cables.**
- **NEVER use a metal hammer on any part of the motor. If it is absolutely necessary to use a hammer, use a plastic hammer.**

Keep the motor properly secured and away from the edge of the work area when servicing the motor, as a dropped motor could cause personal injury or destroy the motor.

Complete the Following Checklist BEFORE powering on your drive.
Failure to do so could void your warranty.

To be performed with motors disconnected from drive:

☐ **Check for >100 MΩ between the motor chassis and motor power terminals.**

To be performed with motors connected to drive:

☐ **Confirm continuity between the drive chassis and the motor chassis.**

☐ **On the drive terminals, check for >100 MΩ between motor shield and power terminals.**

☐ **Check VM wiring for correct polarity.**

☐ **Check motor wiring for correct polarity/phase.**

☐ **Check that all screws are tightened down properly. Driving a motor with a terminal loosened could result in the terminal block overheating and causing a fire.**

☐ **If you are unsure of the condition of a motor, have it inspected by a qualified professional.**

Refer to TB155 for further details.

Basic Motor Safety, Procedures, and Best Practices

- **Be safely dressed when handling a motor.** Wear safety shoes and gloves. Avoid loose clothing which can get caught on the motor. Be careful not to let hair get caught in the rotary section of the motor. Do not handle the motor with wet hands.

- Shut off the power before working on a motor. Wait at least 5 minutes after the motor is shut off before touching any power terminals.

- Always use the correct cables. Centroid cables are shown in the motor compatibility table. Wiring diagrams and pin outs for motors are provided in Appendix B.

- Ensure that the motor and motor related components are mounted securely. Ensure that the base or frame to which the motor is mounted to is strong enough.

- Do not touch the rotary section of the motor when it is running unless instructed to.

- When attaching a component having inertia to the motor, ensure any imbalance between the motor and component is minimized.

- Be sure to attach a key to a motor with a keyed shaft.

- Use the motor in appropriate environmental conditions. Do not store flammables in close proximity to the motor. When not in use, store the motor in a dry location between 0° to 40° C.

- Do not remove the nameplate from a motor.

Table of Contents

Introduction

With the large number of aging FANUC equipped CNC machine tools in the world, CENTROID has answered the call for an affordable and reliable upgrade! Directly control FANUC servo motors with CENTROID's MPU11 based AC/DC drive. Retaining the Fanuc servo motor while eliminating the Fanuc user interface and motion control provides savings in time and money.

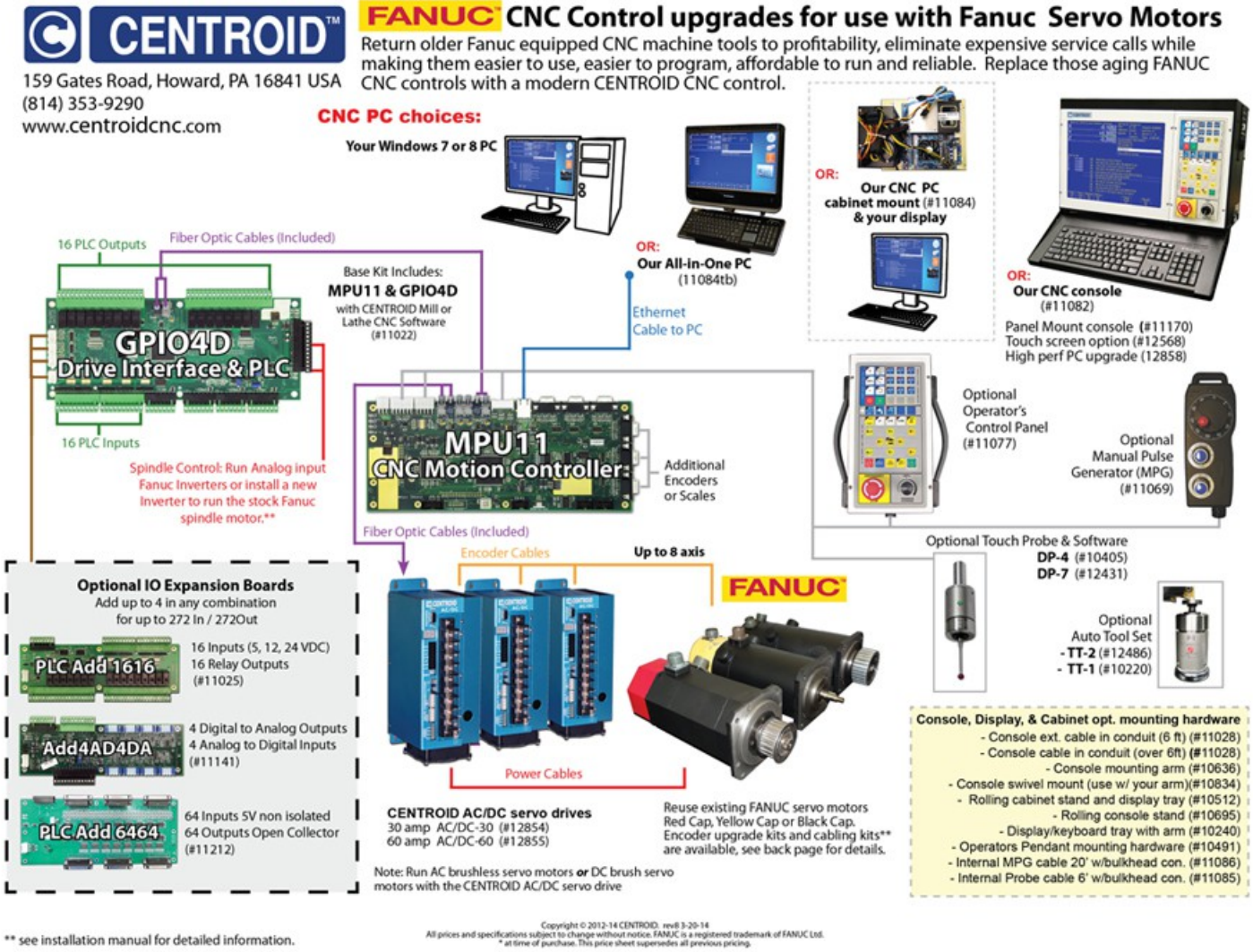
This manual covers:

- How to install, align, configure, and tune Fanuc AC and DC motors using Centroid encoders.
- How configure and tune DC Fanuc motors re-using original Fanuc pulse coders
- The basics needed to connect a Fanuc spindle motor to a GPIO4D

Motor series supported:

- Gettys ● Fanuc (Black Cap)
- M Series (Yellow Cap)
- Early red caps
- S Series
- α Series
- αC Series
- β Series
- Three models of spindle servo motors.

If the Fanuc motor has a yellow or black end cap, it is a DC motor. If the Fanuc motor has a red cap, it is an AC motor. The first step in retrofitting a motor to find your motor in our Motor Compatibility Tables listed on the following pages. Samples of Fanuc motor labels are shown in Appendix to help identify your motor.



Fanuc AC Motor Compatibility Table [1]

Fanuc Motor Series	Motor Model	Motor Type	Power Cable[4]	AC/DC Drive Model	Encoder Retrofit Kit	Encoder Cable
Early Red Caps	0	A06B-0511-Bxxx	**Medium AC or DC Cable** Drawing #. S13370	**AC/DC–30**[2]	**Retrofit Kit # 12859** Installation Instructions Page 31	**AC/DC Encoder Cable** Sub assembly #12912 Drawing # S13369
	5	A06B-0512-Bxxx				
	10	A06B-0501-Bxxx	**Large AC Power Cable** Drawing # S13362			
	20	A06B-0502-Bxxx		**AC/DC - 60**		
	30	A06B-0503-Bxxx				
S Series	0-0SP	A06B-0374-Bxxx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30**[2]	**Retrofit Kit # 12859 or # 12876** See next page to choose a kit for your application.	
	0S	A06B-0313-Bxxx				
	5S	A06B-0314-Bxxx				
	5S/3000	A06B-0514-Bxxx				
	6S	A06B-0316-Bxxx				
	6S/3000	A06B-0320-Bxxx				
	10S	A06B-0315-Bxxx	**Large AC Power Cable** Sub assembly # 12894 Drawing # S13362	**AC/DC - 60**		
	10S/3000	A06B-0317-Bxxx				
	20S	A06B-0502-Bxxx				
	20S/1500	A06B-0505-Bxxx				
	20M[7]					
	30S	A06B-0590-Bxxx	**Extra Large AC Power Cable** Drawing # S13371			
	30R	A06B-0506-Bxxx				
	30/2000					
	40	A06B-0581-Bxxx				
	20S/3000	A06B-0318-Bxxx	Not Recommended [3]			
	30S/3000	A06B-0319-Bxxx				
	40S/2000	A06B-0583-Bxxx				
α (Alpha) Series & αC Series[6]	α3/3000	A06B-0123-Bxxx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30**[2]	**Retrofit Kit # 12876** Installation Instructions Page 28	
	α6/2000	A06B-0127-Bxxx				
	α6/3000	A06B-0128-Bxxx				
	αC12/2000	A06B-0141-Bxxx	**Large AC Power Cable** Sub assembly # 12894 Drawing # S13362	**AC/DC - 60**		
	α12/2000	A06B-0142-Bxxx				
	α12/3000	A06B-0143-Bxxx				
	αC22/1500	A06B-0145-Bxxx				
	α22/1500	A06B-0145-Bxxx				
	α22/1500	A06B-0146-Bxxx				
	α30/1200	A06B-0151-Bxxx				
	α22/2000	A06B-0147-Bxxx				
	α30/2000	A06B-0152-Bxxx	**Extra Large AC Power Cable** Drawing # S13371			
	α40/2000	A06B-0157-Bxxx (Without fan)				
	αC3/2000	A06B-0121-Bxxx	Not Recommended [3]			
	αC6/2000	A06B-0126-Bxxx				
	α22/3000	A06B-0148-Bxxx				
	α30/3000	A06B-0153-Bxxx				
	α40/2000	A06B-0158-Bxxx (With fan)				
	α1/3000	A06B-0371-Bxxx				
	α2/2000	A06B-0372-Bxxx				
	α2/3000	A06B-0373-Bxxx				
β (Beta) Series & βis Series	β3/3000	A06B-0033-Bxxx	TBD[5] Please contact Centroid for a retrofit solution.			
	β6/2000	A06B-0034-Bxxx				
	β4/4000*is*	A06B-0063-Bx0x				
	β8/3000*is*	A06B-0075-B203				
	β12/300*is*	A06B-0078-Bx0x				
	β22/2000*is*	A06B-0085-Bx0x				
	β0.5/3000	A06B-0113-Bxxx	Not Recommended [3]			
	β1/3000	A06B-0031-Bxxx				
	β2/3000	A06B-0032-Bxxx				

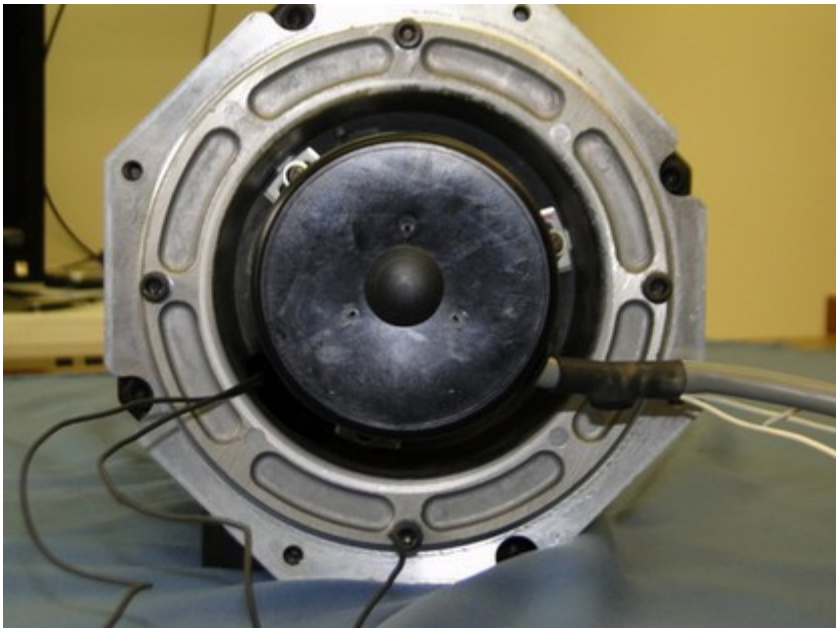
1. This table is not a complete list of all Fanuc AC motors, just motors we have verified.
2. An AC/DC-60 may be substituted for an AC/DC-30.
3. Motors with a continuous stall current of above 30A or below 5A are not recommended with the AC/DC. *(This gives the AC/DC an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)*
4. You may reuse the existing power cables from your Fanuc with the AC/DC. Cable information is provided for ordering replacement cables and troubleshooting.
5. Encoder retrofit kit currently not available, Centroid can provide engineering to develop or installer to mount encoder.
6. Most Fanuc documentation lists the αC Series as a member of the α Series, while some Fanuc documentation lists the αC Series as a member of the β series.
7. Not to be confused with the yellow-capped DC motor also designated "20M".

Cable drawings and pinouts can be found in Appendix B, Motor RPM, torque, hp, and wattage can be found in Appendix D

Choosing a Retrofit Kit for Your Fanuc “S” Series AC Servo Motor

In order to differentiate between the two different styles of encoder used on Fanuc's “S” series motors, it is necessary to remove the red motor end caps and visually inspect the pulse coders.

If your servo motor's encoder resembles this one, you will need assembly **#12859**. Instructions found in section “**AC Motors: Early and S Series Models**” on page 31.



If your servo motor's encoder resembles this one, you will need assembly **#12876**. Instructions found in section “**AC Motors: α (Alpha) Series Models”** on page 37.

Black End Cap (Fanuc ● Gettys)
DC Motor Compatibility Table [1]

Fanuc Measurement Technology	Motor Model	Motor Type	Power Cable[3]	AC/DC Drive Model	Encoder Retrofit Kit	Encoder Cable
Tachogenerator where xxx is 001 - 028	00	A06B-0631-B0xxx	**TBD[4]**			
	0	A06B-0613-B0xx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30[2]**	**Encoder Retrofit Kit # 12903** Installation Instructions Page 15	**AC/DC Encoder Cable** Sub assembly #12912 Drawing #S13369
	5	A06B-0614-Bxxx				
	10	A06B-0601-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361	**AC/DC - 60**		
	20	A06B-0602-Bxxx				
	30	A06B-0603-Bxxx				
Pulse Coder where xxx is 031 or 032	00	A06B-0631-B0xx	**TBD[4]**			
	0	A06B-0613-B0xx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30[2]**	**Reuse stock Fanuc encoder OR replace with Centroid Encoder Retrofit Kit # 12896** Installation Instructions Page 22	**Fanuc Coder Cable** Sub assembly # 12893 Drawing # S13357
	5	A06B-0614-Bxxx				
	10	A06B-0601-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361	**AC/DC - 60**		
	20	A06B-0602-Bxxx				
	30	A06B-0603-Bxxx				

1. This is not a list of all Fanuc DC motors, just the motors we have verified.

2. An AC/DC-60 servo drive may be substituted for an AC/DC-30 servo drive.

3. You may reuse the existing power cables from your Fanuc with the AC/DC. Cable information is provided for ordering replacement cables and troubleshooting.

4. CENTROID Encoder retrofit kit has not been developed yet. Centroid can provide engineering services to develop an encoder kit or adapt your own.

Motors with a continuous stall current of above 30A or below 5A are not recommended with the AC/DC servo drive.
(This gives the AC/DC servo drive an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)

Cable drawings and pinouts can be found in Appendix B

Motor RPM, torque, hp, and wattage can be found in Appendix D

Yellow End Cap (M Series)
DC Motor Compatibility Table [1]

Fanuc Measurement Technology	Motor Model	Motor Type	Power Cable[3]	AC/DC Drive Model	Encoder Retrofit Kit	Encoder Cable
Tachogenerator or Resolver where xxx is 001 or 005	00M	A06B-0632-Bxxx			**TBD**[4]	**AC/DC Encoder Cable** Sub assembly #12912 Drawing # S13369
	0M	A06B-0641-Bxxx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30**[2]		
	5M	A06B-0642-Bxxx				
	10M	A06B-0651-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361			
	20M	A06B-0652-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361	**AC/DC – 60**		
	30M	A06B-6053-Bxxx				
Pulse Coder where xxx is 011, 012, or 005	0M	A06B-0641-Bxxx	**Medium AC or DC Cable** Drawing # S13370	**AC/DC – 30**[2]	**Reuse stock Fanuc encoder OR replace with Centroid Encoder Retrofit Kit # 12896** Installation Instructions Page 22	**AC/DC Encoder Cable** *(Use with Retrofit Encoder)* Sub assembly #12912 Drawing # S13369 **Fanuc Coder Cable** *(Use with Existing Encoder)* Sub assembly # 12893 Drawing # S13357
	5M	A06B-0642-Bxxx				
	10M	A06B-0651-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361			
	20M	A06B-6052-Bxxx	**Large DC Power Cable** Sub assembly # 12895 Drawing # S13361	**AC/DC – 60**		
	30M	A06B-6053-Bxxx				

1. This is not a list of all Fanuc DC motors, just the motors we have verified.

2. An AC/DC-60 servo drive may be substituted for an AC/DC-30 servo drive.

3. You may use the existing power cables from your Fanuc with the AC/DC servo drive . Cable information is provided for ordering replacement cables and troubleshooting.

4. CENTROID Encoder retrofit kit has not been developed yet. Centroid can provide engineering services to develop an encoder kit or adapt your own.

Motors with a continuous stall current of above 30A or below 5A are not recommended with the AC/DC servo drive.
(This gives the AC/DC servo drive an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)

Cable drawings and pinouts can be found in Appendix B

Motor RPM, torque, hp, and wattage can be found in Appendix D

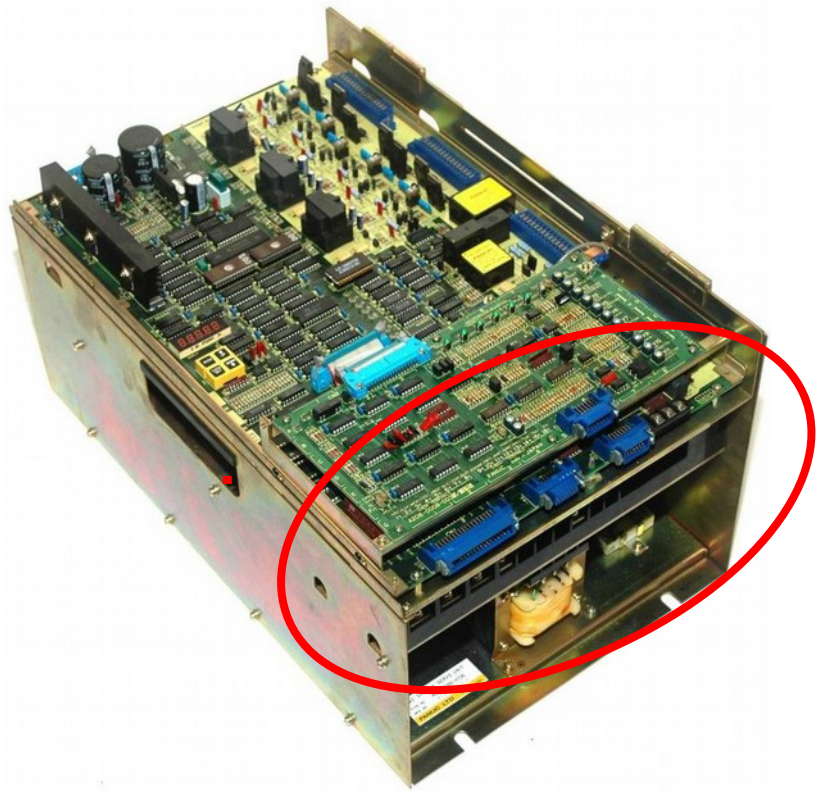
Fanuc Spindle Inverter

If your spindle is a 6044, 6055, or 5059 and does NOT use optical fiber inputs, then it is compatible with the Centroid GPIO4D Drive Interface and PLC. Supported spindles require a 0 to +10 VDC input with forward and reverse commands. Mills with the orient function contain an extra circuit board on the spindle control as shown below.

Spindle Inverter Compatibility Table [1]

Spindle Motor Type	Support
A06B-6044-xxxx	Models Without Fibers Supported
A06B-6055-xxxx	
A06B-6059-xxxx	
A06B-6064-xxxx	Not Supported
α## / #### (Alpha Series)	

1. This is not a list of all Fanuc spindle motors, just the motors we have verified.



Spindle Control with the ORIENT function.

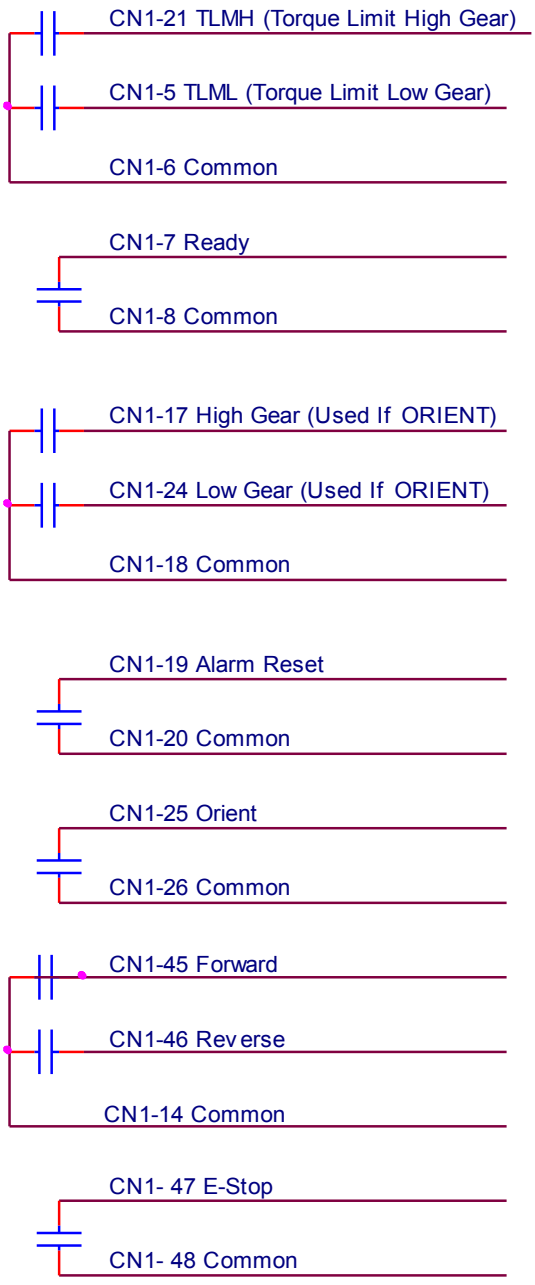
For more reading on AC spindle inverters, read **Tech Bulletin #008** "**AC Inverter Spindle Motors**" and **Tech Bulletin #152** "**Inverter Control**".

If connecting the spindle encoder output directly to a Centroid system (unnecessary in most situations), a Motrona Si 251 Sine/Cosine Inerpolater with Adjustable Multiplication Rate Interface is available from Centroid.

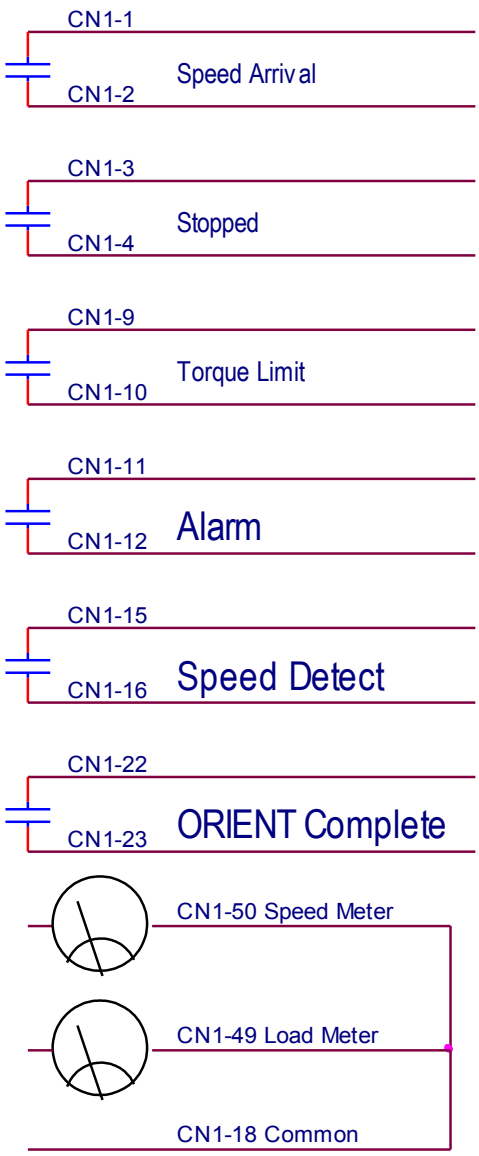
The following pages contain I/O information and an example schematic.

I/O Information for a Fanuc Spindle Drive

Spindle Drive Inputs



Spindle Drive Outputs



Spindle Speed

* The D/A chip on the board needs pulled out. It will be in a socket on the spindle control board labeled CBI or CCD. Only one socket will have a chip.

If the spindle drive has the ORIENT function, it will have a ORIENT card on top of the main card.

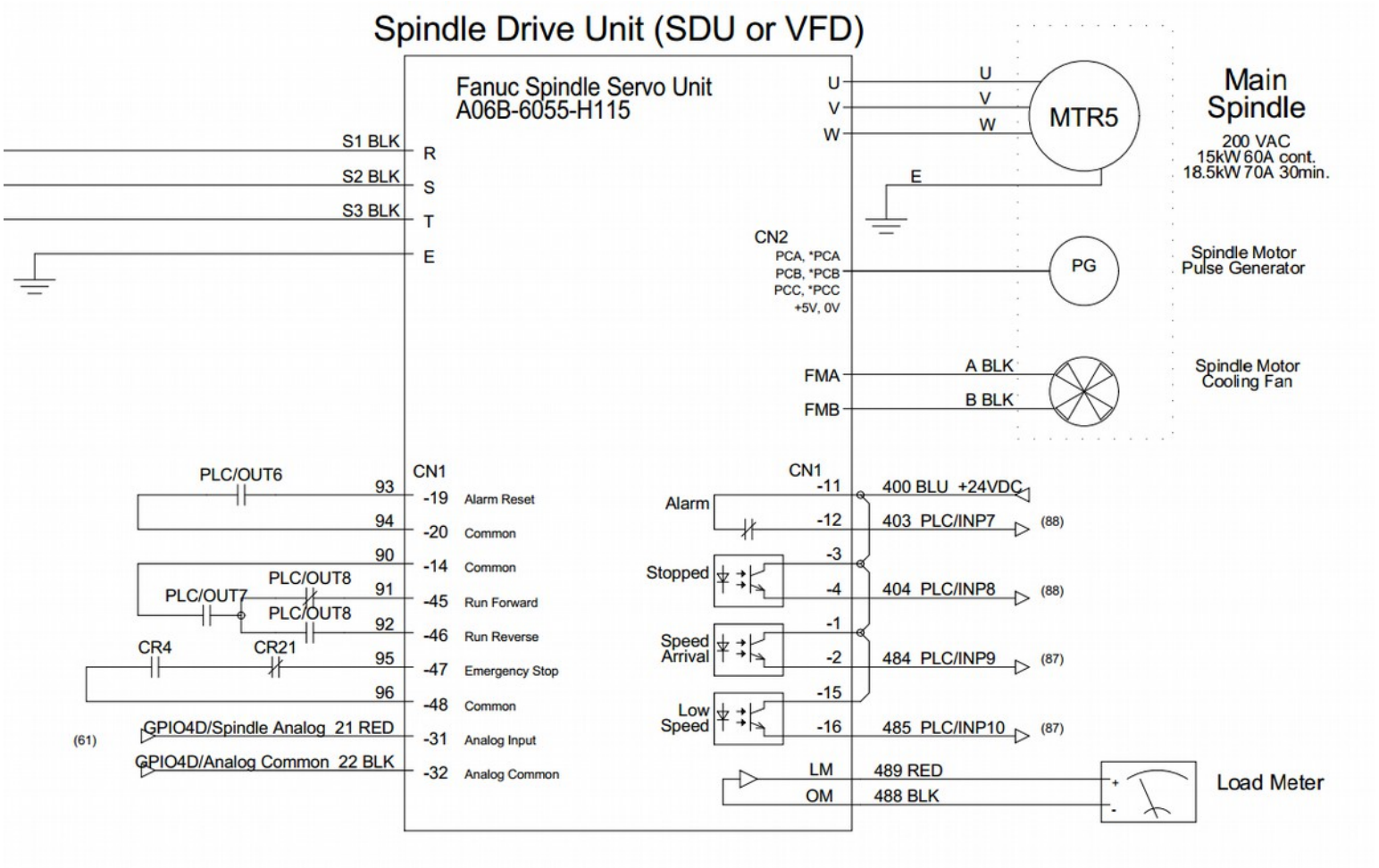
A20B-0008-0240 (0241)

A20B-0008-0030 (0031)

A20B-0009-0520

CN2 connector has feedback from motor, and MUST be left on.

Example of a Schematic for a Fanuc Spindle Drive



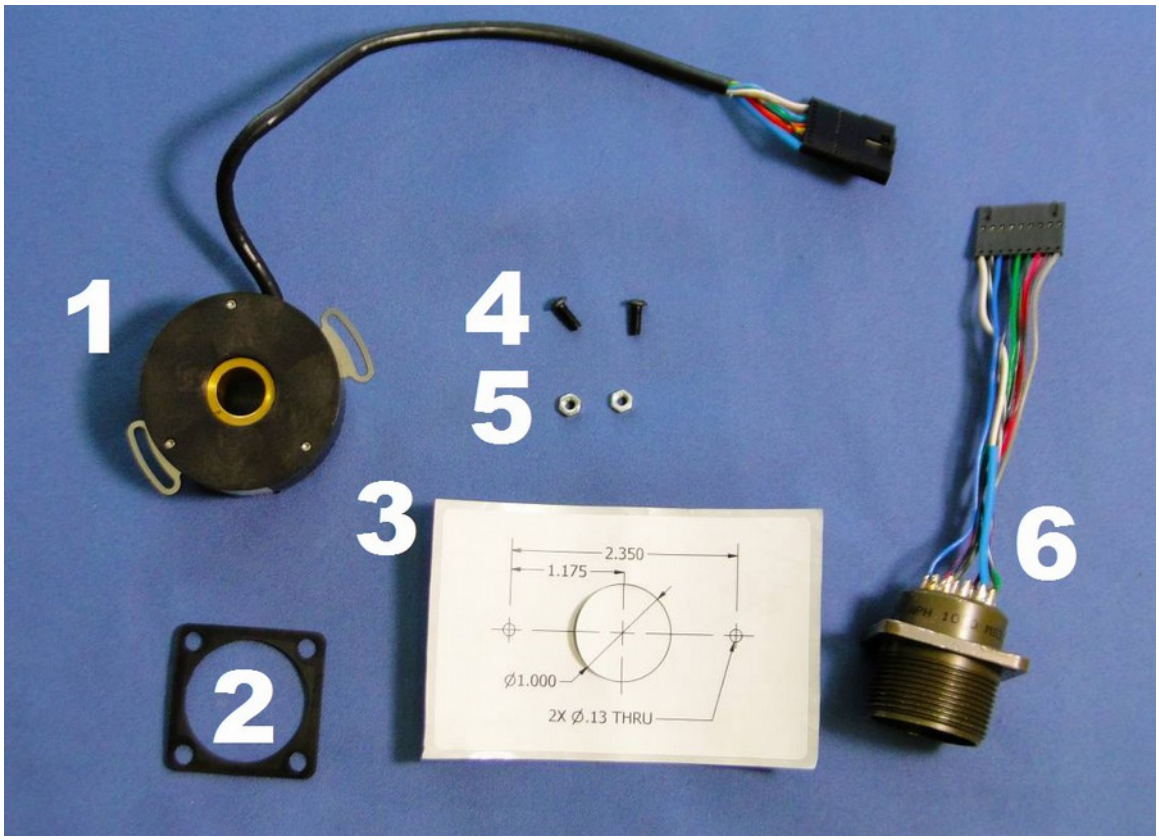
DC Motors

Yellow (M Series) and Black (Fanuc●Gettys) end caps are used on DC motors. At the time of this publication, black cap motors with resolvers and yellow cap motors with tachogenerators/resolvers are not supported.

If the motor has a functioning encoder, it can be used without any modification. Skip to <u>Software Setup</u> section.

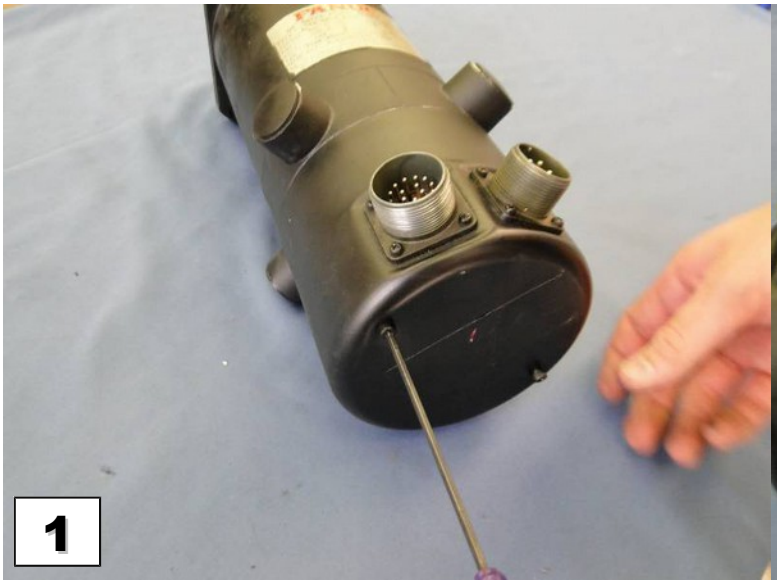
DC Motors: Black End Cap Tachogenerator

` This guide is for upgrading the tachogenerator on a black end cap motor. To retrofit a black end cap DC motor, use the Fanuc Encoder Retrofit Kit **12903** as shown below.

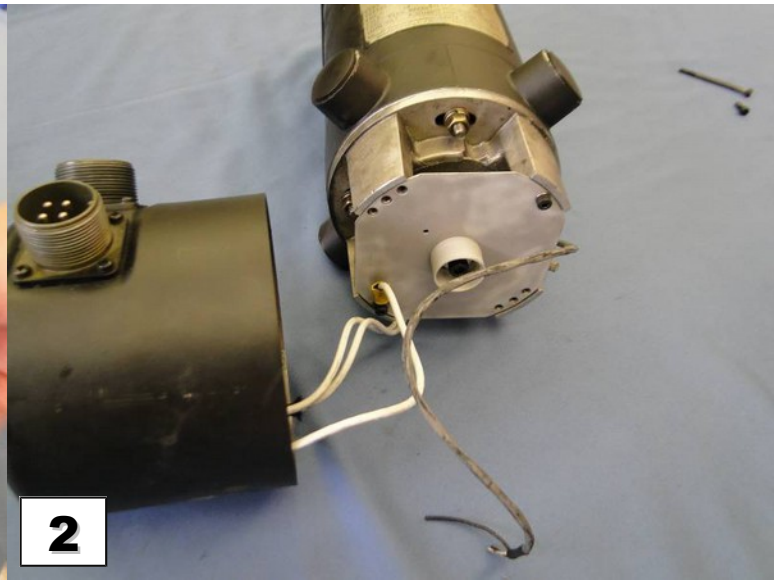


1. 1 Encoder (PN 7546)
2. 1 Pigtail Gasket (PN 4602)
3. 1 Encoder Drill Template (PN 12906)
4. 2 Encoder Mounting Bolts (PN 7485)
5. 2 Encoder Mounting Nuts (PN 7571)
6. 1 Encoder Pigtail (PN 12890)

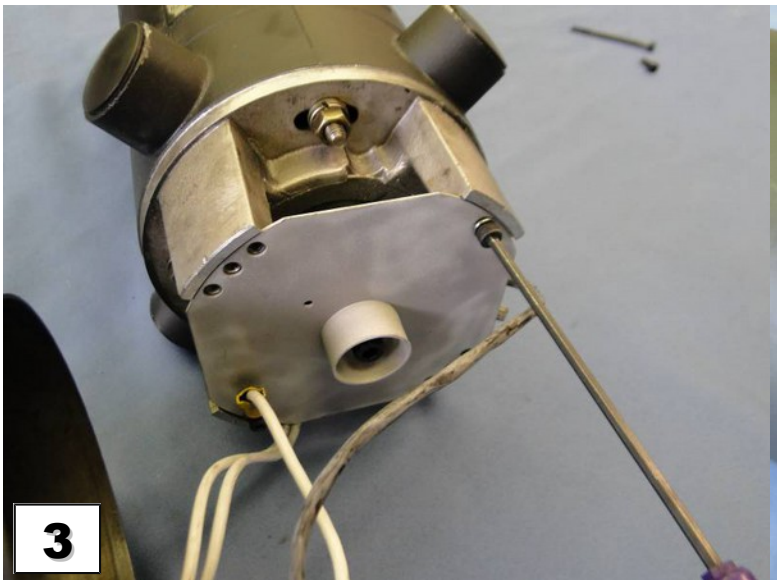
Encoder Installation



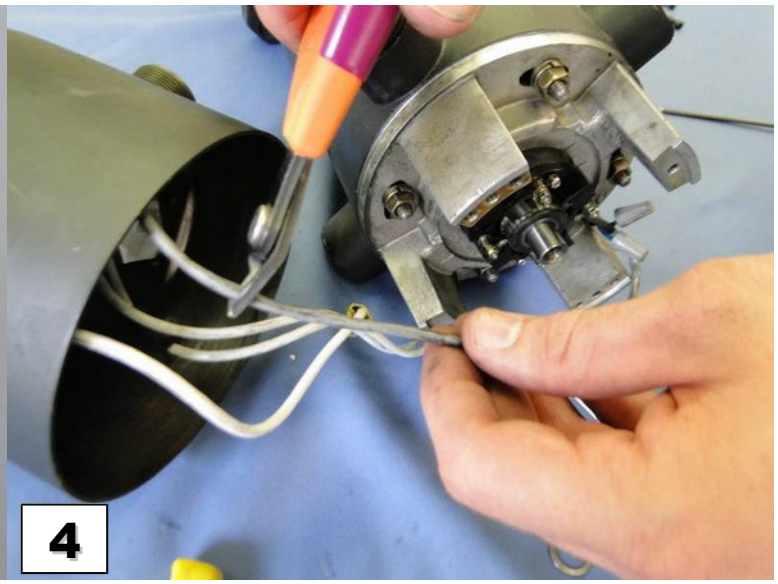
Remove the two bolts holding the black end cap in place using a 3mm hex key. Set aside the end cap bolts. You will use them again in a later step.



Remove the end cap to expose the tachogenerator assembly.



Remove the mounting plate bolts using a 3mm hex key. Pull off the mounting plate. Set aside both the mounting plate and mounting plate bolts, you will use them again in a later step.



Disconnect the temperature sensor wires and the tachogenerator wires. Cut the wires to the tachogenerator. Unscrew the wire nuts to remove the wire for the temperature sensor. **DO NOT CUT THE POWER WIRES GOING TO THE MOTOR!**

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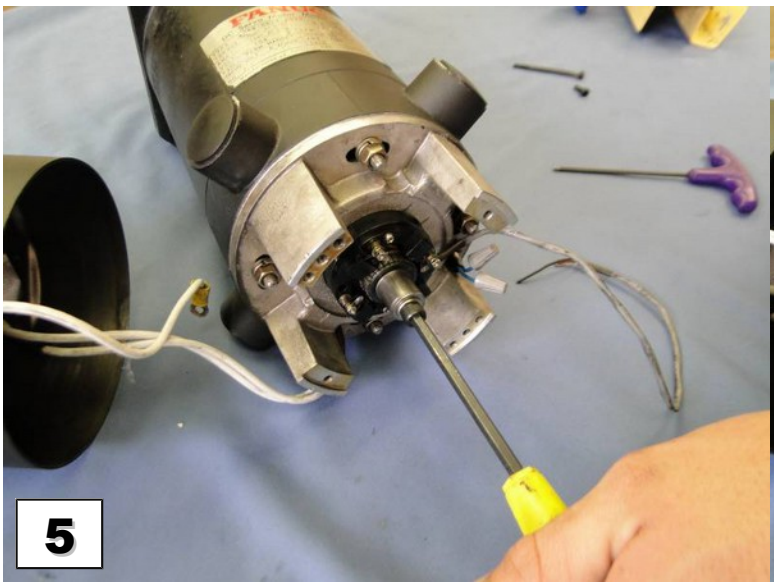
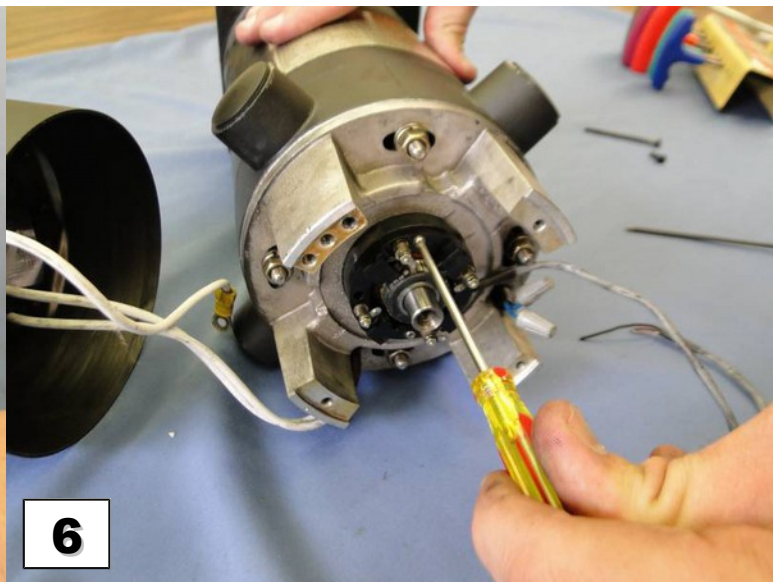
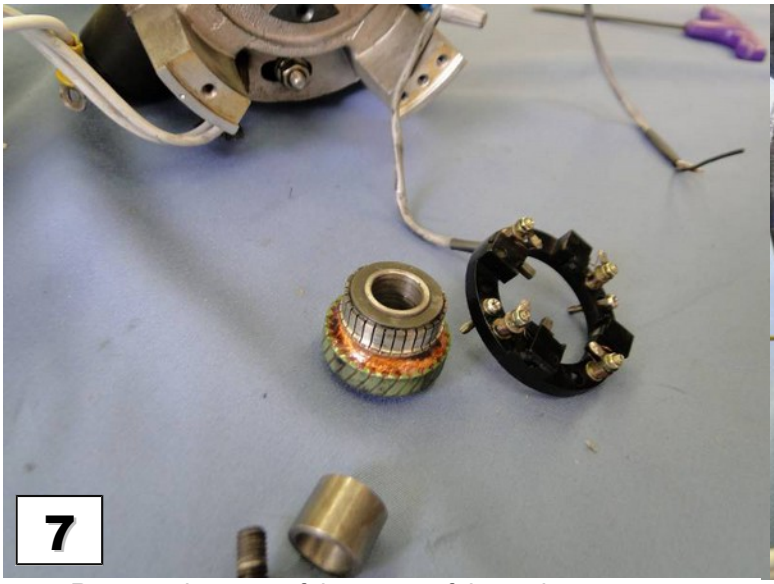


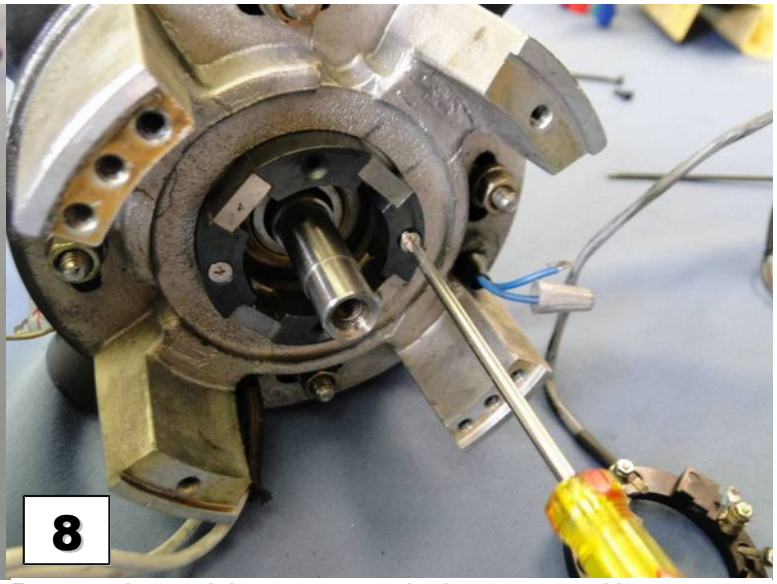
Remove the center bolt using a 5mm hex key.



Remove the retaining screws on the outer stator with a Phillips screwdriver.



Remove the rotor of the stator of the tachogenerator.



Remove the retaining screws on the inner stator with a screw driver.

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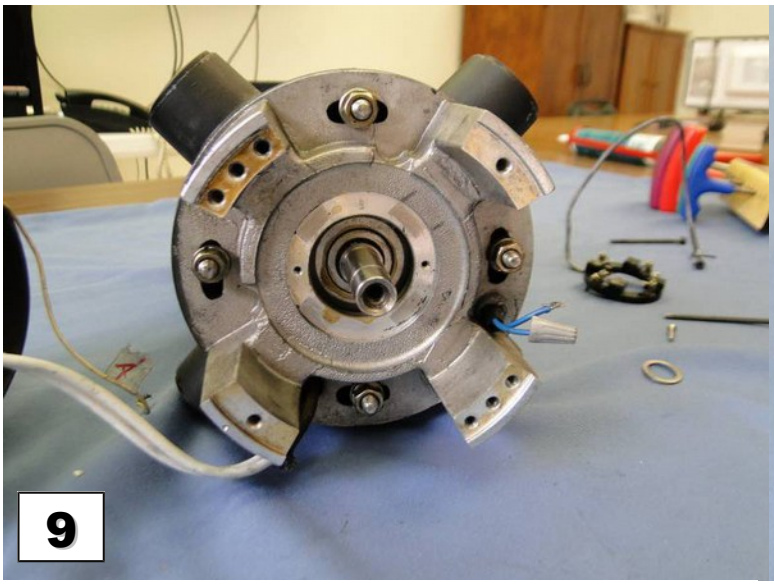
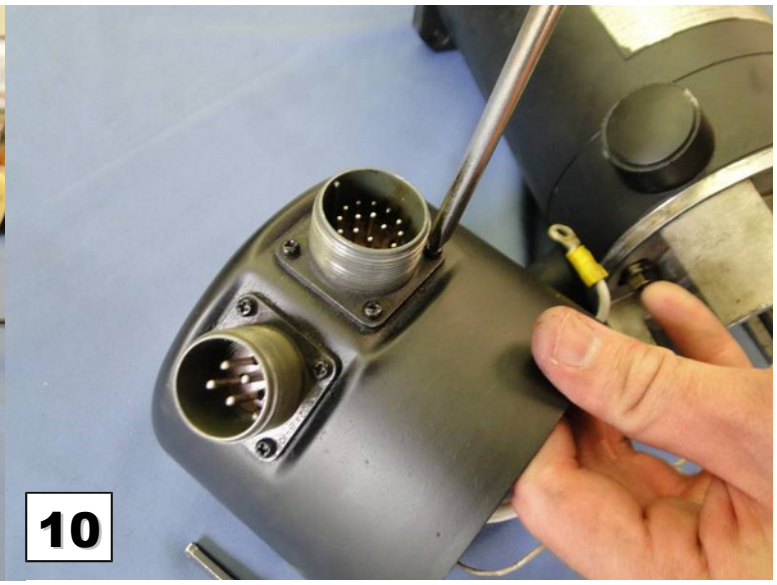
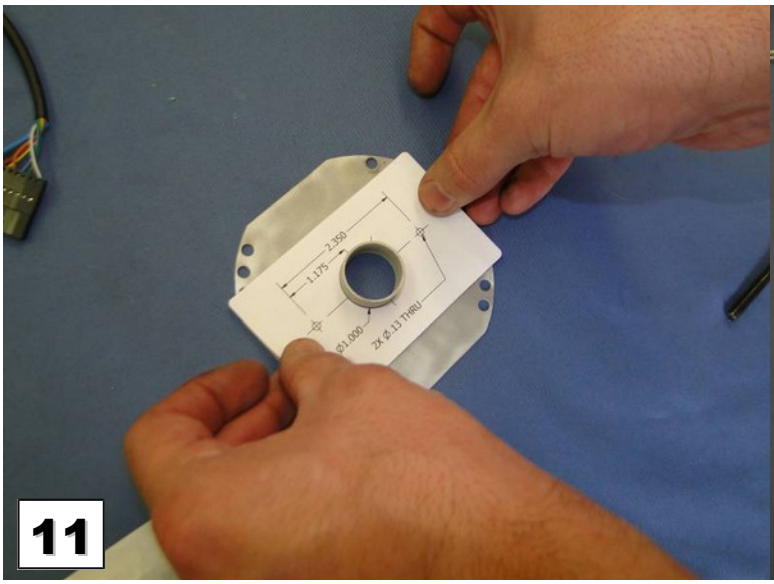


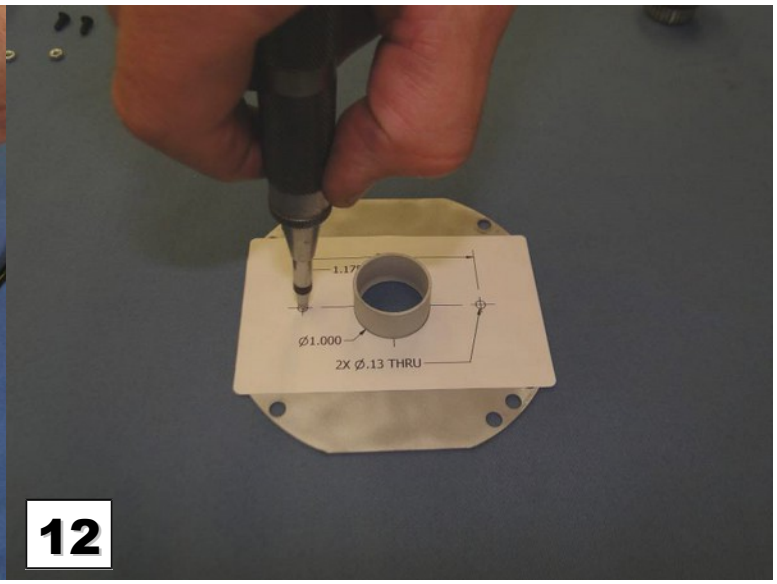
Remove the remaining piece of the tachogenerator. The motor should look like this.



Remove the four encoder connector screws. Set aside the connector screws. You will use them again in a later step.



Acquire the mounting plate you removed in Step 3. If the mounting plate is dirty or greasy, clean it with some isopropyl alcohol. Cut out the 1-inch hole on the center of the sticker and apply to the mounting plate. If your sticker gets lost or damaged, a template to make a new one is included in Appendix A.



Use a center punch to mark the holes on the mounting plate.

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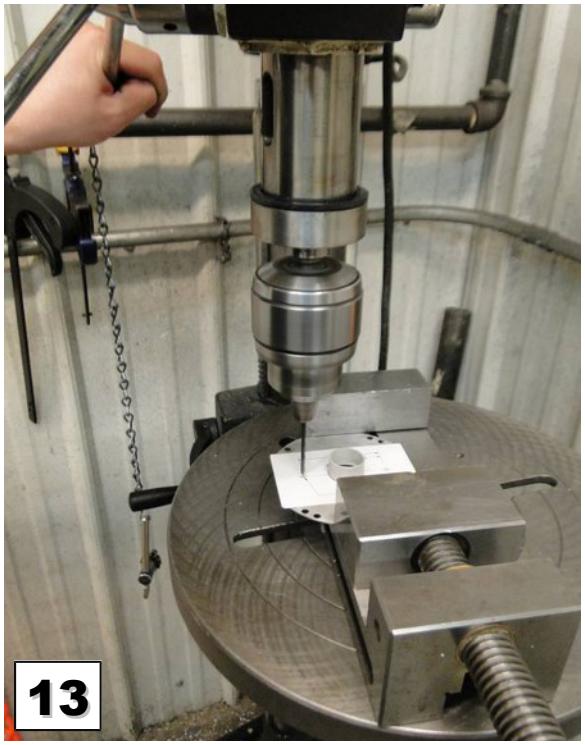
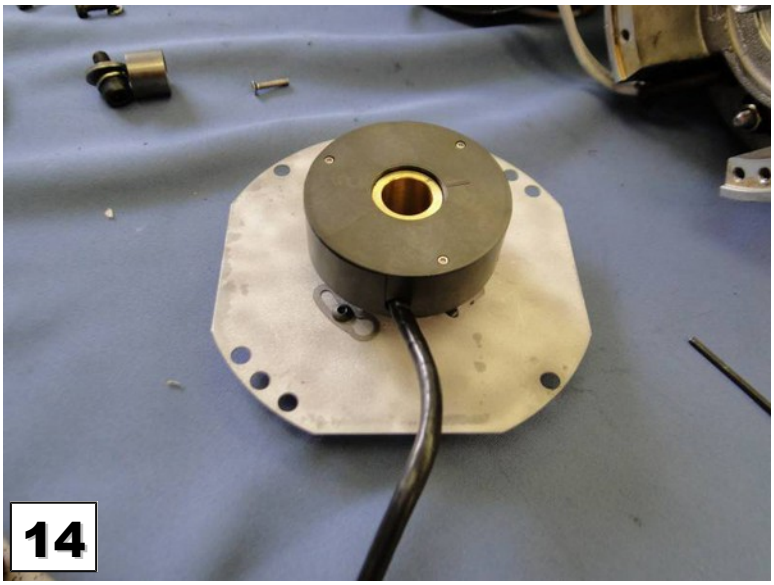
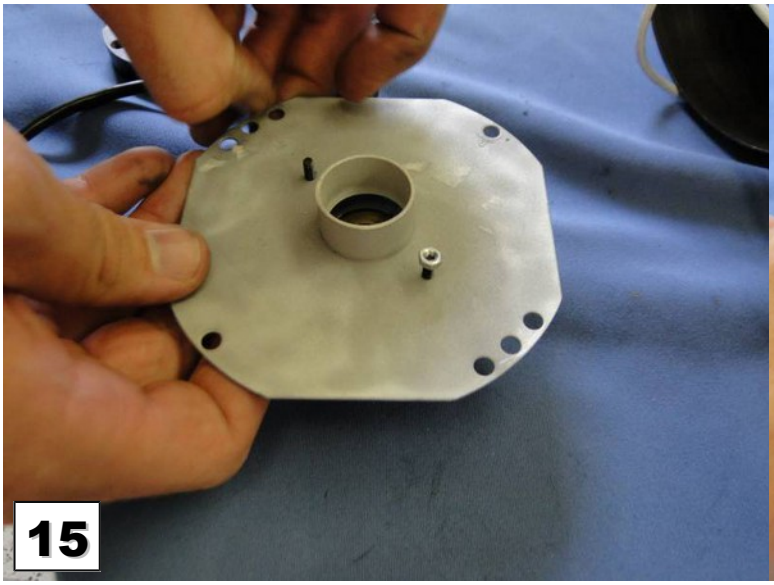


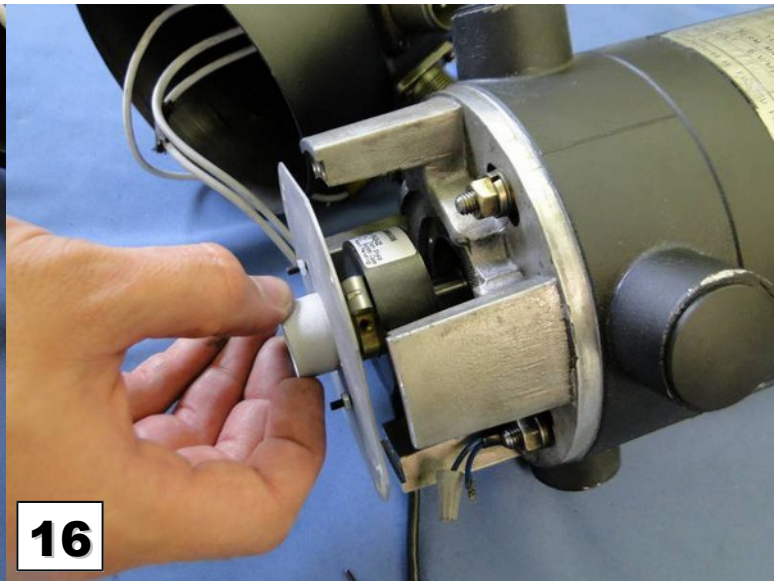
Use a drill press and a #30 drill bit to make both holes in the mounting plate.



Place the encoder on the mounting plate. Insert the encoder mounting bolts through the mounting plate.



Loosely mount the encoder using the nuts included in the retrofit kit. The bolts should be loose enough that the encoder can slide slightly in each direction.



Check to make sure the encoder collar screws are backed out. Slide the encoder assembly onto the back of the motor.

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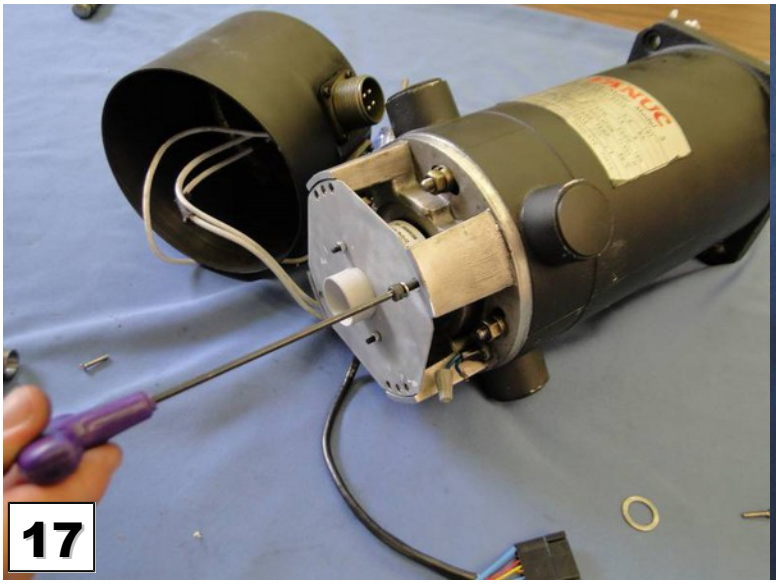
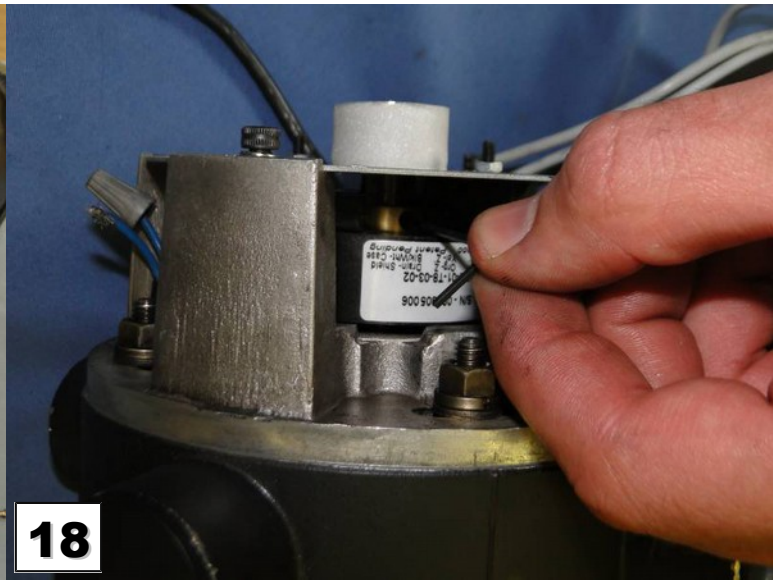
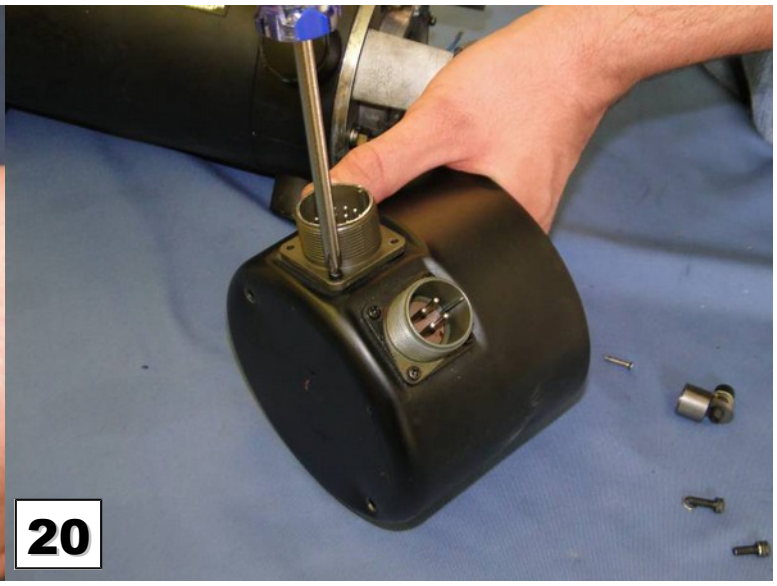


Re-insert the mounting plate bolts that were removed in step 3 with a 3mm hex key.



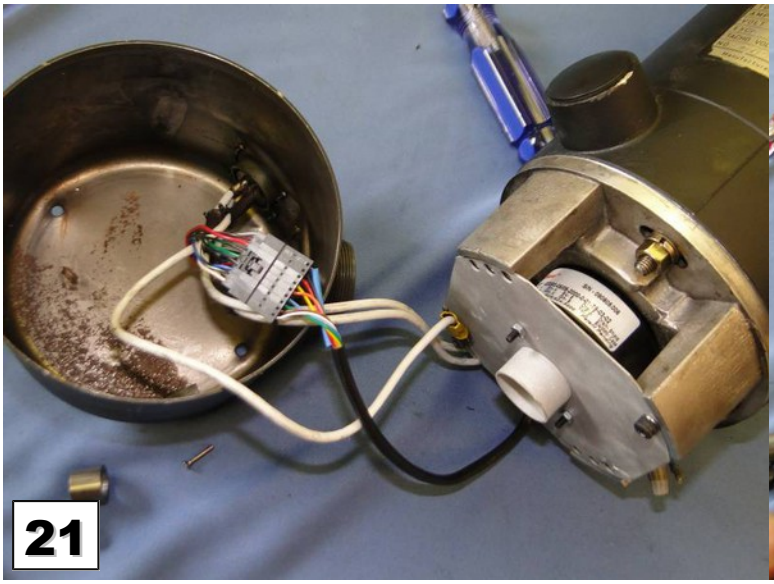
Tighten the encoder set screws and mounting bolts.

Slide the gasket with the encoder pigtail into the black end cap.

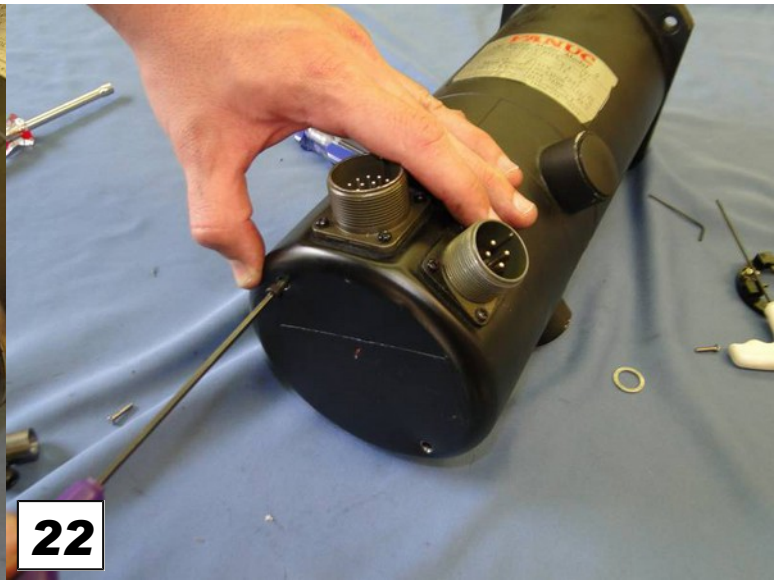


Tighten the encoder pigtail using the bolts you removed in Step 10.

.



Connect the encoder pigtail connector to the encoder.



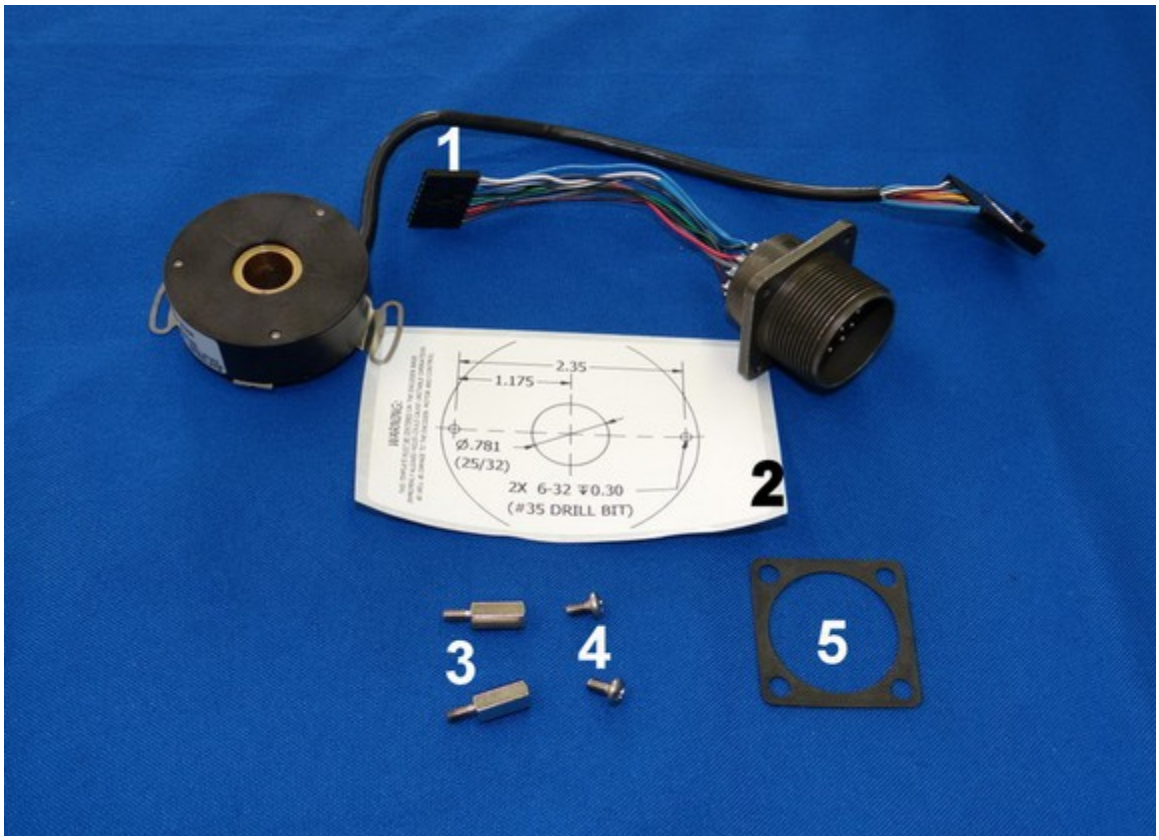
Apply a bead of non-corrosive RTV sealant (such as Dow Corning 3165 or 748) onto the end cap mounting surface. Reinstall the end cap with the bolts removed in step 1.

You are done installing the encoder!

Jump to the Software Setup section.

DC Motors: Black and Yellow End Cap with Stock Encoder

This guide is for upgrading the relatively low-resolution Fanuc pulse to a high-resolution encoder. To retrofit a black end cap DC motor, use the Fanuc Encoder Retrofit Kit **12896** as shown below.



1. 1 Encoder and MS Connector (PN 12892)
2. 1 Encoder Drill Template (PN 12983)
3. 2 Encoder Standoffs (PN 3636)
4. 2 Encoder Mounting Screws (PN 887)
5. 1 Pigtail Gasket (PN 4602)

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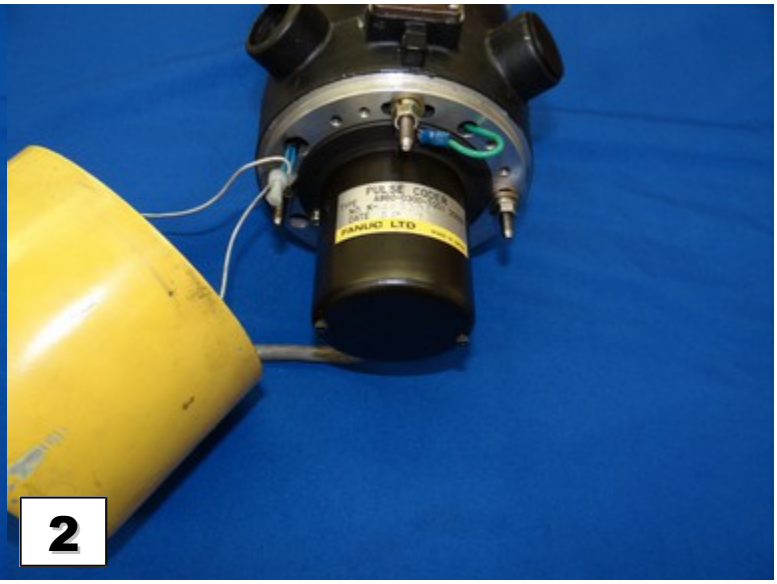
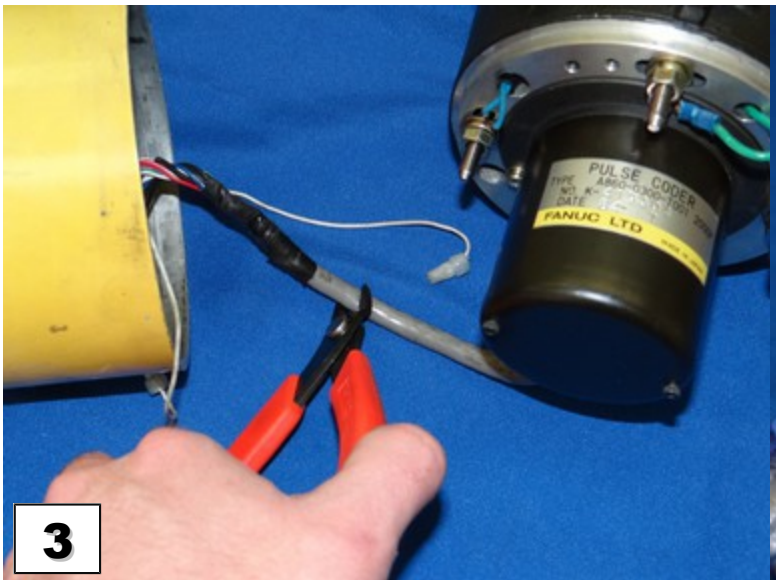
Encoder Installation

Remove the two bolts holding the black end cap in place using a 3mm hex key. Set aside the end cap bolts. You will use them again in a later step.



Remove the end cap to expose the pulse coder assembly.



Cut the pulse coder signal cable as well as the two temperature sensor wires. **DO NOT CUT THE GROUND WIRE!**

Using a Phillips screwdriver, remove the three pulse coder mounting screws. Set them aside. They will be used again in step 21.

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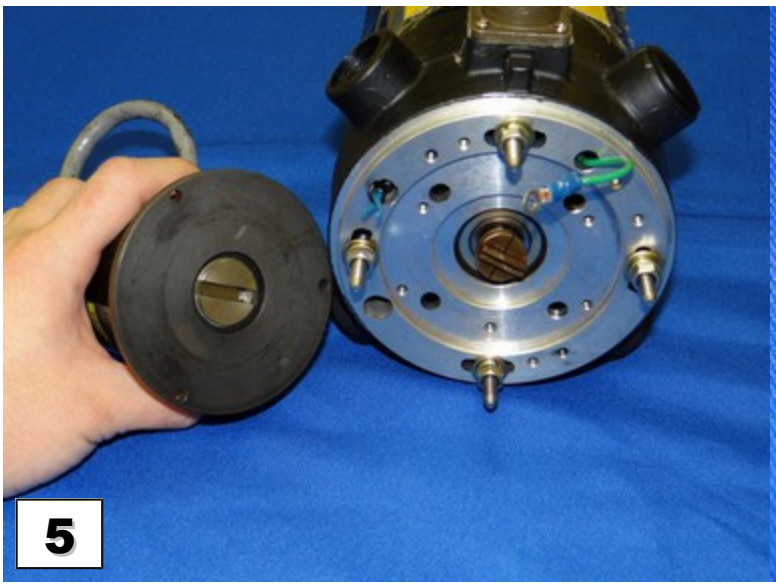
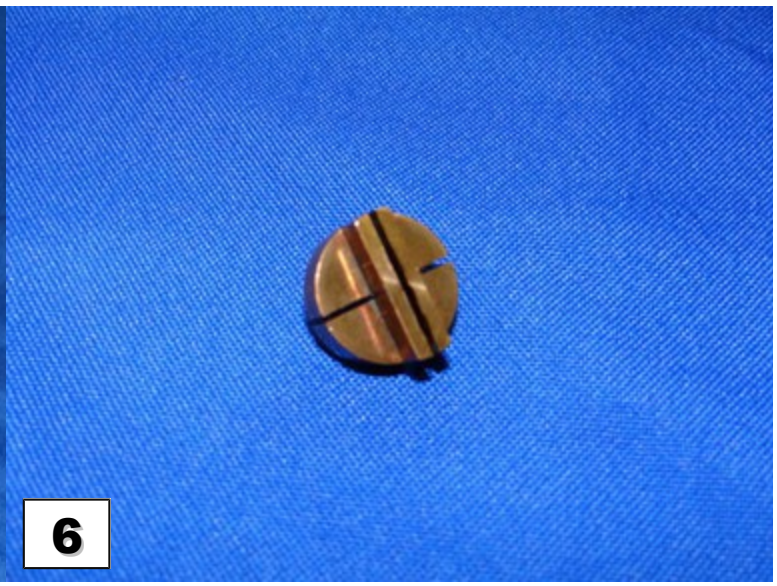


Remove the pulse coder. A brass coupling will remain on either the motor or pulse coder side.



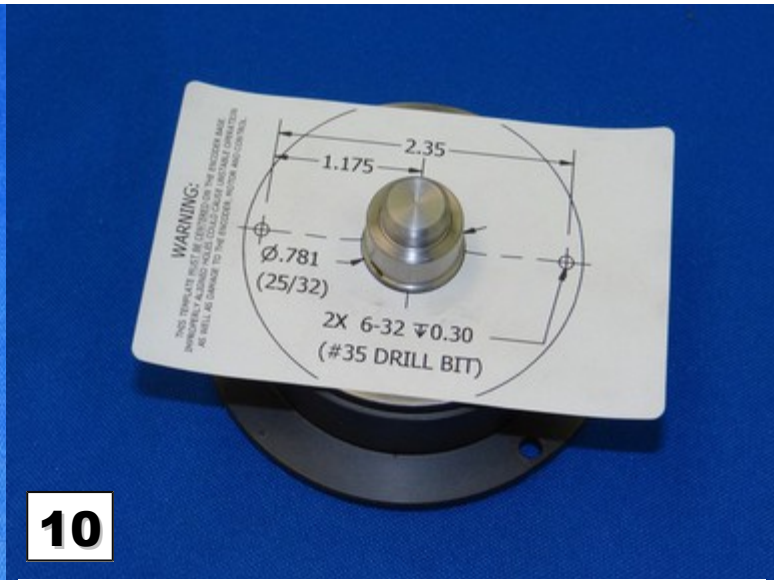
Remove and inspect the coupler. It should fit snugly into the encoder and the motor. If the coupler is worn or damaged, order a new one from Fanuc.

Size 0 and 5 motors: Part# A290-0611-x532
Size 10, 20, 30 motors: Part# A290-0501-x503

Using a hex key, remove the two encoder cover bolts.

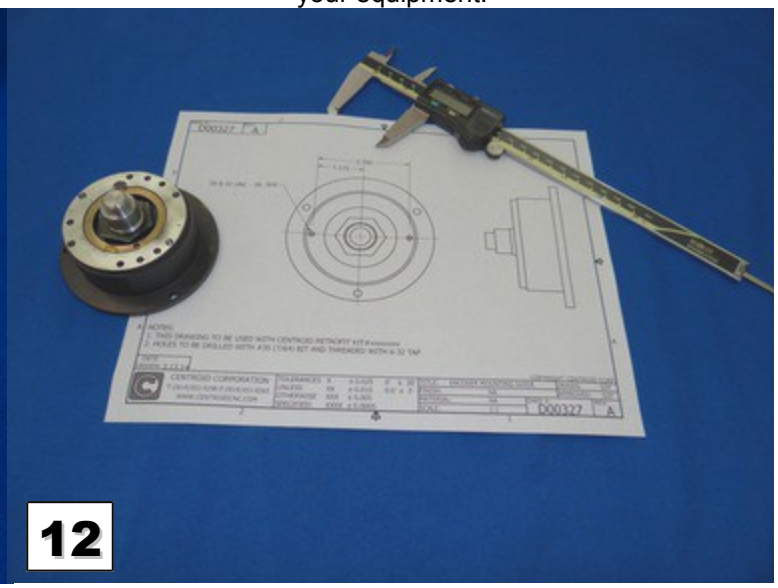
Remove the encoder cover.

Remove all the electronics and optics found within the encoder. Be careful, as the encoder contains a glass disk which may shatter during removal. Clean off all dirt and glue residue.



Cut out the center circle on the template, peel off the backing, and apply it to the encoder base. If you wish, you may also cut along the outer circle on the template and use it as an additional reference when aligning it. Position the template such that the 6-32 hole locations will not interfere with any of the existing holes on the encoder base. The template **MUST BE CENTERED** on the encoder base. Improper alignment could cause unstable operation as well as cause damage to your equipment.

Using a sprung center punch, mark the two hole centers on the base through the template.



Refer to drawing D00327 in appendix A of this manual and double check the center mark locations against the drawing. Again, **THE HOLE LOCATIONS ARE CRITICAL**. Ensure that the actual locations of the center marks are within 0.005” from their specified locations.

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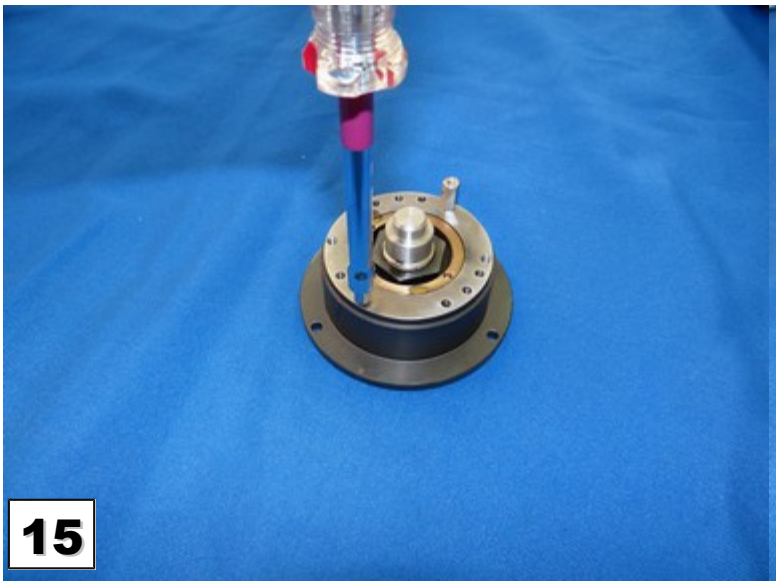
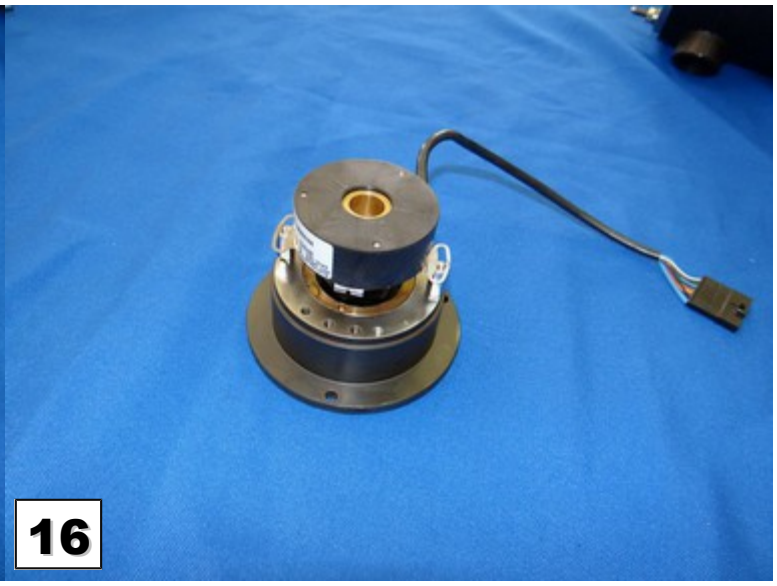
Using a drill press with a #35 (or 7/64”) drill bit, drill holes on the center marks approx 0.5” deep. The exact hole depth will vary depending on the clearance required for your tap. Once again, check the hole locations against drawing D00327.

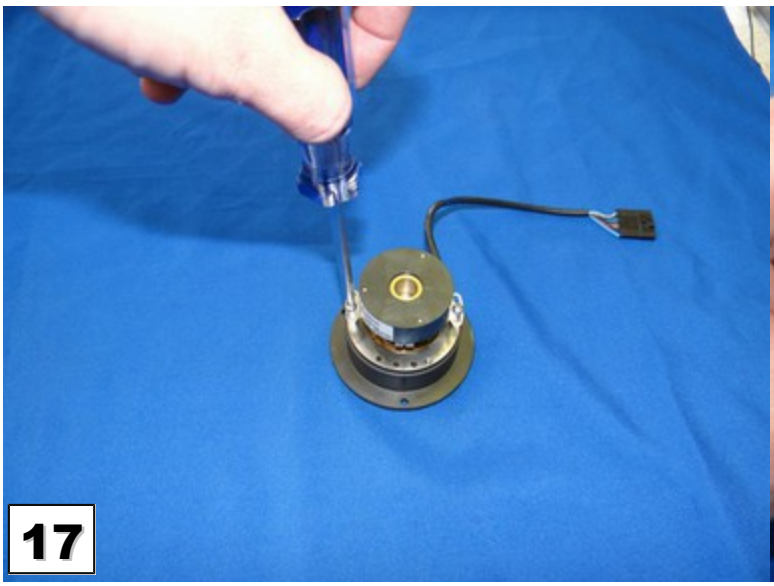
Using a 6-32 tap, a tap handle, and some cutting fluid, carefully thread the holes you just drilled to a minimum depth of 0.3” Clean the holes of burrs and shavings.



Using a nut driver, screw the standoffs from your kit into the holes you just tapped. Tighten to approximately 8 In-Lb or 0.9 Nm. **Do not over-tighten**.



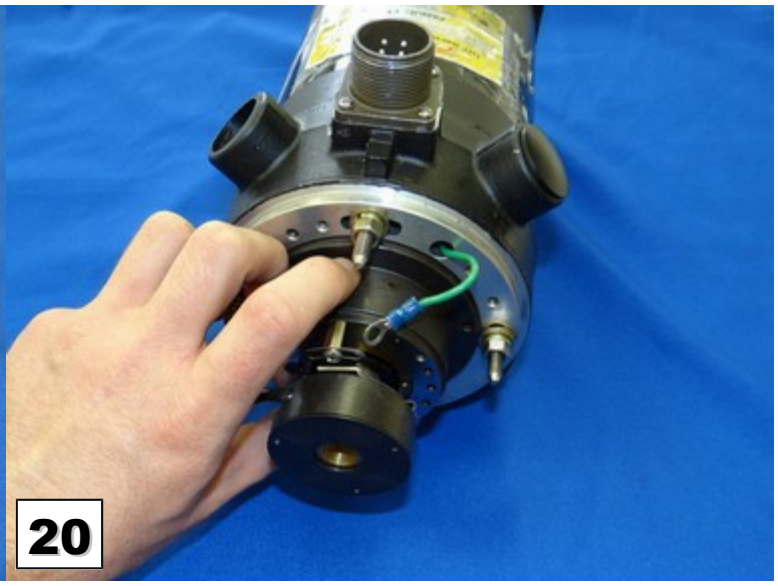
Slide the encoder onto the shaft.



Using a Phillips screw driver and the crews from the retrofit kit, secure the encoder flex mount to the standoffs. Tighten to approximately 8 In-Lb or 0.9 Nm.

Using a hex key, tighten the two set screws on the encoder collar.

Re-insert the brass coupler removed in step 6.



Line up the coupling and place the encoder base back into its original location on the motor.

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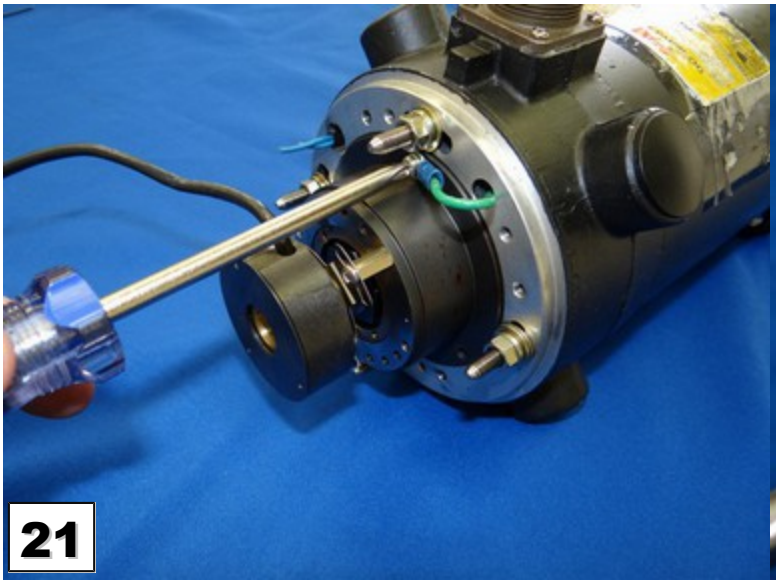
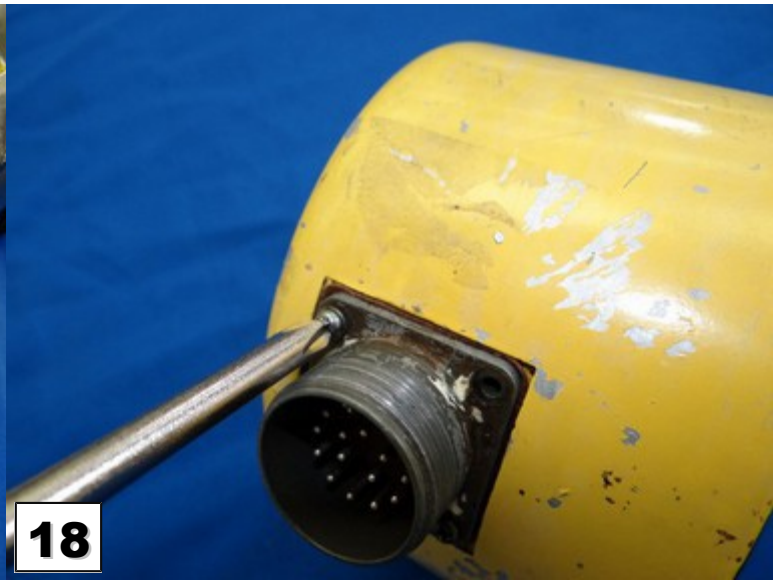
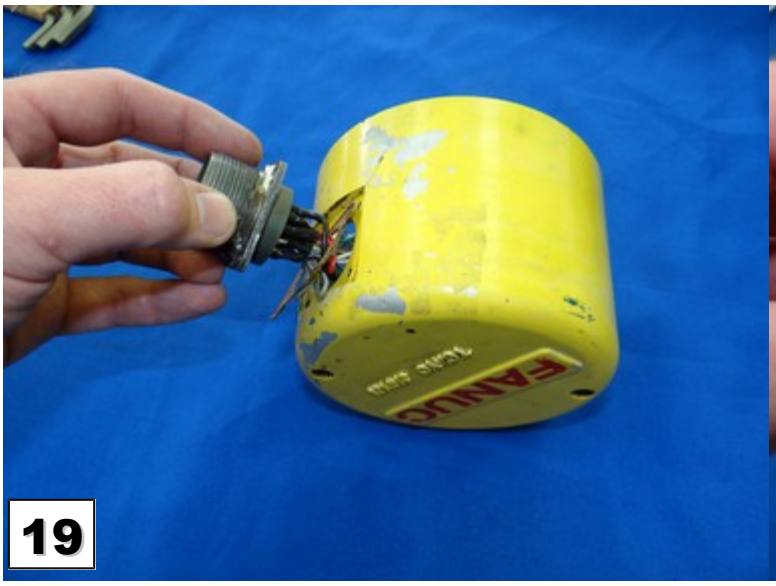


Re-insert the screws that were removed in step 4. If the ground wire was originally held down by one of the mounting screws, re-attach it now. Alternately, the ground wire may be bolted to one of the unused holes in the motor chassis with a m4 bolt or screw.



Using a Phillips screw driver, remove the four MS connector mounting screws. Set them aside. They will be used again in step 24.



Remove the original MS connector, wiring, and gasket. Clean the mounting area.

Install the pigtail connector and gasket from your kit using the screws removed in step 22.

Connect the pigtail to the encoder.

Apply a bead of non-corrosive RTV sealant (such as Dow Corning 3165 or 748) onto the end cap mounting surface. Reinstall the end cap with the bolts removed in step 1.

You are done installing the encoder!

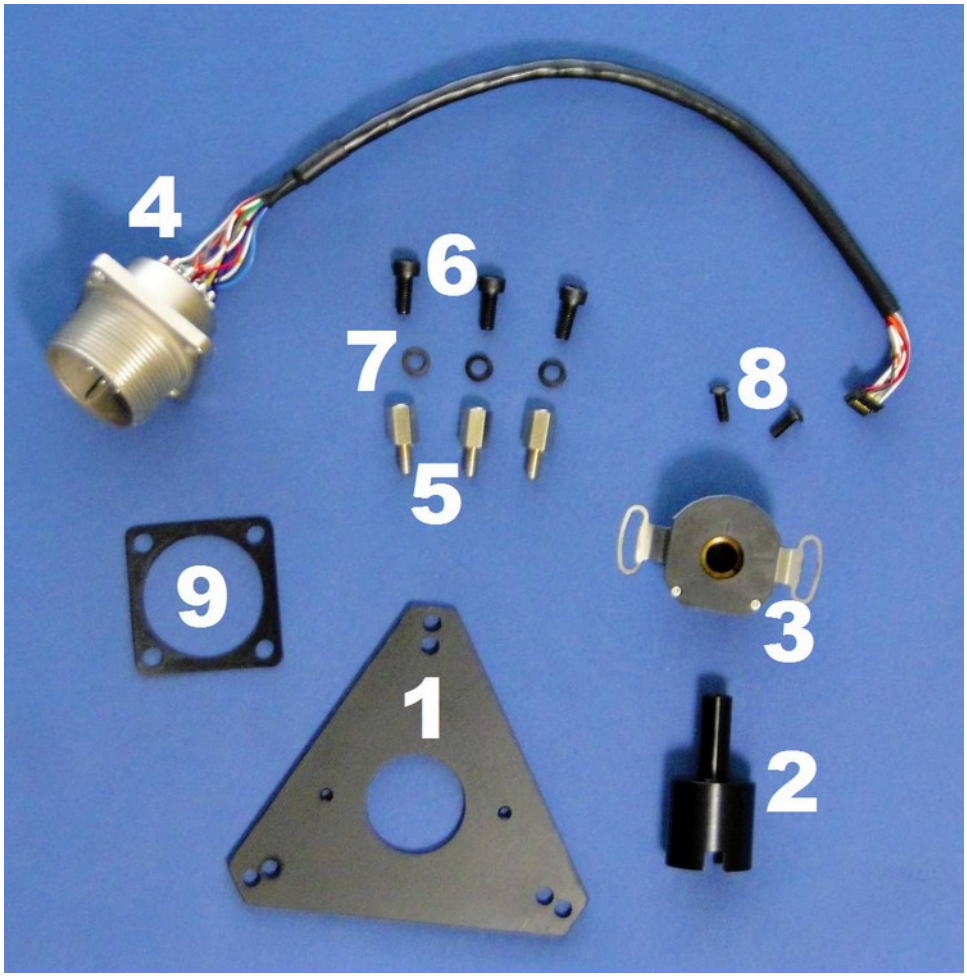
Jump to the Software Setup section.

AC Motors

Red end caps are used on Fanuc AC motors. The Fanuc AC motors have coders/encoders that use a physically different connector and a proprietary continuation protocol and must be retrofitted to use a Centroid encoder.

AC Motors: Early Red Caps and Some S Series Models

To retrofit a non-S or early S series motor, use the Fanuc Encoder Retrofit Kit **12859** as shown below



1. 1 Adapter Plate (PN 12879)
2. 1 Adapter Shaft (PN 12880)
3. 1 Encoder, 40,000 Count (PN 7480)
4. 1 Encoder Pigtail (PN 12821)
5. 3 M4 standoffs (PN 7486)
6. 3 Plate Mounting Bolts (PN 6685)
7. 3 Lock Washers (PN 7484)
8. 2 Encoder Mounting Bolts (PN 2762)
9. 1 Pigtail Gasket (PN 4602)

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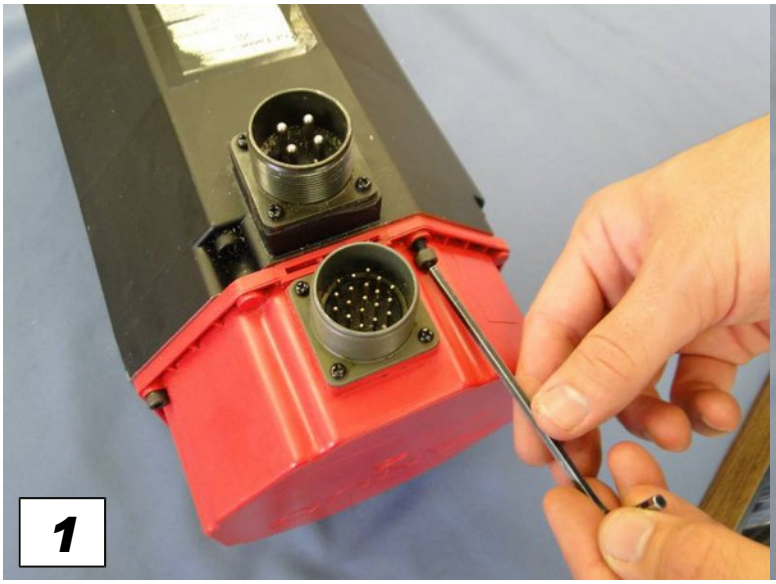
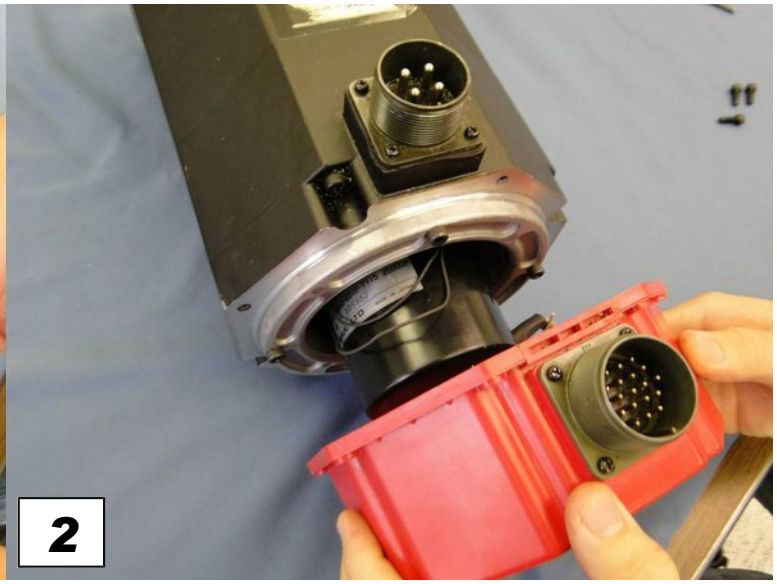
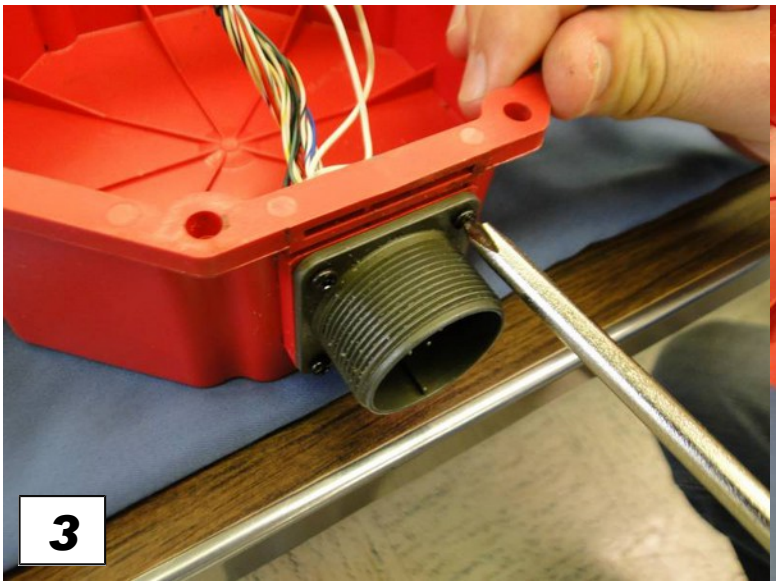
Encoder Installation



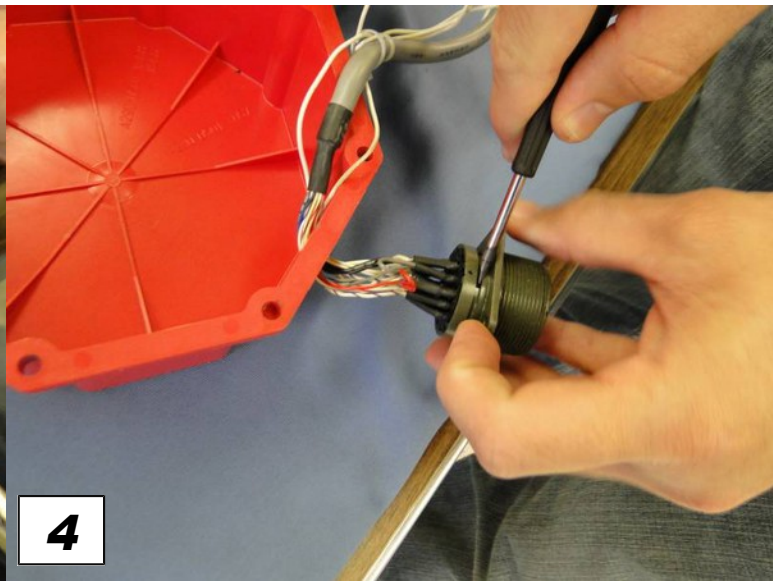
Remove the four bolts holding the red end cap in place using a 4mm hex key. Set aside the end cap bolts, you will use them again in a later step.



Remove the end cap and expose the pulse coder assembly.



Remove the four coder connector screws with a Phillips screwdriver. Set aside the connector screws. You will use them again in a later step.



On two-piece connectors, remove the connector by prying the connector apart with a flat blade screwdriver. Then remove the connector from the end cap. On single-piece connectors, cut the wires to remove the connector from the end cap.

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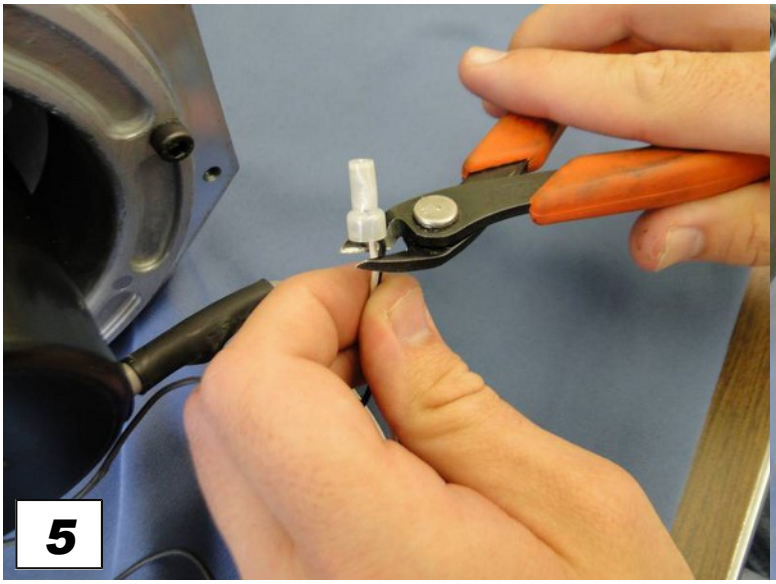
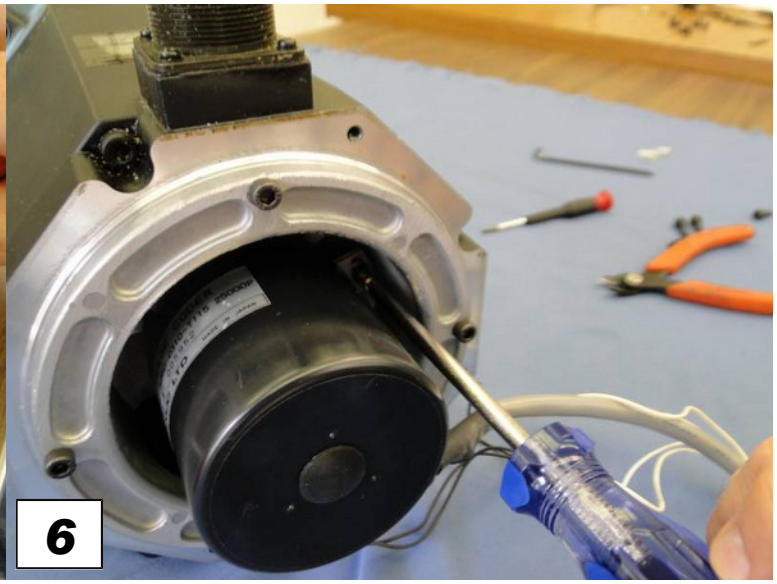
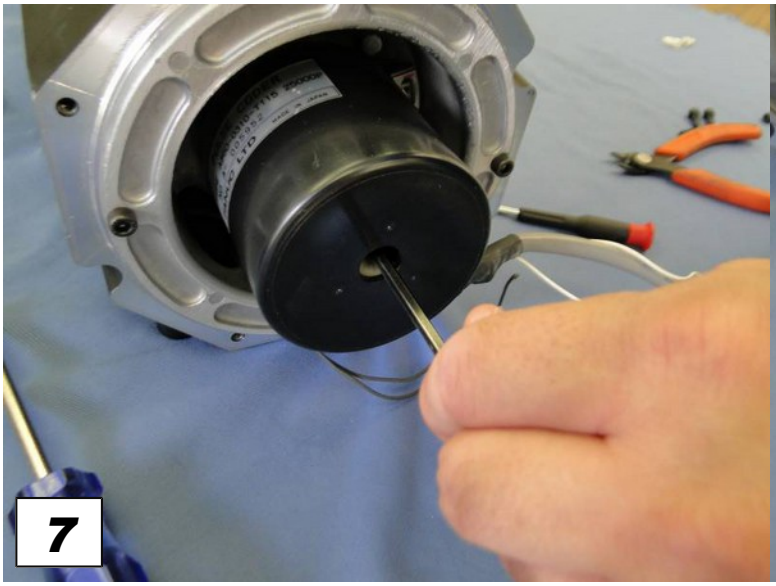


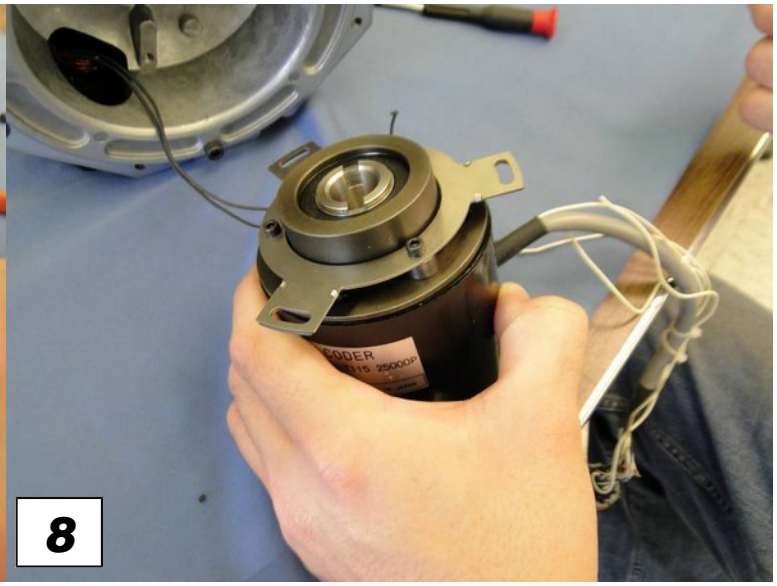
Cut the temperature sensor wires going from the motor to the pigtail connector.



Remove the encoder mounting bolts.



Remove the rubber dust cover on the pulse encoder. Loosen the center bolt using a 4mm hex key while holding the motor shaft.



Gently pull the encoder off the motor. If the encoder is stuck, Use two allen wrenches to get under the encoder and pry up and out on the encoder **NEVER use a metal hammer or any type of impact to remove an encoder!** Once the encoder is out then the center bolt can be removed.

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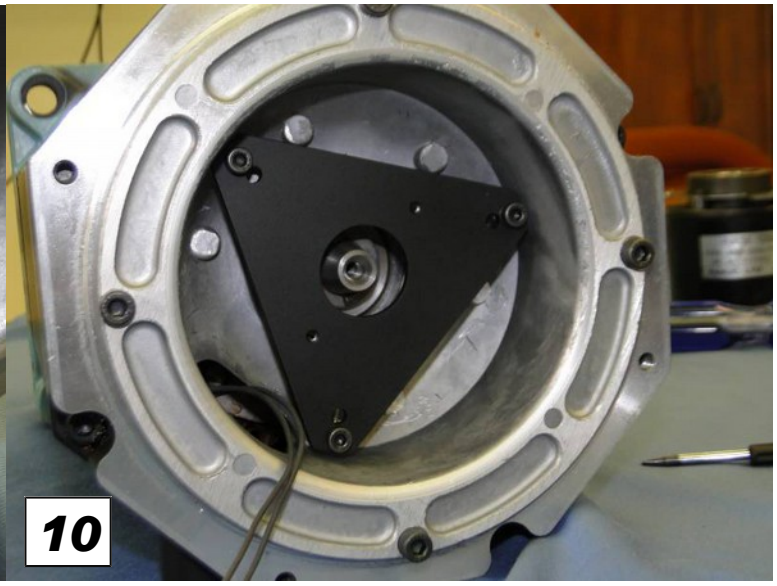
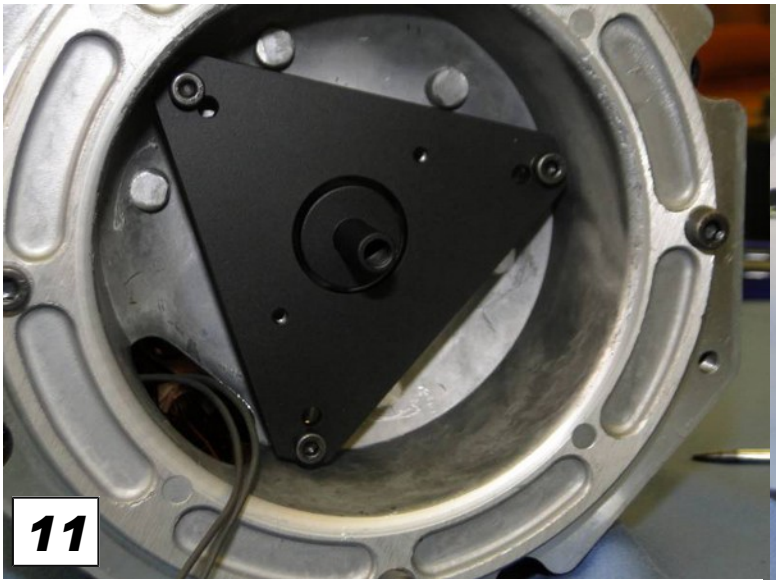
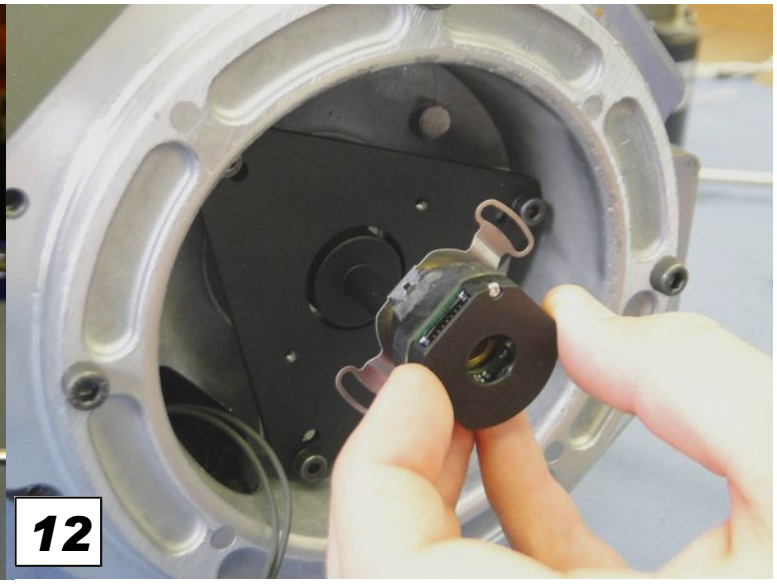
Using a 7mm nut driver, screw the M4 standoffs from the upgrade kit into the inside of the motor chassis. Tighten to approximately 8 Lb-In or 0.9 Nm. **DO NOT OVER-TIGHTEN!**



Use the three plate mounting bolts with lock washers to attach the adapter plate to the M4 standoffs inside the motor chassis. Use a 3 mm hex key to attach the plate mounting bolts. Tighten to approximately 8 In-Lb or 0.9 Nm.



Place the adapter shaft from the kit onto the motor's encoder mounting shaft.



Check to make sure the encoder collar screws are backed out. Gently slide the encoder from the kit onto the adapter shaft.

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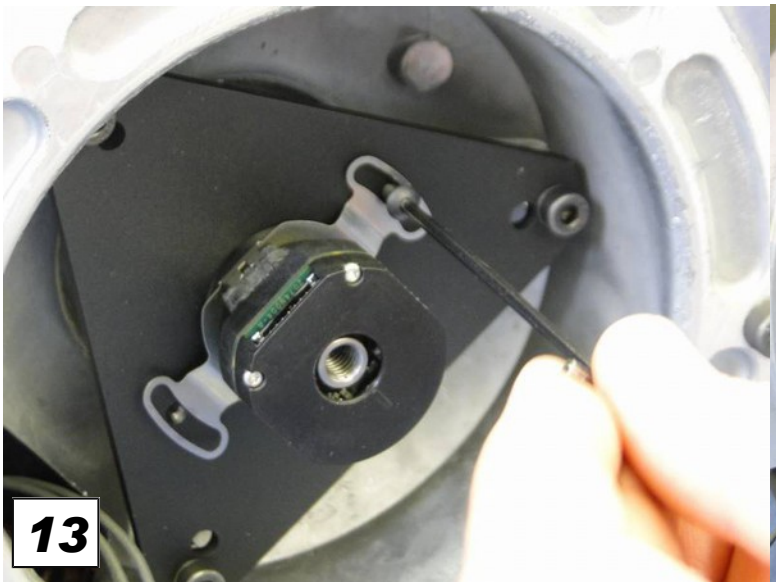
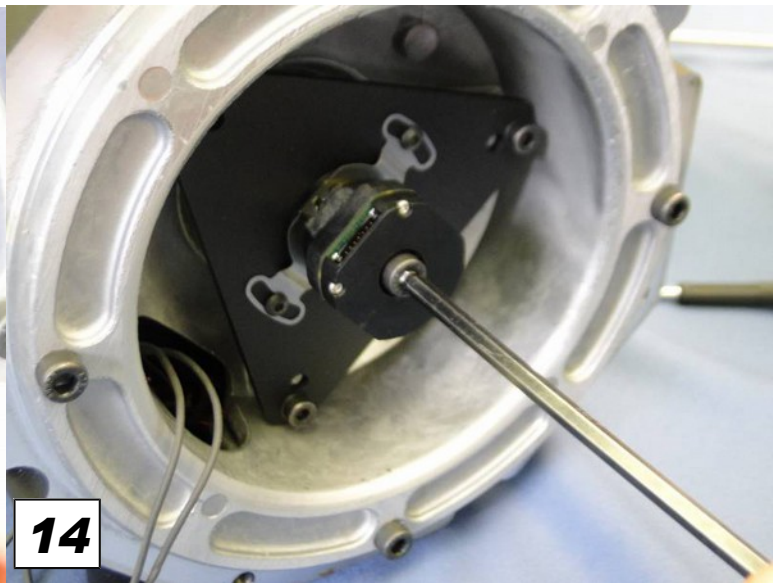
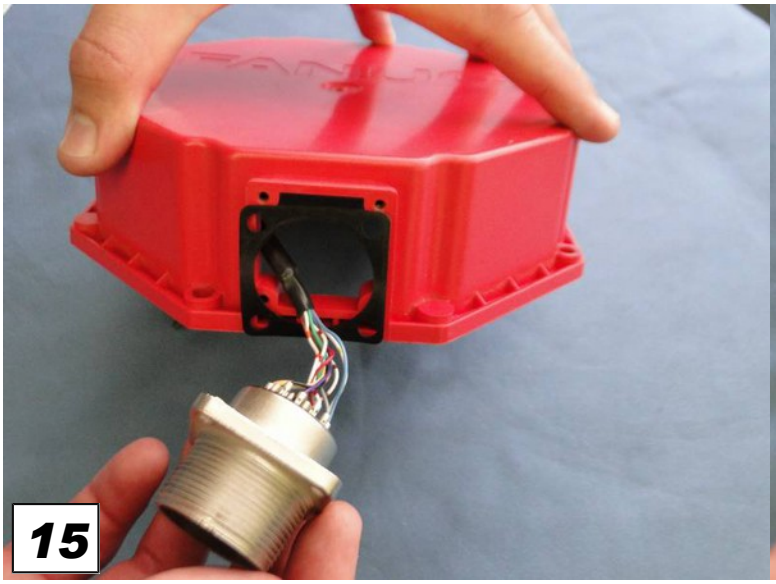


Install the encoder mounting screws using a 2mm hex key. Leave the screws loose, as you will need the encoder to be moveable during the alignment.



Reuse the center bolt that was removed from the old encoder in step 7. Using a 4mm hex key, tighten the bolt into the encoder mounting shaft.



Slide the gasket with the encoder pigtail into the red end cap.

Reusing the screws from step 3, tighten down the pigtail and gasket into the red end cap.

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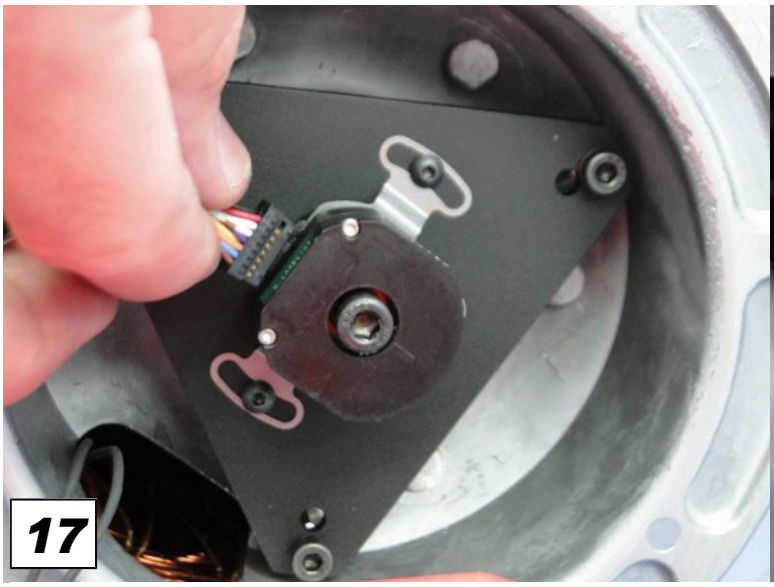
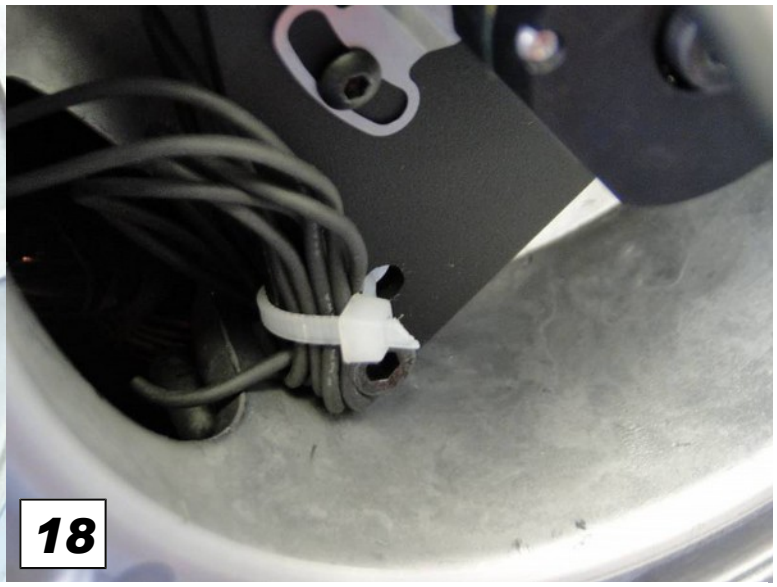


Plug the pigtail connector firmly into the encoder.



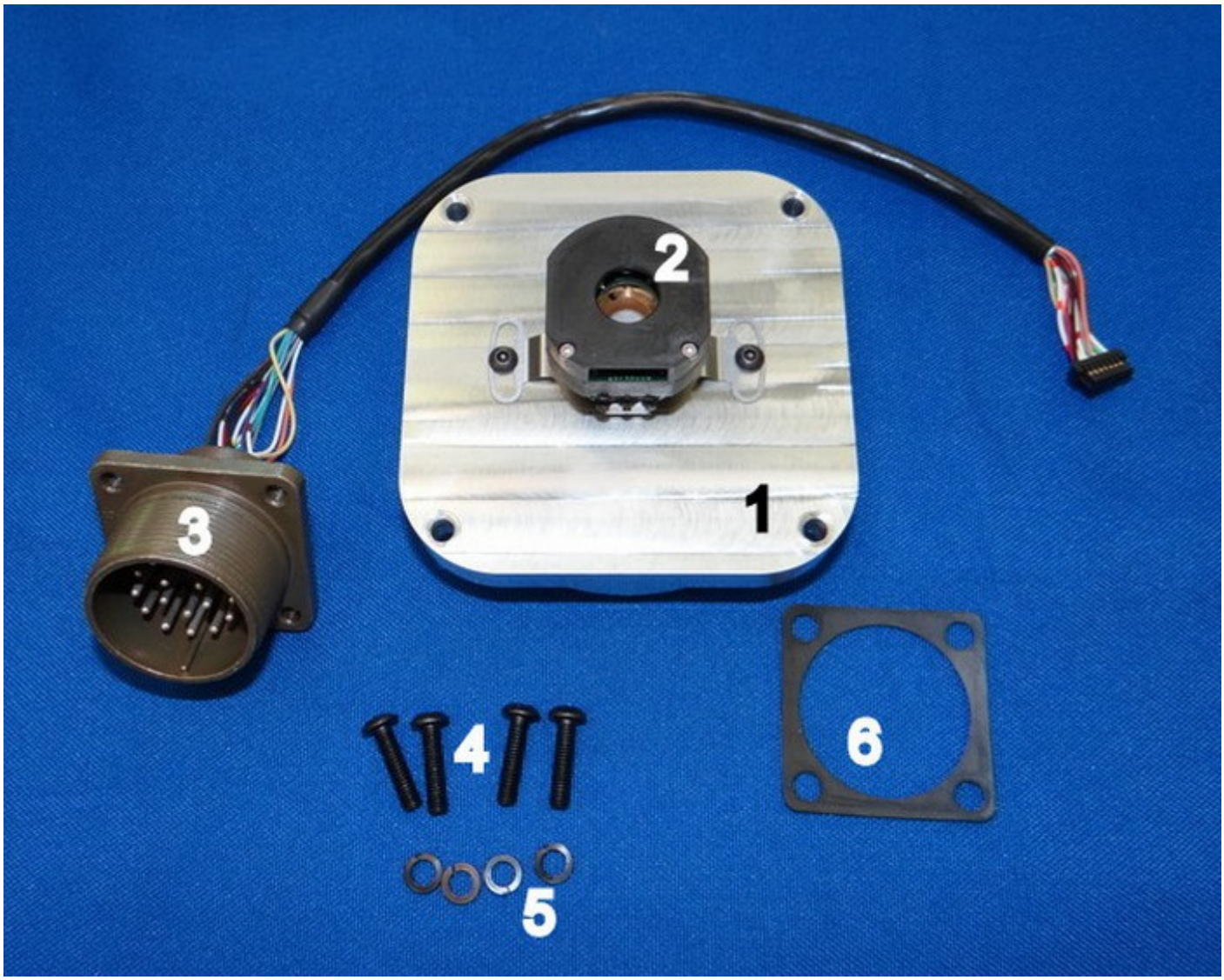
Use zip-ties to hold the temperature sensor wire *(and any other loose wires inside the end cap)* neatly in place.

You are done installing the encoder!

Jump to the Software Setup section.

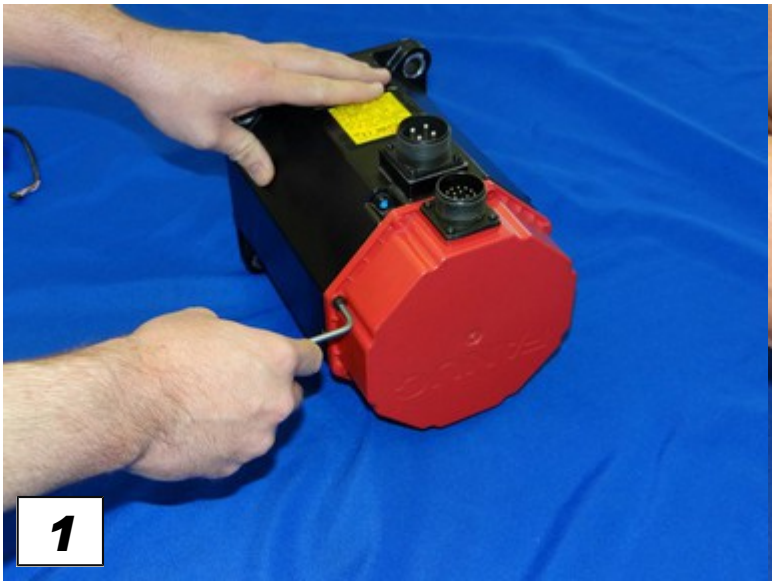
AC Motors: α (Alpha) Series and some S Series Models

To retrofit an α (alpha) series AC motor and late S series motors, use the Fanuc Encoder Retrofit Kit **12876** as shown below

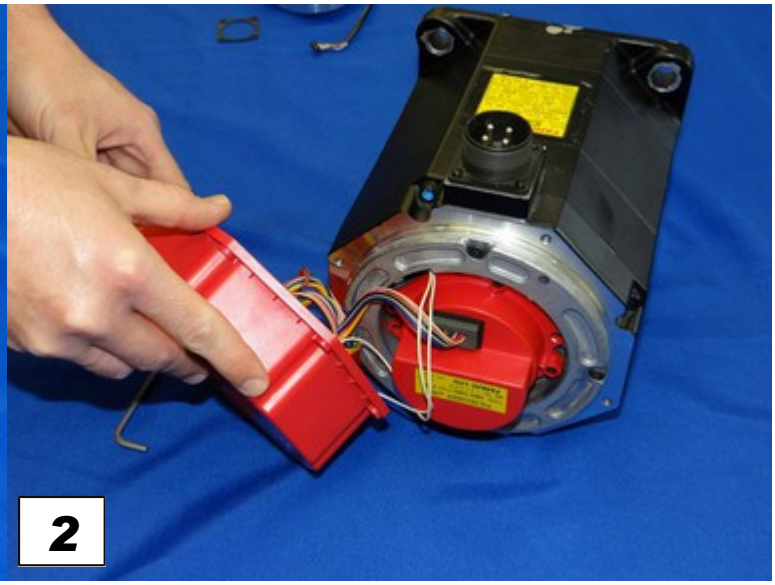


1. 1 Adapter plate assembly (PN 12986)
2. 1 Encoder, 40,000 Count (PN 7480)
3. 1 Encoder Pigtail (PN 12892)
4. 4 Plate Mounting Bolts (PN 6417)
5. 4 Lock Washers (PN 7484)
6. 1 Pigtail Gasket (PN 4602)

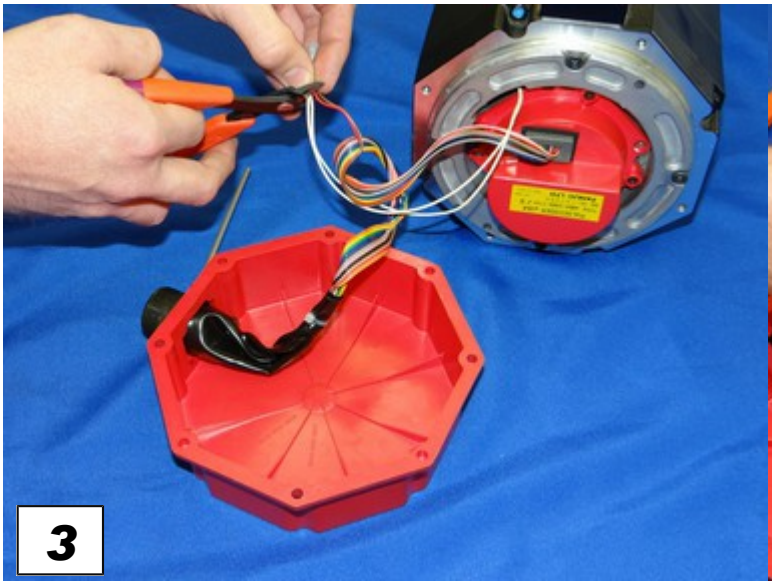
Encoder Installation



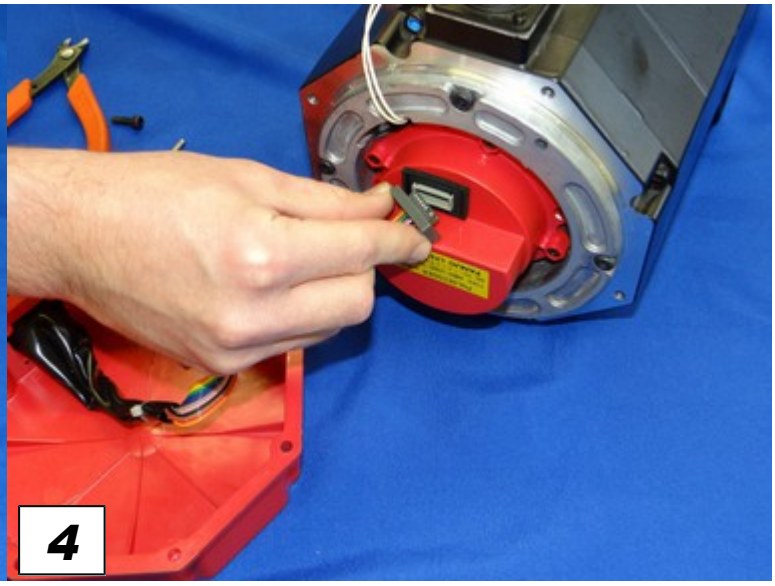
Remove the four bolts holding the red end cap in place using a hex key. Set the end cap bolts aside. You will use them again in a later step.



Remove the end cap and expose the pulse coder assembly.



Cut the temperature sensor wire going from the motor to the pigtail connector.



Unplug the pigtail connector from the pulse coder.

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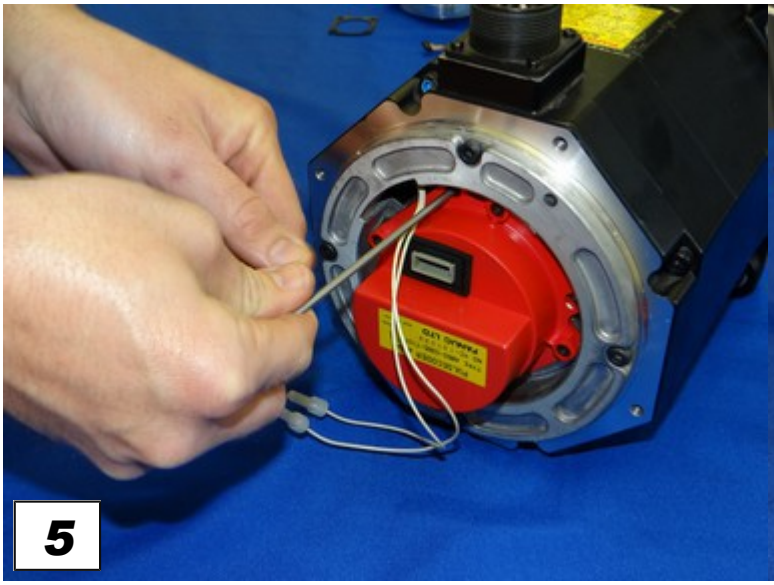
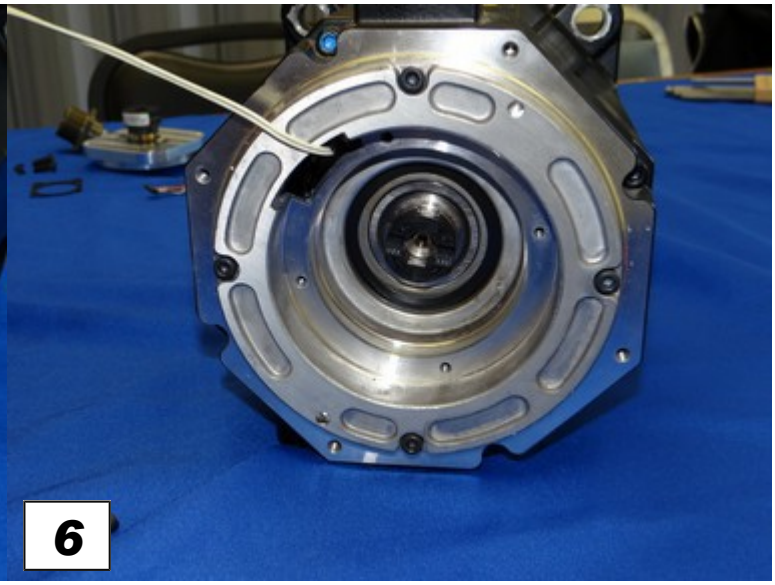
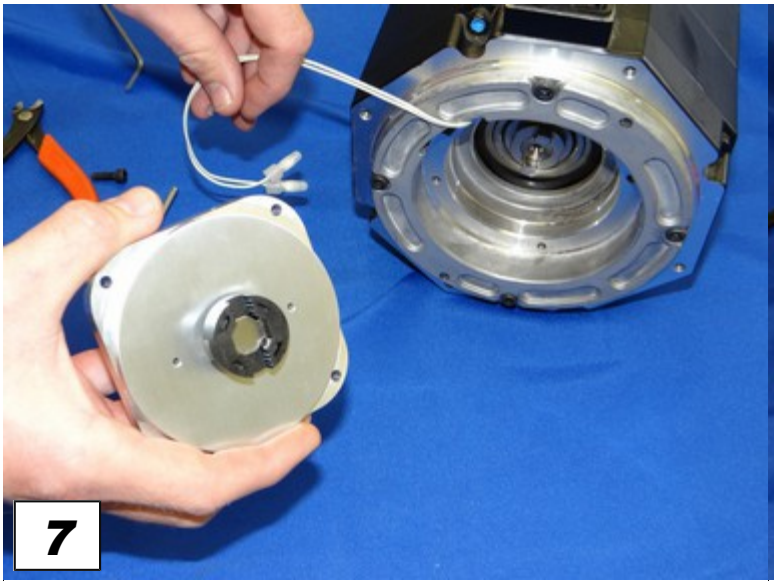


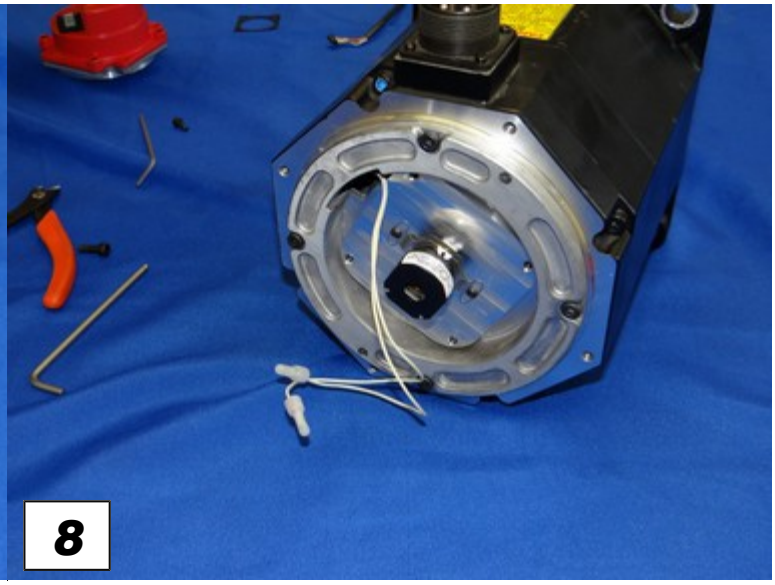
Remove the four bolts holding the pulse coder in place using a 3mm hex key.



Remove the pulse coder. A black plastic coupling will remain on either the motor or pulse coder side. It will be used in the next step.



Fit the plastic coupling to the shaft of the adapter plate from the retrofit kit. It must be a snug fit. If the coupling is heavily worn or damaged, a replacement should be ordered (Fanuc part# A290-0501-V535)



Fit the retrofit assembly onto your motor, making sure that the black coupler mates with both the encoder shaft and the motor. Line up the four bolt holes on the adapter plate with the threaded holes on the motor.

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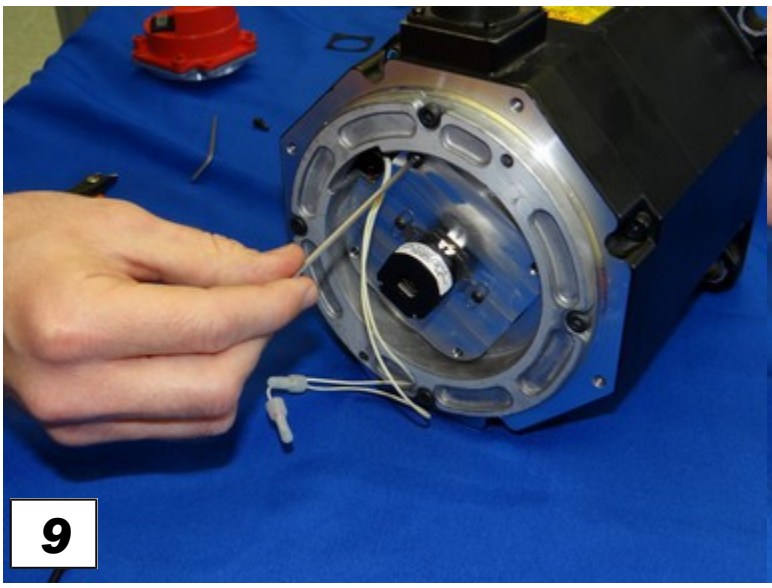
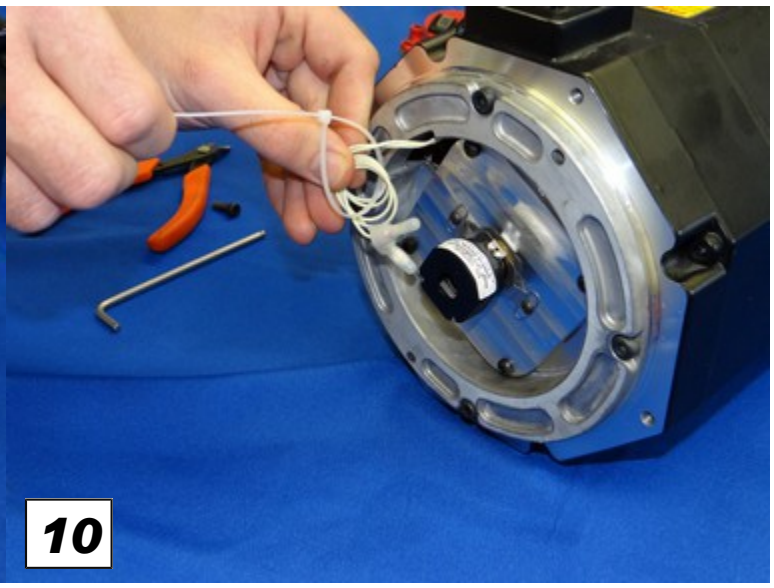
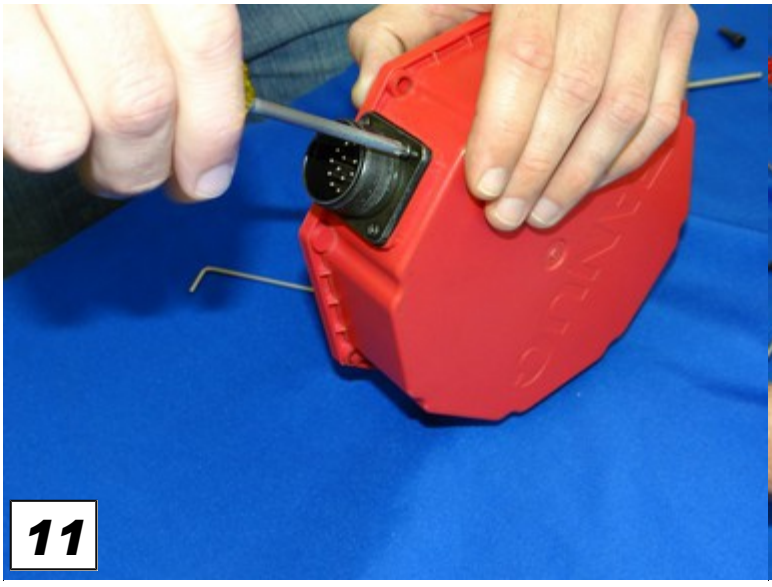


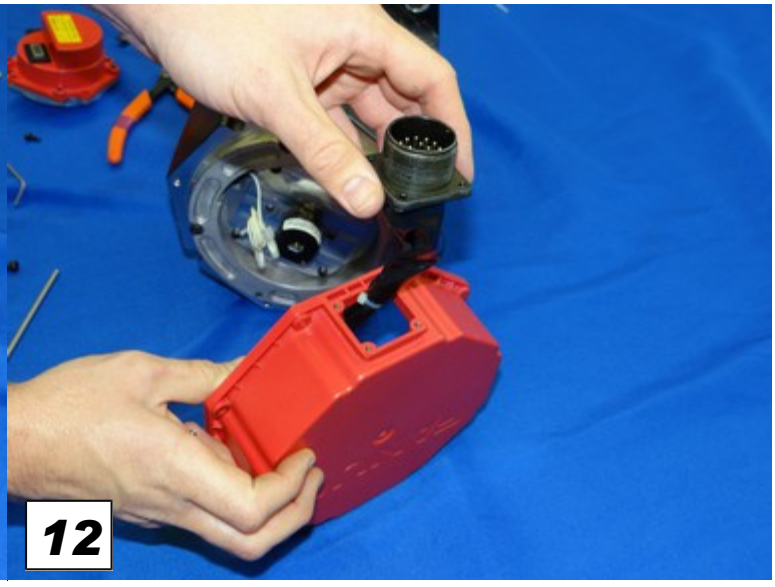
Using a hex key, secure the retrofit assembly in place with the four mounting screws and lock washers supplied with your kit.



Use zip-ties to hold the temperature sensor wires *(*and any other loose wires inside the end cap*)* neatly in place.



Using a Phillips head screwdriver, remove the four MS connector mounting screws and set them aside. You will need them again in step 13.



Remove the original MS connector and wiring.

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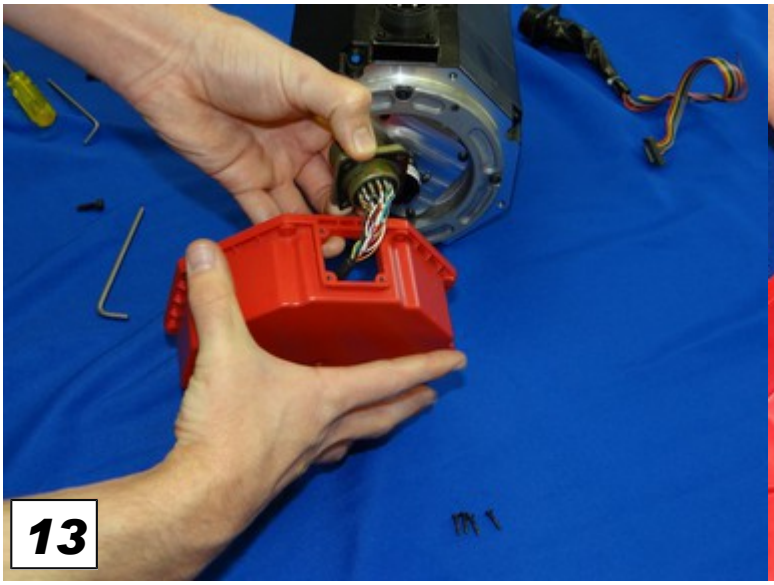
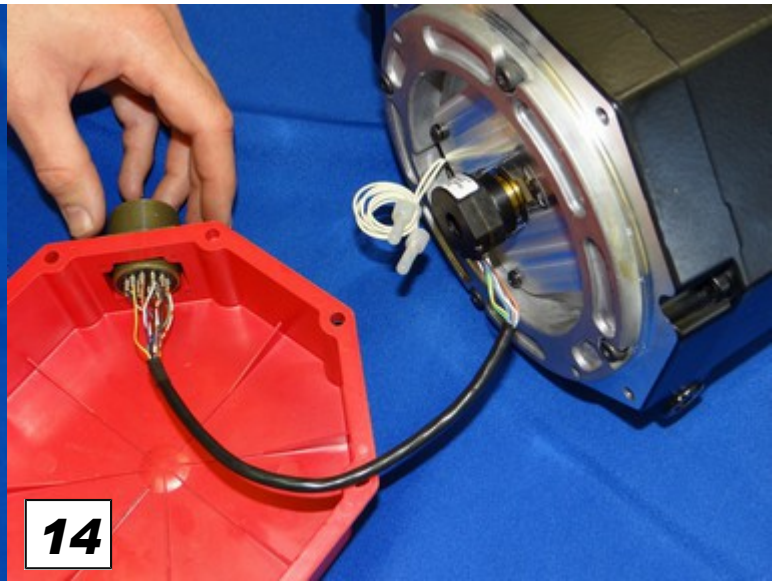


Slide the encoder pigtail with the gasket into the end cap and secure them in place with the four screws removed in step 11.



Plug the pigtail connector firmly into the encoder.

You are done installing the encoder!

Jump to the Software Setup section.

Software Setup

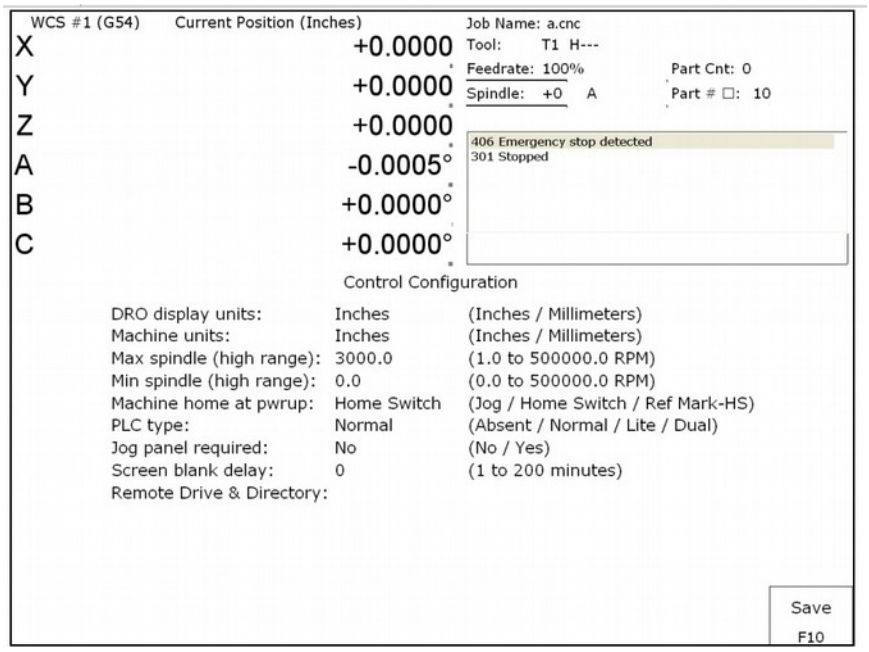
The AC/DC needs the CNC11 software configured correctly to use the servo motor. The software configuration procedure(s) described in this manual are intended for someone familiar with the CNC11 software, the AC/DC drive, and available technical bulletins. This documentation is designed to be used in correlation with the manuals and technical bulletins, and is not intended to replace any pre-existing documentation.

Control Configuration

The machine parameters need to be adjusted for your Fanuc drive before you can use it. Heating coefficients as well as temperature warning and error levels are calculated in imperial units. The machine units **must** be set to **inches** from the Control Configuration menu before entering or changing temperature parameters! After saving temperature parameters, the control may be set back to millimeters if desired. Changing the machine units from inches to millimeters will “automatically” convert temperature values.

NOTE: Cooling parameters do not change when switching from inches to millimeters because cooling parameters are calculated as a unit-less value.

To get to the control configuration menu, press **F1-Setup**. Next, press **F3 – Config** *(The default password is **137**)*, then **F1 – Contrl**. Press **F10-Save** when finished.



Control Configuration Menu

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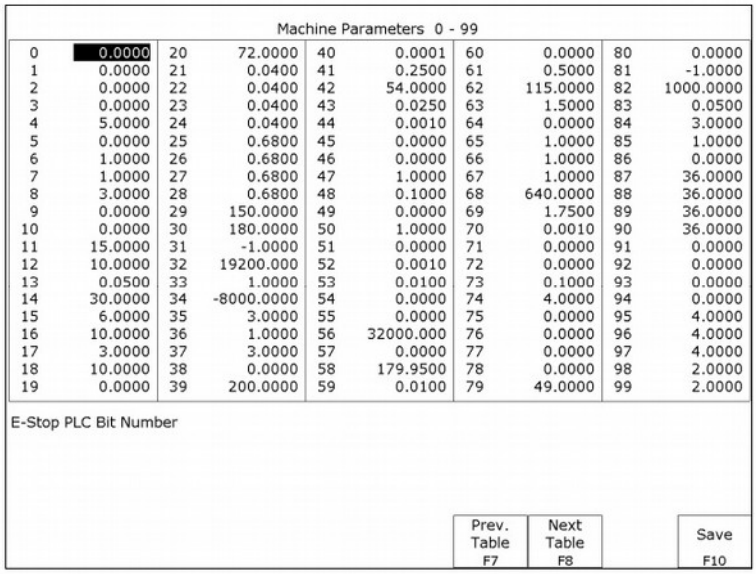
Motor Parameters

In the CNC11 software, access the machine parameters menu by pressing **F1 – Setup**, **F3 – Config**, and then **F3 - Parms**.



Machine Parameters Menu

The table below contains the most important parameters for configuring the AC/DC drive. Set up the control to match your motor combination. (note: consult the CNC11 manual for a more complete listing of all machine parameters and their uses.)

Recommended Fanuc Parameters

Parameter Number	Setting	Setting Description
21-24	Motor dependent[1]	Motor heating coefficients axes 1-4
25-28	Motor dependent[1]	Motor cooling coefficients axes 1-4
29	212 (°F)	Motor temperature warning
30	260 (°F)	Motor temperature error
132-135	Motor dependent[1]	Motor heating coefficients axes 5-8
236-239	Motor dependent[1]	Motor cooling coefficients axes 5-8
256	2	Drive mode
284-291	Dependent on brake resistor	Brake resistor wattage (300 w typical)
300-307	1- 8, Depending on Machine	Drive axis mapping
308-315	7 -14, Depending on Machine	Encoder assignments
340-347	1.75	Precision mode delay
357-364	Motor Dependent[1]	Maximum RPM, may also be set from drive PID screen
374	255	Debug log axis inclustion (bitwise)
375	4000	Debug log size (samples) 0 to 32768
376	1	Data Log collection type: 1= current data, 2=position data

1. Tables containing temperature information and maximum RPMs are provided later in this section of the document.

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Recommended Temperature Coefficients for DC Drives

(Measured in Imperial Units)

Series	Drive Model	Drive Type	Heating Coefficients	Cooling Coefficients
Black End Cap (Fanuc ● Gettys)	0	A06B-0613-B0xx	4.0135	3.3333
	5	A06B-0614-Bxxx	3.6486	3.0303
	10	A06B-0601-Bxxx	0.5017	1.6667
	20	A06B-0602-Bxxx	0.2527	1.5873
Yellow End Cap (M Series)	0M	A06B-0641-Bxxx	12.3874	0.0574
	5M	A06B-0642-Bxxx	7.1351	0.0517
	10M	A06B-0651-Bxxx	2.8668	0.0369
	20M	A06B-0652-Bxxx	1.1149	0.0323
	30M	A06B-0653-Bxxx	0.5902	0.0304
S Series Red Cap & Early Red Cap	0	A06B-0511-Bxxx	11.7374	3.7037
	5	A06B-0512-Bxxx	10.8766	3.3333
	10	A06B-0501-Bxxx	3.4637	2.7778
	20M	A06B-0505-Bxxx	1.7194	2.5641
	20S/1500			
	20	A06B-0502-Bxxx	0.9672	2.5641
	20S			
	30	A06B-0503-Bxxx	0.7993	2.5641
	30R	A06B-0506-Bxxx	0.4600	2.5641
	30/2000			
	40	A06B-0581-Bxxx	0.2965	1.8519
	0-0SP	A06B-0374-Bxxx	16.6116	8.3333
	0S	A06B-0313-Bxxx	26.4090	3.7037
	5S	A06B-0314-Bxxx	14.9505	3.3333
	5S/3000	A06B-0514-Bxxx	4.8340	3.3333
	6S	A06B-0316-Bxxx	6.3282	3.0303
	6S/3000	A06B-0320-Bxxx	4.0692	3.0303
	10S	A06B-0315-Bxxx	7.2561	2.7778
	10S/3000	A06B-0317-Bxxx	1.7904	2.7778
	20S	A06B-0502-B065	0.9969	2.5641
	20S/1500	A06B-0505-Bxxx	1.4384	2.5641
	30S	A06B-0590-Bxxx	1.5897	2.5641
	30/2000	A06B-0506-Bxxx	0.4730	2.5641
α (Alpha) Series Red Cap & αC Series Red Cap[1]	α3/3000	A06B-0123-Bxxx	26.4090	3.7037
	α6/2000	A06B-0127-Bxxx	16.0374	3.3333
	α6/3000	A06B-0128-Bx77	5.0293	3.3333
	α12/2000	A06B-0142-Bxxx	5.4121	2.7778
	α12/3000	A06B-0143-Bx75	1.7445	2.7778
	α22/1500	A06B-0146-Bxxx	2.4760	2.5641
	α22/2000	A06B-0147-Bx75	1.1063	2.5641
	α30/1200	A06B-0151-Bxxx	2.2628	2.3810
	α30/2000	A06B-0152-Bxxx	0.8804	2.3810
	α40/2000	A06B-0157-Bx75	0.4599	2.2222
	αC12/2000	A06B-0141-Bx75	12.0400	2.7778
	αC22/1500	A06B-0145-Bxxx	2.4760	2.5641
β (Beta) Series Red Cap & βis Series Red Cap	β3/3000	A06B-0033-Bxxx	22.3805	4.1667
	β6/2000	A06B-0034-Bxxx	20.0468	4.1667
	β4/4000is	A06B-0063-Bx0x	56.9187	8.3333
	β8/3000is	A06B-0075-B203	34.9260	8.3333
	β12/300is	A06B-0078-Bx0x	9.6681	6.6667
	β22/2000is	A06B-0085-Bx0x	6.5645	5.5556

1. Most Fanuc documentation lists the αC Series as a member of the α Series, while some Fanuc documentation lists the αC Series as a member of the β series.

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PID Menu Setup

From the main menu, Press **F1 - Setup**, **F3 - Config**, then **F4 – PID** to enter the PID Menu as shown below. Press **F1 – PID Config** to edit the configuration. Enter the settings for the PID loop from the tables below. The tables are intended to be used as a baseline of sample values to get started. The PID values shown need some fine tuning and adjusting before your motor can be used in a machine, which is covered in later sections. Press **F10-Save & Exit** when you are done.

α and β Motors

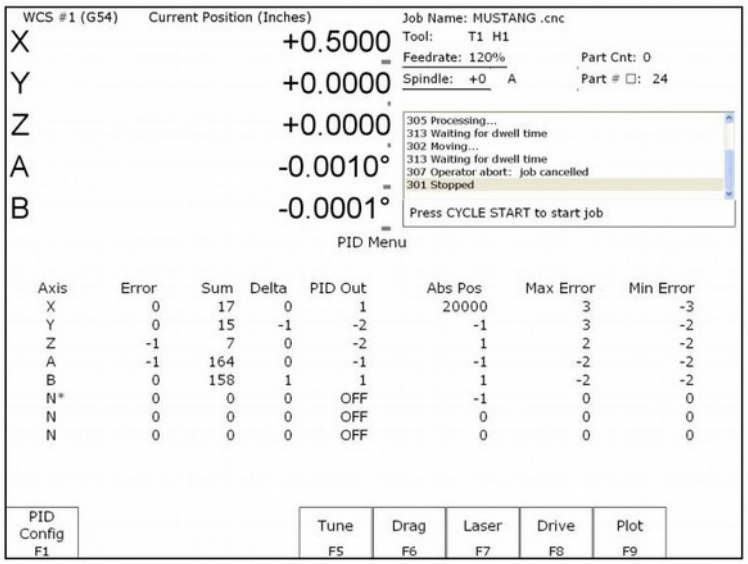
Series	Drive Model	Drive Type	Position PID		
			Kp	Ki	Kd
α (Alpha) Series & αC Series[2]	α3/3000	A06B-0123-Bxxx	1	0.02	1
	α6/2000	A06B-0127-Bxxx	2	0.02	3
	α6/3000	A06B-0128-Bxxx	3	0.02	5
	α12/2000	A06B-0142-Bxxx	3	0.02	5
	α12/3000	A06B-0143-Bxxx	5	0.02	7
	α22/1500	A06B-0146-Bxxx	10	0.02	12
	α22/2000	A06B-0147-Bxxx	10	0.02	12
	α30/1200	A06B-0151-Bxxx	10	0.02	12
	α30/2000	A06B-0152-Bxxx	10	0.02	12
	α40/2000	A06B-0157-Bxxx	10	0.02	12
	αC12/2000	A06B-0141-Bxxx	7	0.02	9
	αC22/2000	A06B-0145-Bxxx	10	0.02	12
β (Beta) Series & βis Series	β3/3000	A06B-0033-Bxxx	1	0.02	1
	β6/2000	A06B-0034-Bxxx	2	0.02	1.8
	β4/4000is	A06B-0063-Bx0x	1	0.02	1
	β8/3000is	A06B-0075-B203	2	0.02	1.8
	β12/300is	A06B-0078-Bx0x	5	0.02	7
	β22/2000is	A06B-0085-Bx0x	10	0.02	12

DC Motors

Series	Drive Model	Drive Type	Position PID		
			Kp	Ki	Kd
Black End Cap (Fanuc • Gettys)	00	A06B-0631-B0xx	1	0.02	1
	0	A06B-0613-B0xx	1.25	0.02	2
	5	A06B-0614-Bxxx	1	0.02	3
	10	A06B-0601-Bxxx	9	0.02	10
	20	A06B-0602-Bxxx	10	0.02	12
Yellow End Cap (M Series)	00M	A06B-0632-Bxxx	0.35	0.005	0.35
	0M	A06B-0641-Bxxx	1	0.02	1
	5M	A06B-0642-Bxxx	2	0.02	1.8
	10M	A06B-0651-Bxxx	9	0.02	7.5
	20M	A06B-0652-Bxxx	10	0.02	12
	30M	A06B-0653-Bxxx	10	0.02	12

S Series & Early Red Caps

Drive Model	Drive Type	Position PID		
		Kp	Ki	Kd
0	A06B-0511-Bxxx	2	0.02	3
5	A06B-0512-Bxxx	2	0.02	5
10	A06B-0501-Bxxx	5	0.02	7
20M / 20S/1500	A06B-0505-Bxxx	10	0.02	12
20 / 20S	A06B-0502-Bxxx	10	0.02	12
30	A06B-0503-Bxxx	10	0.02	12
30R / 30/2000	A06B-0506-Bxxx	10	0.02	12
40	A06B-0581-Bxxx	10	0.02	12
0-0SP	A06B-0374-Bxxx	2	0.02	3
0S	A06B-0313-Bxxx	2	0.02	3
5S	A06B-0314-Bxxx	2	0.02	3
5S/3000	A06B-0514-Bxxx	2	0.02	3
6S	A06B-0316-Bxxx	3	0.02	5
6S/3000	A06B-0320-Bxxx	3	0.02	5
10S	A06B-0315-Bxxx	5	0.02	7
10S/3000	A06B-0317-Bxxx	5	0.02	7
20S	A06B-0502-B065	10	0.02	12
20S/1500	A06B-0505-Bxxx	10	0.02	12
30S	A06B-0590-Bxxx	10	0.02	12
30/2000	A06B-0506-Bxxx	10	0.02	12



PID Menu

Drive Configuration Setup

From the main menu, press **F1 - Setup**, **F3 - Config**, **F4 - PID**, and then **F8 – Drive** to enter the Drive Configuration menu. Press **F1 – Drive PID** to edit the configuration. Enter the settings for the current feedback PID loop from the tables below. Press **F10-Accept** when you are done.

DC Motors

End Cap Color	Drive Model	Drive Type	Current PID									
			Poles	(ACDC-30) Current	(ACDC-60) Current	Angle	Kp	Ki	Kd	Inertia In-lb sec²	Kt	Max RPM
Black (Fanuc ● Gettys)	0	A06B-0613-B0xx	0	80%	40%	0	0.75	0.075	0	0.0252	2.12	2,000
	5	A06B-0614-Bxxx	0	80%	40%	0	2.00	0.100	0	0.0434	4.23	2,000
	10	A06B-0601-Bxxx	0	Not Recommended	60%	0	3.50	0.100	0	0.1736	4.72	1,500
	20	A06B-0602-Bxxx	0	Not Recommended	80%	0	3.50	0.100	0	0.2864	6.74	1,500
Yellow (M Series)	0M	A06B-0641-Bxxx	0	Not Recommended	100%	0	2.00	0.100	0	0.0220	3.73	2,000
	5M	A06B-0642-Bxxx	0	60%	30%	0	6.00	0.100	0	0.0320	5.80	2,000
	10M	A06B-0651-Bxxx	0	80%	40%	0	3.50	0.100	0	0.1130	8.85	1,500
	20M	A06B-0652-Bxxx	0	Not Recommended	60%	0	3.50	0.100	0	0.1649	11.28	1,500
	30M	A06B-0653-Bxxx	0	Not Recommended	80%	0	3.50	0.100	0	0.3211	13.89	1,200

S Series & Early Red Caps

Drive Model	Drive Type	Current PID									
		Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec²	Kt	Max RPM
0	A06B-0511-Bxxx	8	70%	35%	0.000	2.00	0.100	0	0.0174	3.73	2,000
5	A06B-0512-Bxxx	8	70%	35%	0.006	2.00	0.100	0	0.0570	7.64	2,000
10	A06B-0501-Bxxx	8	100%	55%	0.000	2.20	0.100	0	0.0330	9.55	2,000
20M 20S/1500	A06B-0505-Bxxx	8	Not Recommended	75%	0.000	2.50	0.080	0	0.1476	13.45	1,500
20 20S	A06B-0502-Bxxx	8	Not Recommended	100%	0.000	2.50	0.080	0	0.1476	10.42	2,000
30	A06B-0503-Bxxx	8	Not Recommended	100%	0.000	2.50	0.080	0	0.2083	14.76	1,200
30R 30/2000	A06B-0506-Bxxx	8	Not Recommended	100%	0.000	2.50	0.080	0	0.2083	9.11	2,000
40	A06B-0581-Bxxx	8	Not Recommended	100%	0.000	2.50	0.080	0	0.2691	16.11	1,200
0-0SP	A06B-0374-Bxxx	8	80%	40%	0.000	2.00	0.100	0	0.0074	3.01	3,000
0S	A06B-0313-Bxxx	8	40%	20%	0.000	2.20	0.100	0	0.0174	5.66	3,000
5S	A06B-0314-Bxxx	8	50%	25%	0.000	2.20	0.100	0	0.0330	8.94	2,000
5S/3000	A06B-0514-Bxxx	8	100%	50%	0.000	2.20	0.100	0	0.0330	5.04	3,000
6S	A06B-0316-Bxxx	8	80%	40%	0.000	2.20	0.100	0	0.0486	9.20	2,000
6S/3000	A06B-0320-Bxxx	8	100%	50%	0.000	2.20	0.100	0	0.0486	7.38	3,000
10S	A06B-0315-Bxxx	8	70%	35%	0.000	2.20	0.100	0	0.0868	13.63	2,000
10S/3000	A06B-0317-Bxxx	8	Not Recommended	75%	0.000	2.20	0.100	0	0.0868	6.82	3,000
20S	A06B-0502-B065	8	Not Recommended	100%	0.003	2.50	0.080	0	0.1800	10.09	2,000
20S/1500	A06B-0505-Bxxx	8	Not Recommended	80%	0.003	2.50	0.080	0	0.1476	12.13	1,500
30S	A06B-0590-Bxxx	8	Not Recommended	75%	0.000	2.50	0.080	0	0.2083	21.15	1,200
30/2000	A06B-0506-Bxxx	8	Not Recommended	100%	0.000	1.50	0.050	0	0.2083	9.12	2,000

α and β Motors

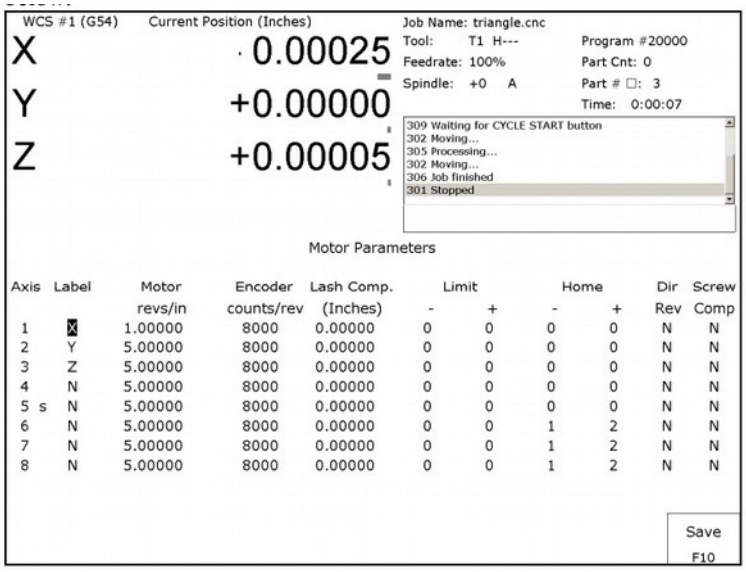
Series	Drive Model	Drive Type	Current PID									
			Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec²	Kt	Max RPM
α (Alpha) Series & αC Series[2]	α3/3000	A06B-0123-Bxxx	8	40%	20%	0.00	1.50	0.050	0	0.0122	5.75	3000
	α6/2000	A06B-0127-Bxxx	8	56%	28%	0.000	1.50	0.050	0	0.0234	9.56	2000
	α6/3000	A06B-0128-Bxxx	8	100%	50%	0.003	1.50	0.050	0	0.0234	5.31	4000
	α12/2000	A06B-0142-Bxxx	8	88%	44%	0.000	2.00	0.100	0	0.0555	12.04	2000
	α12/3000	A06B-0143-Bxxx	8	Not Recommended	75%	0.000	2.00	0.100	0	0.0555	6.82	3000
	α22/1500	A06B-0146-Bxxx	8	Not Recommended	62%	0.000	2.50	0.100	0	0.1042	15.58	1500
	α22/2000	A06B-0147-Bxxx	8	Not Recommended	90%	0.000	2.50	0.100	0	0.1042	10.36	2000
	α30/1200	A06B-0151-Bxxx	8	Not Recommended	63%	0.000	2.50	0.100	0	0.1476	20.98	1200
	α30/2000	A06B-0152-Bxxx	8	Not Recommended	100%	0.000	2.50	0.100	0	0.1476	13.10	2000
	α40/2000	A06B-0157-Bxxx	8	Not Recommended	100%	0.000	2.50	0.100	0	0.1996	12.39	2000
	αC12/2000	A06B-0141-Bxxx	8	60%	30%	0.010	4.00	0.075	0	0.0555	18.06	2000
	αC22/1500	A06B-0145-Bxxx	8	Not Recommended	62%	0.000	4.00	0.075	0	0.1042	15.58	1500
β (Beta) Series & βis Series	β3/3000	A06B-0033-Bxxx	8	50%	25%	0.000	2.00	0.100	0	0.0174	4.96	3,000
	β6/2000	A06B-0034-Bxxx	8	50%	25%	0.000	2.00	0.100	0	0.0347	9.29	3,000
	β4/4000is	A06B-0063-Bx0x	8	40%	20%	0.000	2.50	0.100	0	0.0046	6.64	4,000
	β8/3000is	A06B-0075-B203	8	60%	30%	0.001	2.50	0.100	0	0.0103	10.27	3,000
	β12/300is	A06B-0078-Bx0x	8	100%	50%	0.000	2.50	0.100	0	0.0208	9.56	3,000
	β22/2000is	A06B-0085-Bx0x	8	100%	50%	0.000	2.50	0.100	0	0.0520	15.67	2,000

Motor Encoder Count Setup

From the main menu, Press **F1 - Setup**, **F3 - Config**, **F2 – Mach.**, then **F2 – Motor** to access the motor parameters menu. Navigate using the arrow keys. Fanuc motors with Centroid encoders have a 40,000 counts per revolution encoder. For motors with the original Fanuc coder, CPR varies by model and options.

Set motor direction using the procedure described in **Tech Bulletin # 137,** "**Setting Direction Reversal**".

Set motor revolutions per inch using the procedure described in **Tech Bulletin # 036**, "**Measuring Revs. Per Inch**".



Motor Parameters Menu

Other Misc Setup Procedures

Set up the home file using the procedure described in **Tech Bulletin #022**, “**Modifying the “HOM” file**”.

You are done configuring software!

Jump to the AC Encoder Alignment on section if you have an AC servo.
Jump to the Calculating and Testing Maximum Feed Rate section if you have a DC servo.

AC Encoder Alignment

Introduction

AC drives rely on knowing the motor position in order to stay synchronized while driving the motor. Before the motor is mounted on a machine, the motors encoder commutation tracks are aligned with the motor phases. The drive applies sinusoidal voltages to the three-phase input to rotate the motor shaft to a starting position. Typically, there will be four poles in a full rotation of the shaft. In Centroid software, the index pulse can be aligned with any one of these.

The drive also looks at the commutation lines from the encoder to give it a coarse position of the shaft for smooth movement on power up. These commutation signals are interpreted by the drive as zones 1 through 6. As the motor turns clockwise looking at the output shaft the encoder counts should increase. Centroid AC motors use a differential, 8 pole, 5V, quadrature encoder with an index pulse. The encoder resolution depends on the motor and the drive (see below).

This procedure can also be repeated if you suspect the encoder alignment is incorrect. An incorrect alignment will show the following symptoms:

1. Axis is jumping.
2. Motor is running roughly.
3. Motor runs better in one direction than the other.
4. Motor has an uneven amount of current draw in one direction than the other.
5. Large current draw with a light load.

Prerequisites

- If connecting a motor to a drive for the first time, please completed the following steps:
  - Check for >100 MΩ between the motor chassis and power terminals.
  - With the motor connected to drive, confirm continuity between the drive chassis and motor chassis.
  - On the drive terminal, check for >100 MΩ between your power and shield terminals.
  - Check VM wiring for correct polarity
  - Additional information on motor testing can be found in your installation manual and Technical Bulletin 155.

Tools and Equipment for Encoder Alignment

- A set of metric and SAE hex keys.
- A small Philips head screw driver set.
- Loctite Blue 242 (Optional)
- If removing the motor from the machine, a set of clamps such as Irwin Quick Grips.
- If there is any contamination or debris inside the end cap, basic cleaning supplies such as a paper towel and all-purpose cleaner.
  - If there is not have a rubber O-ring or gasket between the end cap and motor, a non-corrosive RTV sealant (such as Dow Corning 3165) is needed.
- If changing the encoder, you will need a Quantum Devices QR12-10000-8-A-B-E-A-A. This is a 10,000 line, 8 pole, 5V, 8mm shaft encoder. Encoder pigtail pinouts are listed in Appendix B.

Alignment Setup

The motor must be disconnected from the machine or have the machine drive belt removed for the alignment process. This procedure is best performed on a sturdy bench where you have good lighting and easy access to the encoder. If the motor is removed from the machine, the motor frame must be firmly secured to the bench using clamps or some other attachment method. The motor may try to jump around during the procedure (especially if something goes wrong during the alignment). Before starting the alignment procedure, the drive software must be configured correctly.

Alignment Procedure

DANGER: Do not jog the axis until instructed!

1. Remove the motor end cap.

    1. **NOTICE:** Any dust, dirt, coolant, or other contamination inside the motor end cap can get inside the sensitive internal components of the optical encoder and cause a premature failure. Make sure the inside of the motor end cap and encoder mounting plate are clean before continuing with encoder alignment.

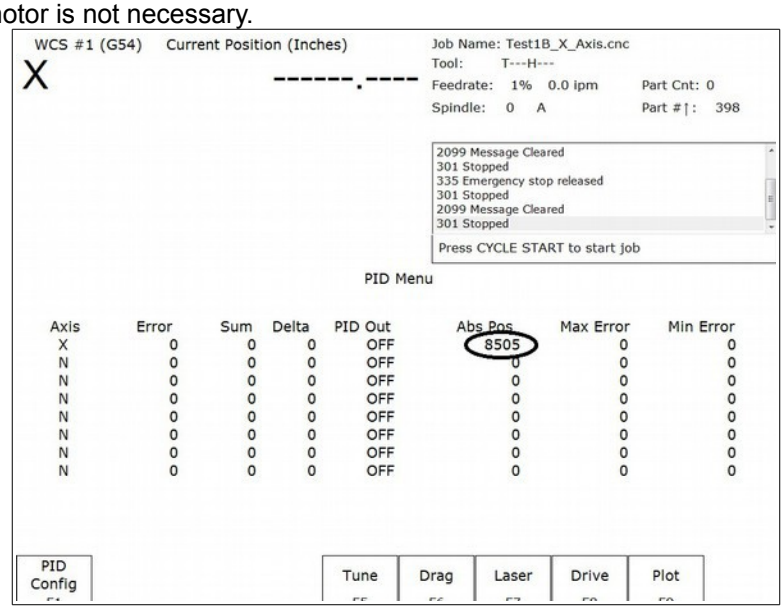
        If there is a large amount of contamination inside the end cap, there is a high probability that the existing encoder will work unreliably and need to be replaced. If there is liquid inside the end cap, there may also be liquid inside the motor. A motor with liquid inside is a serious safety hazard, and will have to be replaced.

2. If installing a new encoder, remove the old encoder. Attach the new encoder. Loosely tighten the encoder ears and encoder set screws so the encoder spins when the shaft moves.

3. Connect power cable and encoder cable from the drive to the motor.

4. Power up your drive and control system running Centroid CNC software

5. In your CNC software, access the PID menu by pressing **F1-Setup**, **F3-Config**, **F4-PID** as shown below in Figure 1. Homing the motor is not necessary.



6. Looking at the motor mounting flange, manually rotate the motor shaft clockwise. The “absolute position” on the PID screen should increase as circled in the picture above. If the position does not increase check the drive communication, encoder cable, and encoder pigtail.

1. **NOTICE:** The AC/DC servo drive needs the encoder correctly connected/wired **before** starting up the CNC11 software or drive. If the encoder is not detected upon start up, you will need to restart both the AC/DC drive and the CNC11 software before trying to test the encoder again. Users can troubleshoot drive errors through the HSC bit screen definitions as described in the AC/DC servo drive manual.

7. Go to the drive configuration menu by pressing **F8-Drive** as shown below in Figure 2.

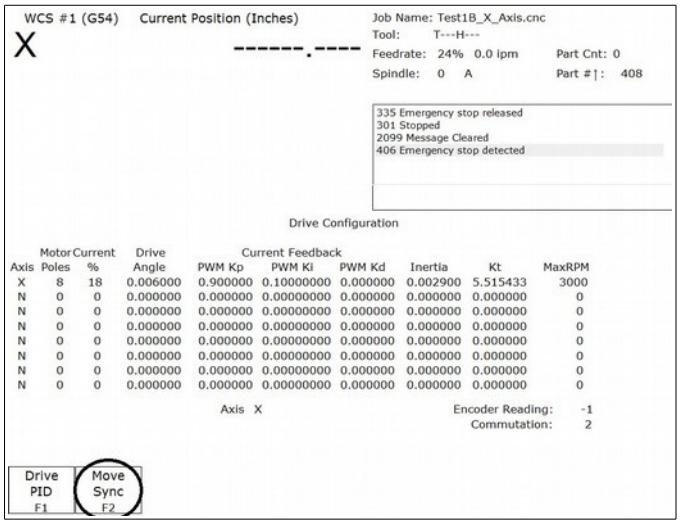


Figure 2. Drive Configuration Menu

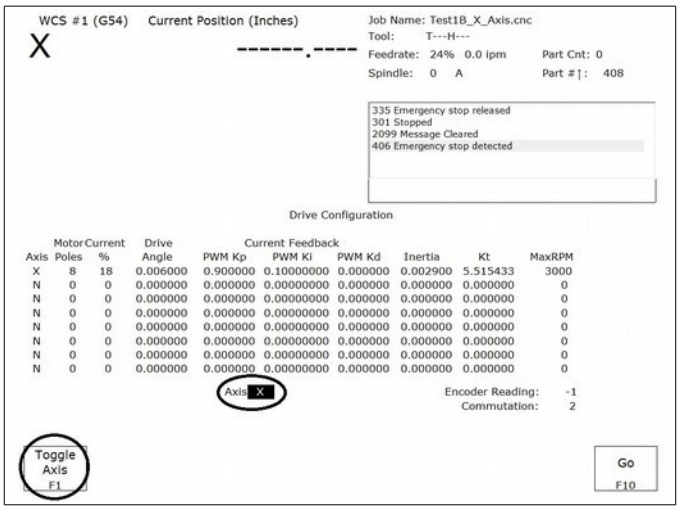


Figure 3. Move Sync

8. Press **F2-Move Sync** as circled in Figure 2**.** The axis selected is shown underneath PWM Kp as circled in Figure 3. If you are not on the correct axis, press **F1-Toggle Axis** until the correct axis label is on the screen. Finally press **F10-GO**. The shaft should rotate. The first move sync rotation may cause the motor to jerk or move roughly. Move sync a few more times by pressing **F2-Move Sync** then **F10-GO** repeatedly. All move syncs after the first sync should cause the shaft to rotate smoothly. **If the motor oscillates wildly, moves erratically, or makes loud unusual noises, kill the motor power immediately!**

1. **DANGER:** An incorrectly wired or configured motor may move violently or unpredictably when attempting move sync. Keep your body (and others) away from the motor when move syncing for the first time, and be prepared to hit the emergency stop.

2. **DANGER:** Large motors may have a tendency to oscillate violently during a move sync due to nature of the current feedback loop. It is recommended for 3KW and larger motors that you adjust the motor current to half of the recommended value in the current feedback menu while move syncing. After the encoder alignment process is complete, set the current back to the recommended setting.

3. **NOTICE:** If the motor slightly oscillates after move syncing or continues to move a little rough while move syncing, grab the motor on the shaft carefully with your hand. Move sync the motor while gently squeezing the motor shaft. If the oscillations and/or jerky movements go away after applying a small amount of load to the shaft, this is normal. This problem will not occur during normal motor operation.

4. **NOTICE:** If no motor movement occurs, an error was encountered. AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in the AC/DC manual.

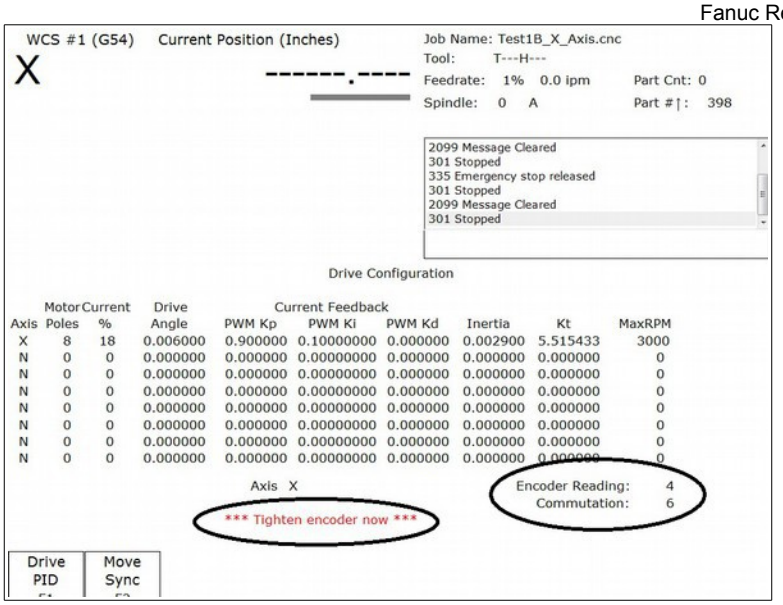


Figure 4. Encoder Alignment

Figure 5. Encoder Collar Set Screws

9. Keep running the move sync operation until the point where the encoder reading is closest to 0 or its maximum encoder count. The “Encoder Reading” is circled in Figure 4.

10. Loosen the encoder collar set screws as shown in Figure 5.

11. Move the encoder until the encoder reading is as close to zero as reasonably possible.

12. Tighten the encoder collar set screws. The encoder collar usually has two set screws on most encoders; make sure both are tight if applicable.

13. Loosen up the encoder ears and use them to fine tune the adjustment. When the encoder is within specifications, a red message will appear on the control saying “*** **Tighten Encoder Now** ***” as circled in Figure 4. For a 40,000 count encoder, it needs to be aligned with +/- 25 counts of zero. Tighten the encoder ears. The encoder mounting plate is usually made out of aluminum, so **DO NOT OVERTIGHTEN!** If the screws do not fit tightly in the encoder mounting plate, Loctite blue (242) or similar may be used.

14. Press **F2-Move Sync** and **F10 - Go** to rotate the motor shaft several full revolutions. Verify that the software still displays “*** Tighten Encoder Now ***” when closest to the zero position. Some encoder re-adjustment may be needed. Observe the commutation count goes 1 through 6 consecutively. The commutation count is displayed below encoder reading as circled in Figure 4. At rest position the commutation zone should be either a 1 or a 6 only. A 0 or a 7 as the commutation value indicates a bad encoder or wiring problem.

15. Loosely tighten the end cap onto the motor. Be careful placing the encoder cable in the end cap. If the cable is causing any strain or pushing on the encoder, it will twist the encoder out of alignment.

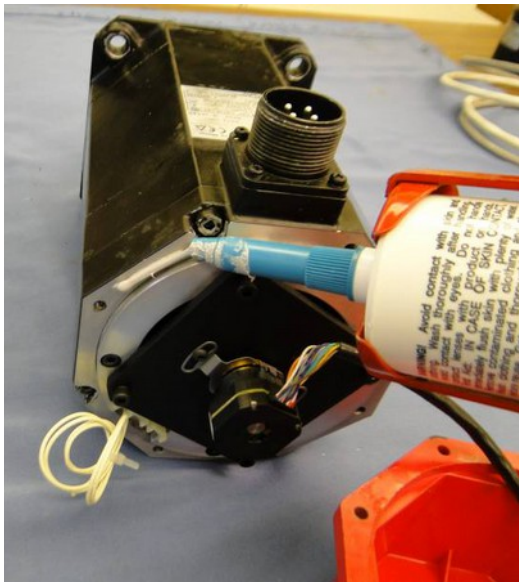
16. Reboot the drive and control system.

17. After a reboot, fast jog the motor in each direction to verify correct operation.

18. In the drive configuration menu, do a final move-sync check to verify that the motor is still aligned correctly. Look for the red message saying "*** **Tighten Encoder Now** ***" when the motor is closest to zero.

19. If there is not a rubber O-ring or gasket between the motor and the end cap, remove the end cap again. Apply a bead of non-corrosive RTV sealant (such as Dow Corning 3165) onto the end cap mounting surface as shown below. Reinstall the end cap.

20. **The motor is ready for normal operation after the system has been rebooted again.**



You are done aligning the encoder!

Continue to Calculating and Testing Maximum Feed Rate on the next page.

Calculating and Testing Maximum Feed Rate

In past Centroid products the maximum feed rate and acceleration was determined by autotune. At the time of this writing, the AC/DC does not support auto tune. Maximum feed rate will have to be manually calculated. To perform this calculation you will need to know the motor revolutions per inch as described in **Tech Bulletin # 036**, "**Measuring Revs. Per Inch**".

Use the following equation: **(maximum motor rpm / motor revolutions per inch) * 0.85 = maximum feed rate**.

Enter the maximum feed rate in the Jog Parameters menu (**F1 - Setup**, **F3 - Config**, **F2 – Mach.**, and then **F1-Jog**.). Upon saving your jog parameters a message will appear that says "*The # axis accel time should be changed to #.#### in the PID menu*". Write this number down, it will be used later. This number is **not** an ideal acceleration rate, but how much the current acceleration rate needs to change to keep machine performance the same.

Use MDI commands to test the calculated machine maximum feed rate. If the machine is displaying the following symptoms the calculated feed rate is too fast and should be decreased:

- The load bar graph in the DRO display of the main menu is red, indicating excessive load on the motors
- The software is giving errors such as position errors.

Deadstart

Deadstart located in the jog parameters menu has to do with direction reversal of an axis. The deadstart usually never has to be changed from the default value on a Milling machine. Sometimes very light wood routing tables with very low resistance and low inertia can benefit with a deadstart change along with other "hand tuning." Call in if you have this case.

Backlash

Set backlash compensation using the procedure described in **Tech Bullion #037**, "**Measuring Backlash**".

A Basic Introduction to Tuning and PID

AC/DC uses a PID loop to control motor movement. PID stands for **Proportional**, **Integral**, and **Derivative**. A PID controller calculates an "error" value as the difference between a measured process variable (motor velocity) and a desired set point (expected motor velocity). The controller attempts to minimize the error by adjusting the power to the motor. The PID controller's calculation algorithm involves three separate parameters: the proportional, the integral and derivative values, denoted in the software as Kp, Ki, and Kd. Additionally, the motors inertia constant plays a large value in how the PID loop behaves.

The general idea of the tuning process is to minimize the Absolute Error (ErrAbs), which is measured in encoder counts. The inertia of the motor varies from machine to machine, and the ideal PID values vary from motor to motor. To achieve optimal performance out of your Fanuc motor, the inertia, position Kp, and position Kd values will have to be manually adjusted. Under most circumstances, the position Ki values usually do not need any adjustment. The current feedback Kp, Ki, and Kd (different from the position feedback Kp, Ki and Kd) should be left alone unless otherwise instructed.

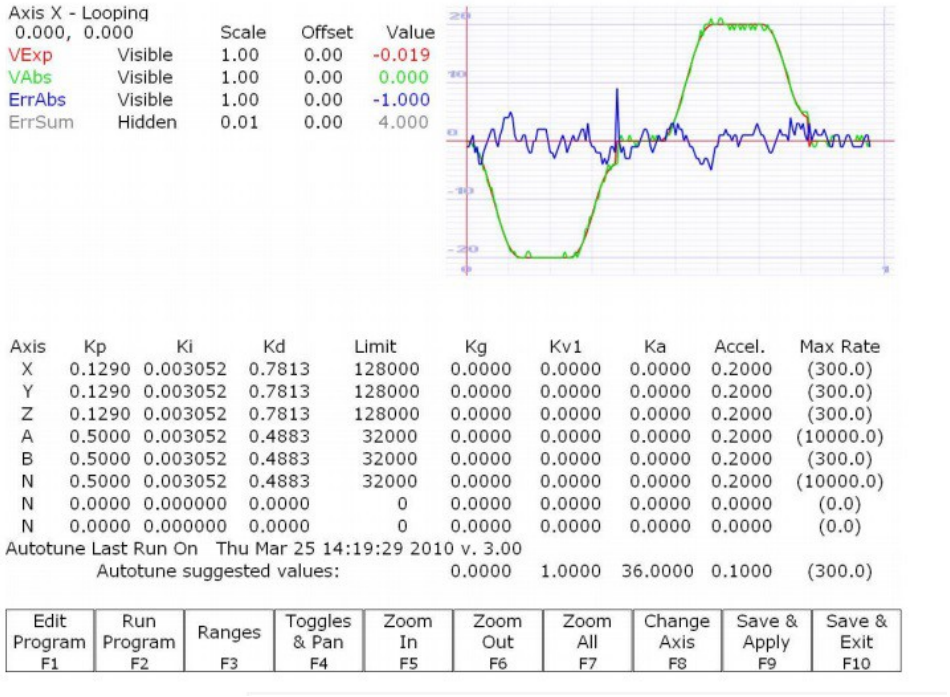
Altering the PID values incorrectly could cause **DRAMATIC** changes in the way the servo system operates, leading to possible machine damage. Be cautious when adjusting the PID values, and be prepared to hit the E-stop as the motor may become unstable or move unpredictably if adjusted incorrectly.

Finally, PID tuning is not a black and white process. What is "good enough" of a value will depend on your accuracy needs and the capabilities of your system. Some experimentation is always required to find the ideal settings.

Tuning Software Setup

Tuning should be done last once everything else is set up and the motor is connected to the machine. Before tuning, configure the software (and align the encoder if necessary) as discussed in the earlier sections of this manual.

First, home the motor. Go to the PID configuration menu by pressing **F1 - Setup**, **F3 - Config**, **F4 – PID**, and then **F1 – PID Config** from the main menu (as shown below). Press **F1-Edit Program** to bring up *PID_Collection_Moves.txt* in the default .txt editor. Edit the G-code so that the motor axis matches the axis of the motor to be tuned. For example, changing the line "*G1 w0.0*" to "*G1 x0.0*" will change the program to modify the X-axis instead of the W-axis. Now you should be looking at the PID configuration menu.



The colors of the text on the top left match the colors of the graphs on the right. For example, if you have a V abs value written in blue in the top left, the graph for V abs will be displayed on blue in the top right. For the rest of the tuning procedure when referring to motor velocity, we are referring to the **V Abs** value and the corresponding graph. When referring to position error, we are referring to the **Err Abs** value and the corresponding graph

The graph can be manipulated with a mouse by clicking, dragging, and scrolling. The graph can be manipulated with the keyboard by using the F3, F4, F5, F6, and F7 keys. This menu and these settings are covered in more detail in the CNC11 manual. Pressing **F8 – Change Axis** will toggle the axis being graphed and will change the error information displayed in the top left of the screen. If necessary, press F8 until the selected axis matches the motor to be tuned.

Press **F2-Run Program** to start the tuning process. The motor should run in a continuous loop and not stop until manually stopped the motor or the values are adjust with the keyboard. If "***finished running program***" is immediately displayed, an error was encountered. Go back to the main menu, and check the message window for errors. Advanced AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in the AC/DC manual.

Note: When viewing the live tuning scope (graphs) be mindful of the scale. You can adjust the scale of the graphic. The encoder counts and the overall turns ratio of the machine will determine the counts per inch. Adjust the scale of the graph to a resonable encoder count amount for the given encoder counts per inch of that axis. In other words on a high count per inch system you may have errors as high as 100 counts, but 100 counts would only be representing .00005" on the machine.

Acceleration Tuning

Accel is the time for the axis to reach maximum velocity. An accel rate of 0.1 second is very fast, where an accel rate of 1.0 will be considered very slow.

Record the acceleration rate suggested by the software when the maximum feed rate was saved in the jog parameters menu. Entered this acceleration rate into the position PID menu (*Press **F1 - Setup**, **F3 - Config**, **F4 – PID,** and then **F1 – PID Config**.)* The rate provided is not the ideal acceleration rate, but a baseline number.

Press **F1-Edit Program**; adjust **PID_Collection_Moves.txt** so that it runs at the maximum feed rate. Save changes. **Press F2-Run Program**. Slowly decrease the acceleration time in 0.05 increments, testing the value in-between each change. If you see any of the following symptoms the acceleration rate is too fast and needs to be slowed down:

- The acceleration rate is causing shock or vibration as the machine moves.
- The machine movement becomes bumpy, rough, or jerky.
- The machine creates unusual or loud noises such as thunks or rapping noises.
- The software is giving errors such as position errors.

Inertia Tuning

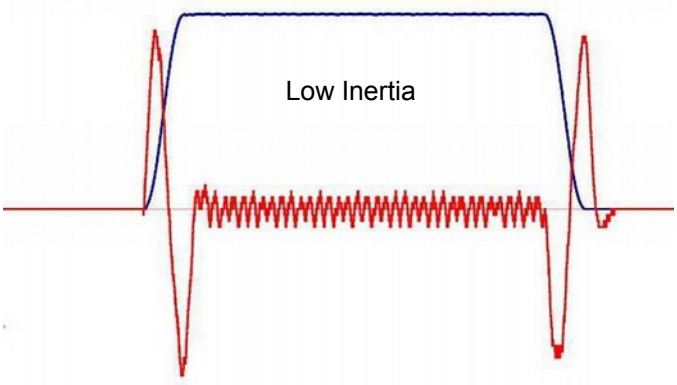
For Inertia, Kp, Ki, and Kd tuning adjust the feed rate in *PID_Collection_Moves.txt* to the average rate during a typical machine operation.

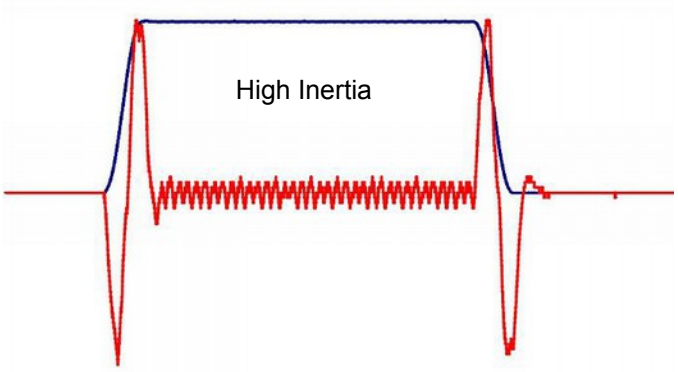
The parameters in this menu, with the exception of inertia, do not change based on machine type, and can therefore be set once from the provided charts. Inertia is set to the motor inertia as a starting point. Once the motor is mounted to a machine, the inertia value will need to be increased to compensate for the additional inertia of the mechanical drive components.

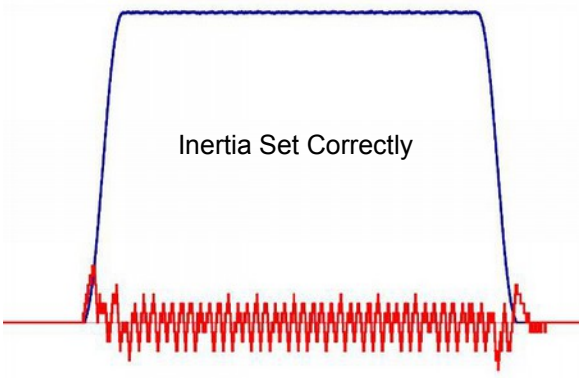
Inertia is adjusted in the drive configuration menu. From the PID configuration menu press **F10 – Save and exit**, **F8 – Drive**, and then **F1 – PID**. Throughout the tuning process make changes in the Drive configuration menu, and then go back to the PID configuration menu and run the collection moves program to see how those changes affect the graph. Repeat this process until results are acceptable.

The following plots demonstrate the effect of the inertia setting. The dark blue line is the motor velocity (V abs) and the red line is position error (Err Abs). In the first example, inertia is set to the motor inertia, but a load has been added, so the setting is too low. The error plot shows that the motor is behind the expected position on acceleration. In the second example, the inertia value has been increased too much. The motor moves ahead of its expected position during acceleration. In the third example, inertia has been set to a reasonably accurate value. The motor follows closely at the beginning of the move.

It is best practice to focus on the error around the rising edge of the motor velocity graph. Start adjusting the inertia in increments of 0.05 at a time, later switching to smaller increments as you approach your final value. Your graph will look slightly different than the graphs displayed below due to factors such as motor velocity, encoder count, other PID values being off, etc. The final inertia value should fall in the range of 0.5 to 0.005.





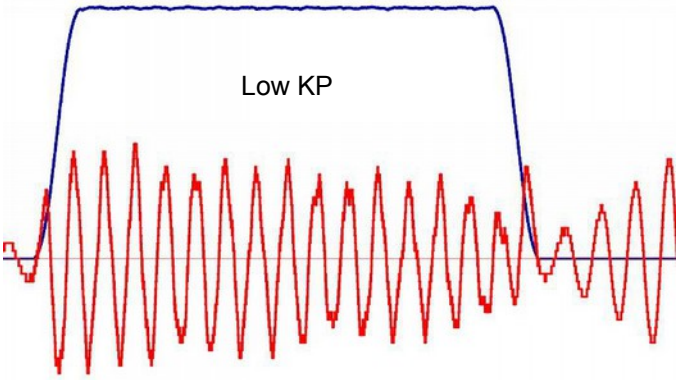


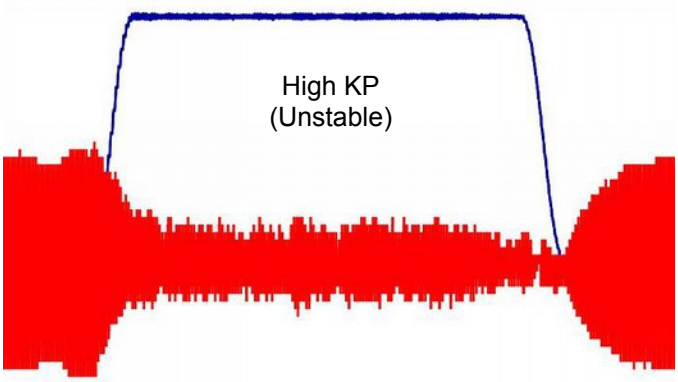
KP Tuning

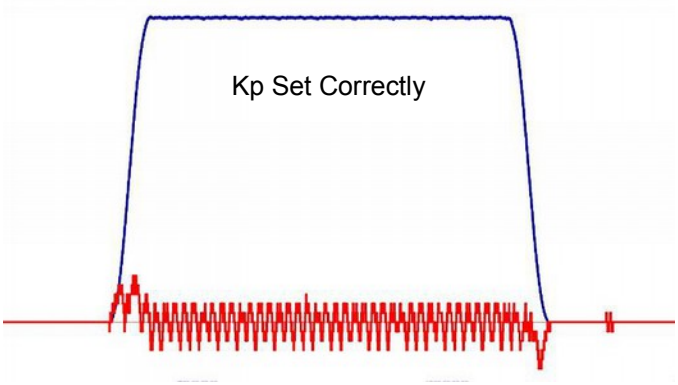
The PID Config menu (F1 **- Setup**, **F3 - Config**, **F4 – PID**, then **F1 – PID Config)** is used to tune the remainder of the motor control parameters. To adjust either type in a new value, or use the “Page Up” and “Page Down” keys of your keyboard to increment or decrement the existing value. Increase Kp until some oscillation is heard or seen on the PID tuning graph. Reduce the setting below the oscillation point to give some headroom for stability.

The following examples show the effect of Kp. The dark blue line is the motor velocity (V abs) and the red line is position error (Err Abs). In the first example, Kp is set too low. Large error peaks show where the motor is not following the requested path. Increasing Kp leads to the second example, where error is low throughout the move. However, there is an increasing oscillation in the error plot, indicating that the motor will soon become unstable. The third example demonstrates a Kp reduction to improve stability. The error plot has nearly minimal error achieved during tuning and does not have signs of instability.

Start adjusting the Kp in increments of 1.0 at a time, later switching to smaller increments as you approach your final value. Your graph will look slightly different than the graphs displayed below due to factors such as motor velocity, encoder count, motor performance, etc. The final Kp value should fall in the range of 1 to 12.





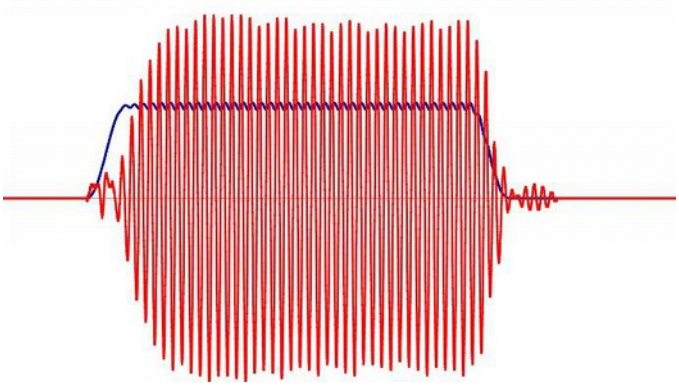


KD Tuning

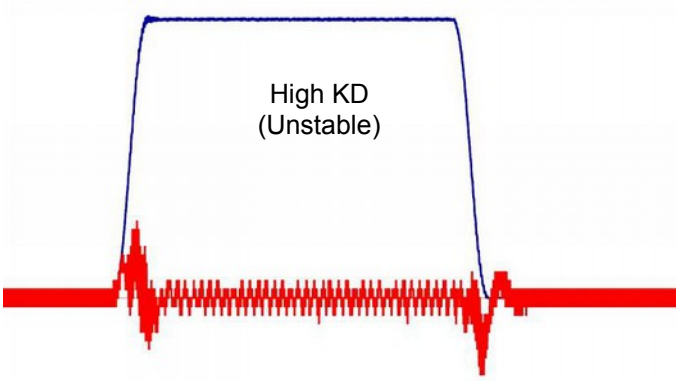
After Kp has been adjusted, continue to tuning Kd. The Kd term adds stability to the effects of Kp. If Kp or Kd have been adjusted far from the default values, a second iteration of the tuning procedure is recommended. Because the two terms are dependent on each other, a better Kd setting may allow Kp to be adjusted for higher performance.

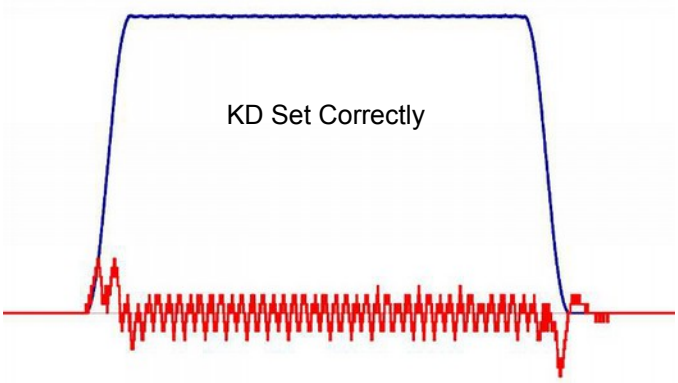
Incorrect Kd settings create oscillations. A low Kd setting creates low frequency oscillations. As Kd is increased, a high frequency oscillation will become noticeable. Often the high frequency oscillation will be audible before it is noticeable on the error plot. The example shows an extreme case of oscillation due to Kd set too high. When Kd is set properly, it will dampen the Kp contribution, giving a smooth error plot.

Start adjusting the Kd in increments of 1.0 at a time, later switching to smaller increments as you approach your final value. Your graph will look different slightly than the graphs displayed below due to factors such as motor velocity, encoder count, motor performance, etc. The final Kd value should fall in the range of 1 to 15.



Low KD



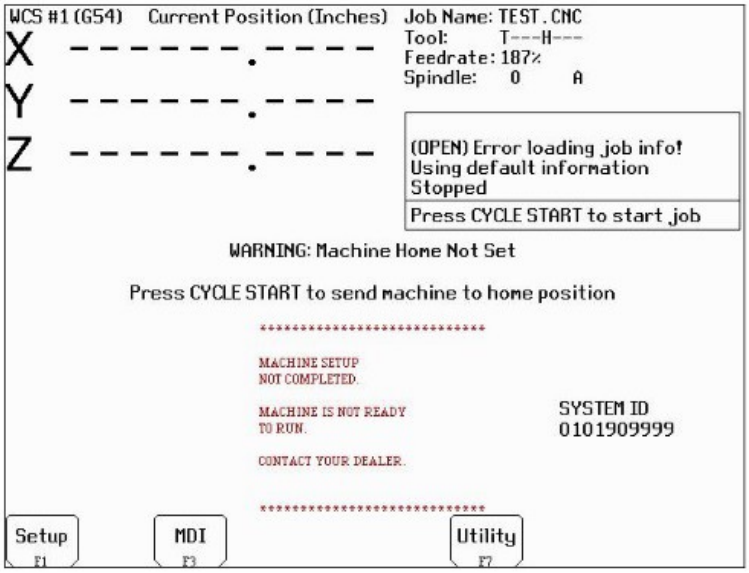


Other Misc Tuning Information

Kg, Kv, and Ka in the PID position menu are not used and do not need adjusted. Ki does not need to be adjusted under most circumstances. After tuning the other values of the PID loop, experimentation with Ki values may sometimes help to reduce error. Adjust Ki in increments of 0.005, with the final value falling in the range of 0.005 to 0.05.

Performing a System Test

When finished, the main menu will display a message saying *"**Machine Setup Not Completed. Machine Is Not Ready To Run. Contact Your Dealer**"* as shown below. At this point you will need to run the **System Test** to clear this message. Documentation on how to perform a system test is located on the Ajax website.



Machine Requiring a System Test

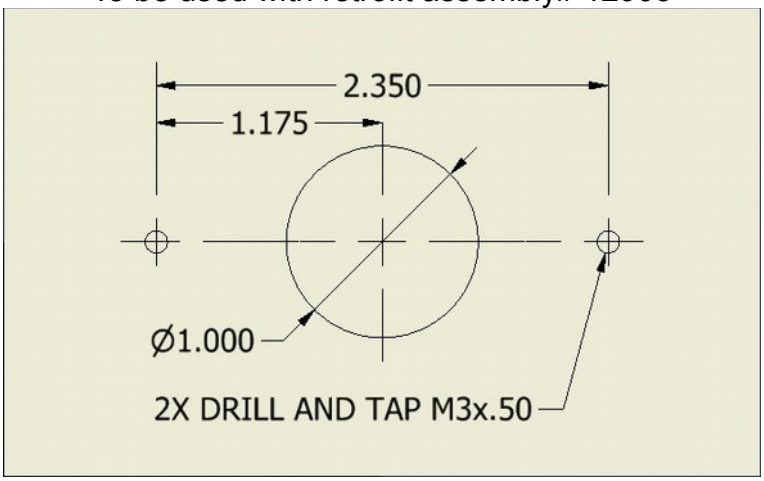
You are done retrofitting your Fanuc motor!

Save all your tuning settings. It is best practice make a "back up" of your CNC11 settings by generating a report as described in the CNC11 manual.

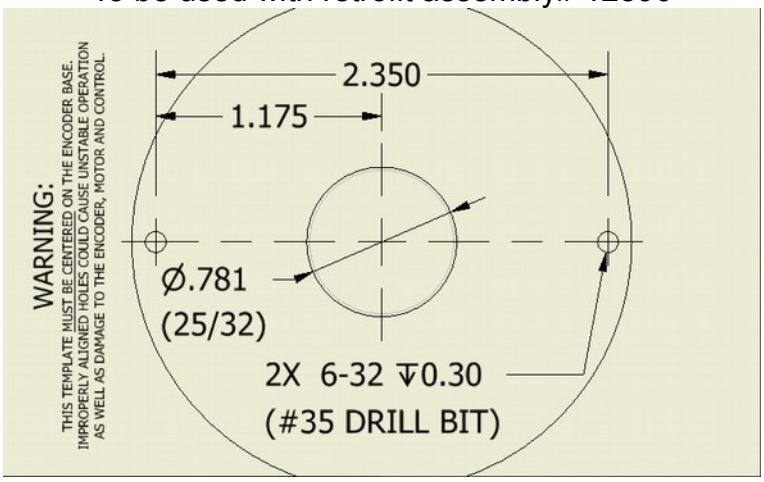
Appendix A – Hole Location Templates and Drawings

If printed correctly, the labels should measure 100mm long by 62mm tall.

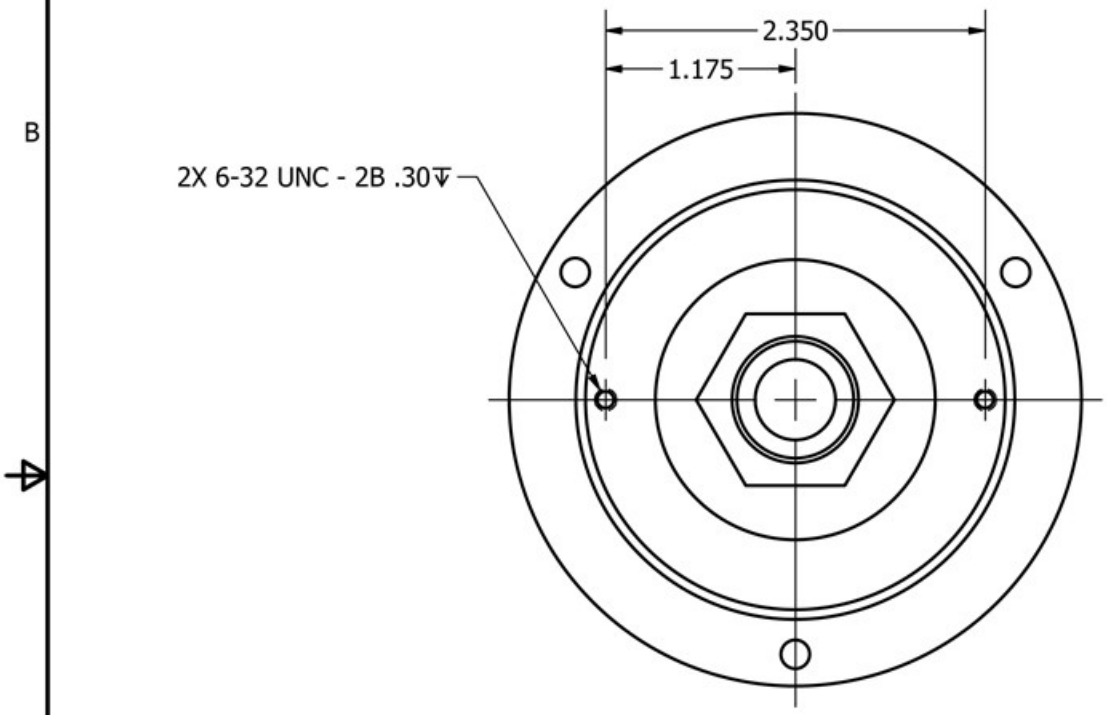
To be used with retrofit assembly# 12903

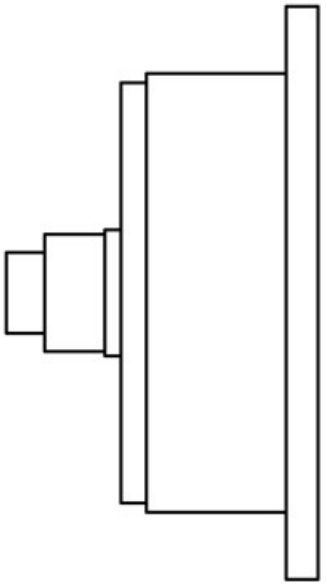


To be used with retrofit assembly# 12896



DWG #:	REV:
D00327	A





NOTES:
1. THIS DRAWING TO BE USED WITH CENTROID RETROFIT KIT# 12896
2. HOLES TO BE DRILLED WITH #35 (7/64) BIT AND THREADED WITH 6-32 TAP

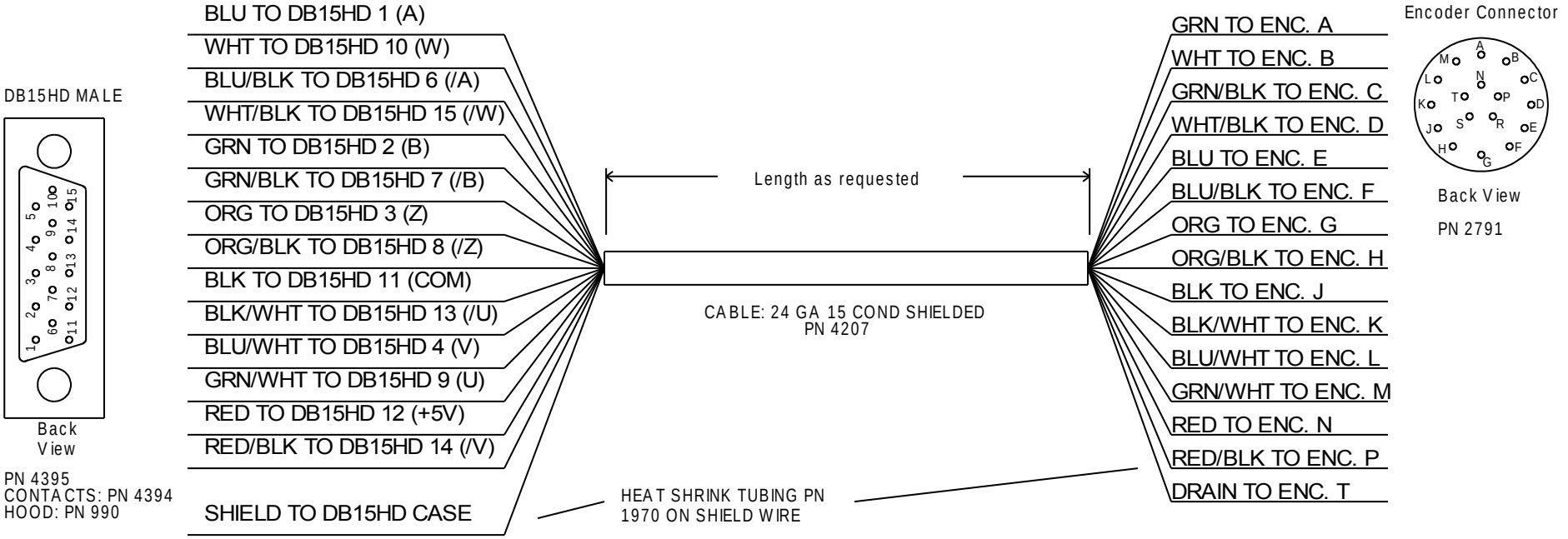
DATE DRAWN: 3.13.14

CENTROID
T:(814)353-9290 F:(814)353-9265
www.CENTROIDCNC.com

TOLERANCES			
UNLESS	X	± 0.025	0° ± 30'
OTHERWISE	XX	± 0.010	0.0° ± 3'
SPECIFIED:	XXX	± 0.005	
	XXXX	± 0.0005	

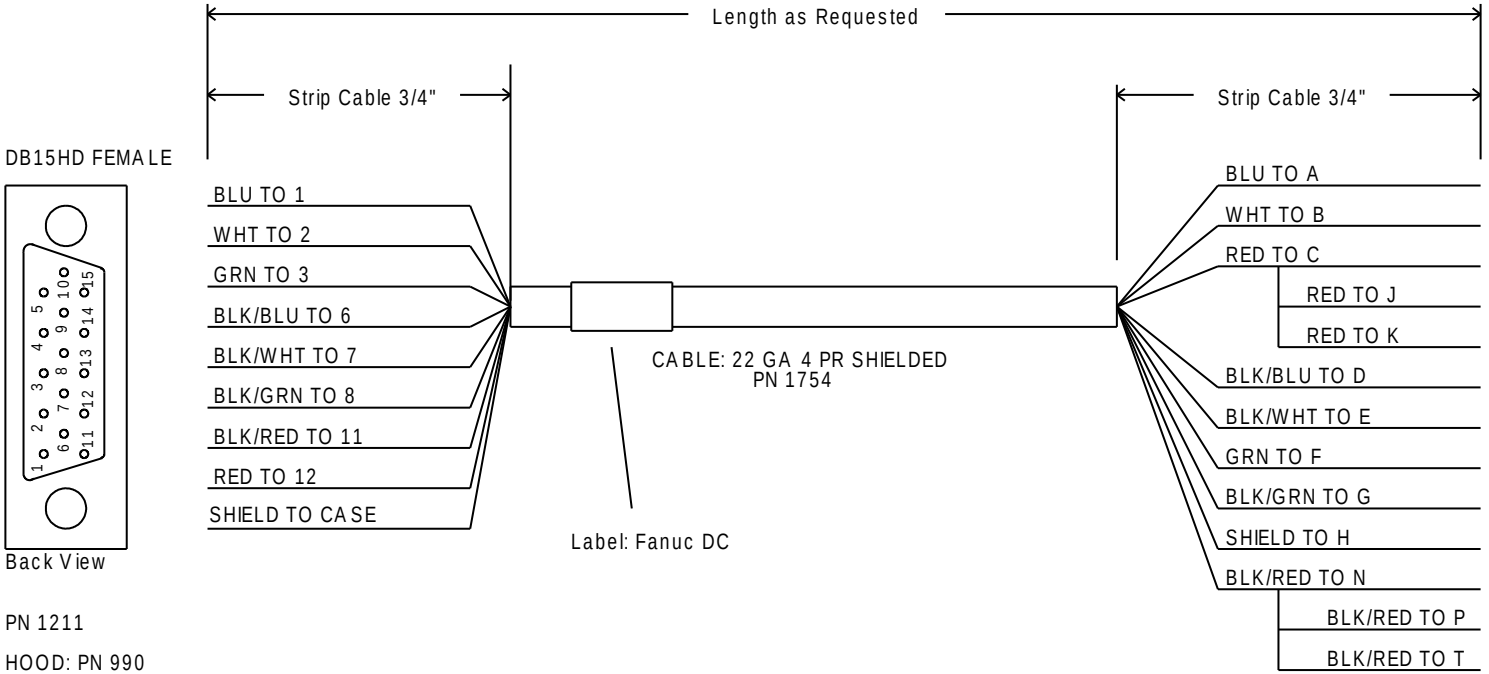
TITLE:	ENCODER MOUNTING GUIDE	DRAWN:	SZP
FINISH:	NA	APPROVED:	
MATERIAL:	NA	DWG #: D00327	REV: A
SCALE:	NTS		

Appendix B – Wiring Diagrams and Pinouts

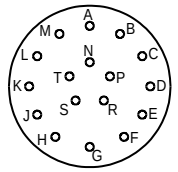


ACDC encoder cable for AC motors or Fanuc DC motors w ith Centroid encoder upgrade.

Sub. Assy.: 12912	DWG NO: S13369	
Title: AC/DC Standard Encoder Cable		
Size: A	Revision: 130912	
Date: Monday, September 30, 2013		Sheet 1 of 1
Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN		Auth: MRR



Encoder Connector



Back View

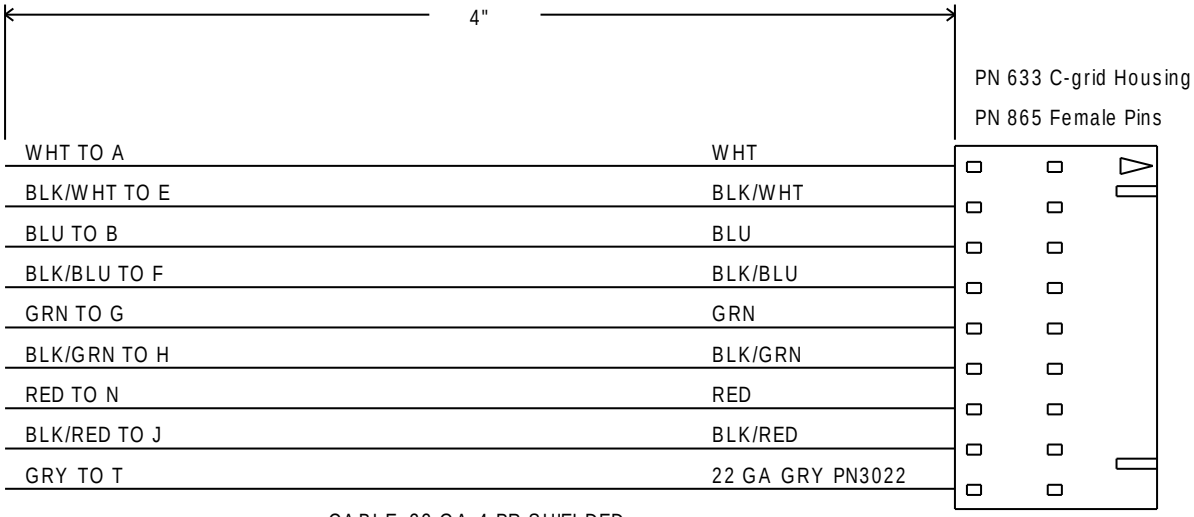
PN 2791

Pin	Signal	Color
A	A	BLU
B	B	WHT
C	+5V	RED
D	/A	BLK/BLU
E	/B	BLK/WHT
F	Z	GRN
G	/Z	BLK/GRN
H	SHIELD	
J	+5V	RED
K	+5V	RED
L		
M		
N	0V	BLK/RED
P	0V	BLK/RED
R	TEMP SW	
S	TEMP SW	
T	0V	BLK/RED

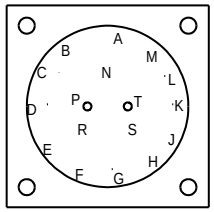
Pin	Signal	Color
12	+5VDC	RED
11	SIGNAL GROUND	BLK/RED
3	Z	GRN
8	/Z	BLK/GRN
2	A	WHT
7	/A	BLK/WHT
1	B	BLU
6	/B	BLK/BLU

For use with original Fanuc yellow or black cap encoders. Do not use if encoder has been upgraded with Centroid encoder.

Sub. Assy.: 12893	DWG NO: S13357
Title: Fanuc DC Encoder Cable	
Size: A	Revision: 130830
Date: Wednesday, September 04, 2013	Sheet 1 of 1
Filename: svn://software/hardware/Cables/MOTOR_CABLES.DSN	Auth: MRR



Encoder Connector

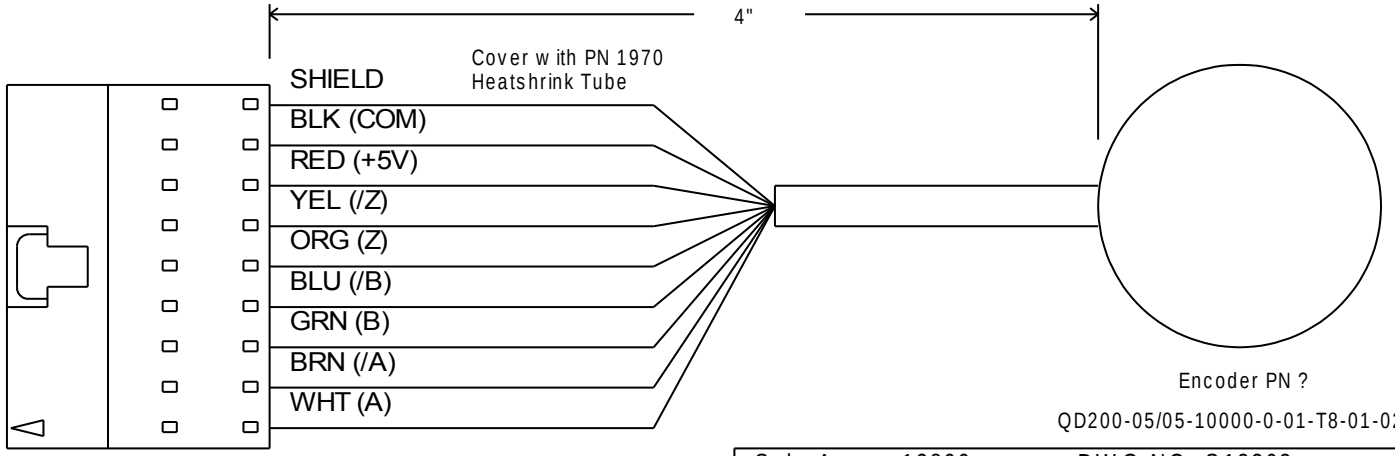


Back View

CONNECTOR: PN 5112

Fill all connector locations with pins when using the crimp style connector.

CABLE: 22 GA 4 PR SHIELDED
PN 1754
Remove shield and jacket, use wires only



PN 859 Housing

PN 2586 Pins

Pin	Signal	Encoder Color	MS Color
A	B	BLU	WHT
B	W		
C	/B	GRN	BLU
D	/W		
E	A	BRN	BLK/WHT
F	/A	WHT	BLK/BLU
G	Z	ORG	GRN
H	/Z	YEL	BLK/GRN
J	0V	BLK	BLK/RED
K	/U		
L	V		
M	U		
N	5V	RED	RED
P	/V		
R	SPARE		
S	N/C		
T	SHIELD		

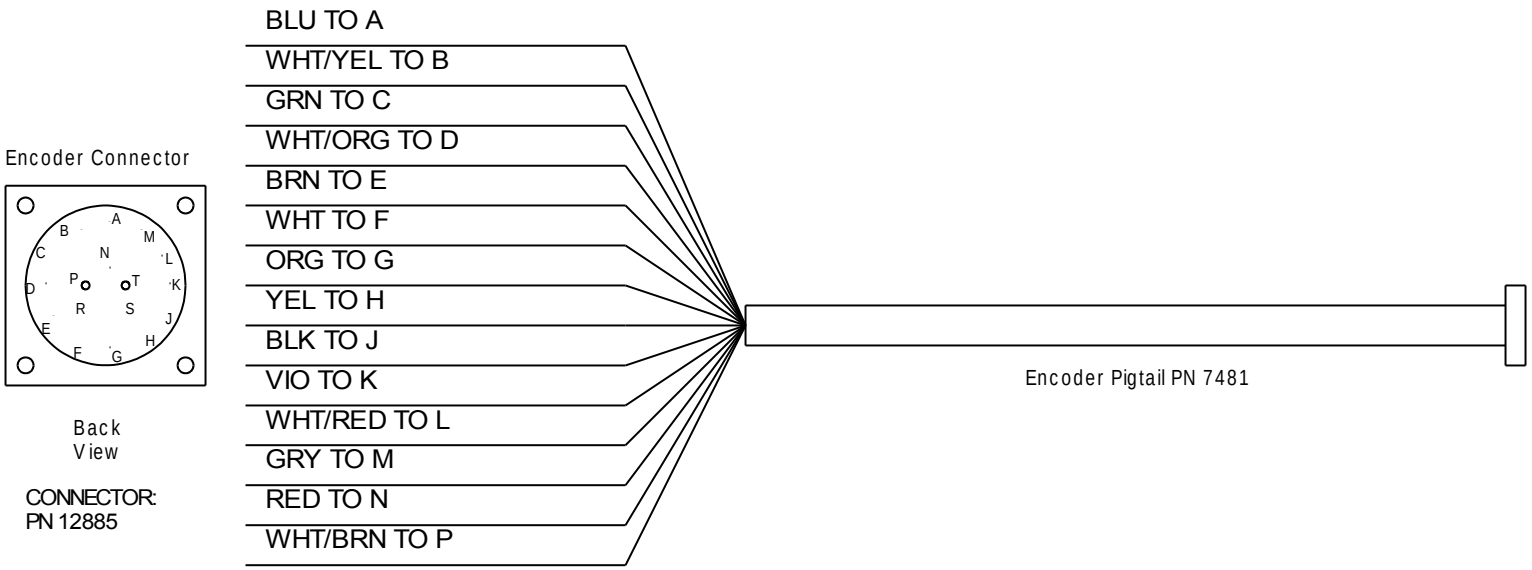
Sub. Assy.: 12890 DWG NO: S13363

Title: QD200 Wiring for Fanuc Black Cap with AC/DC

Size: A | Revision: 130905

Date: Thursday, September 05, 2013 | Sheet 1 of 1

Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN | Auth: MRR



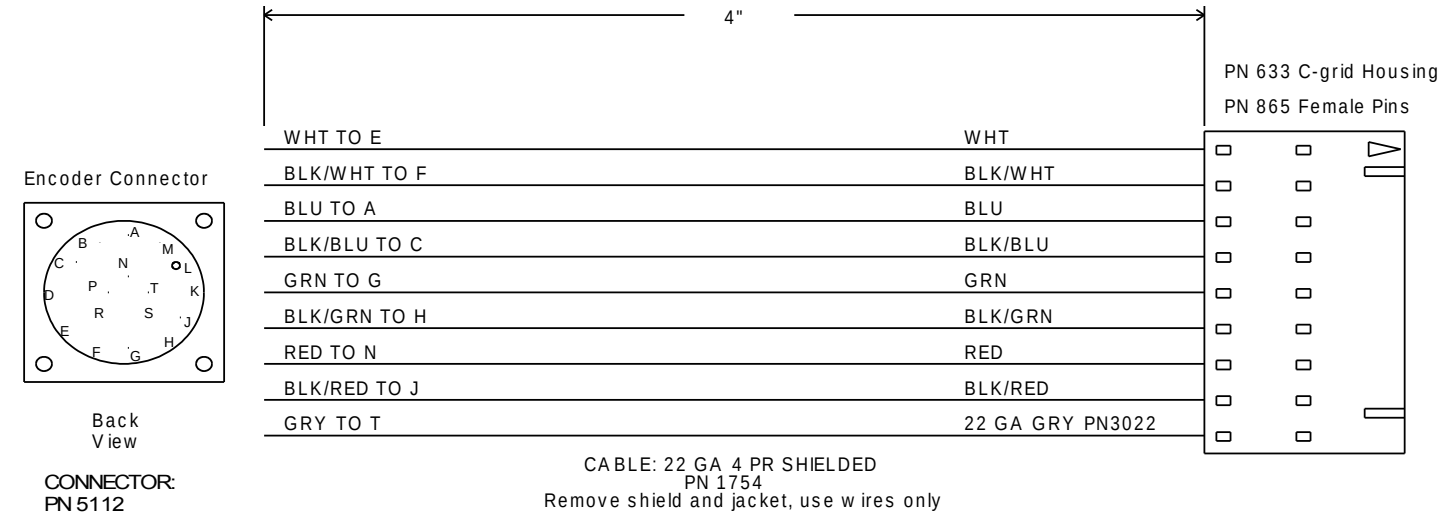
PN 12885 is PN 5112 with slotted screw holes

Fill all connector locations with pins when using the crimp style connector.

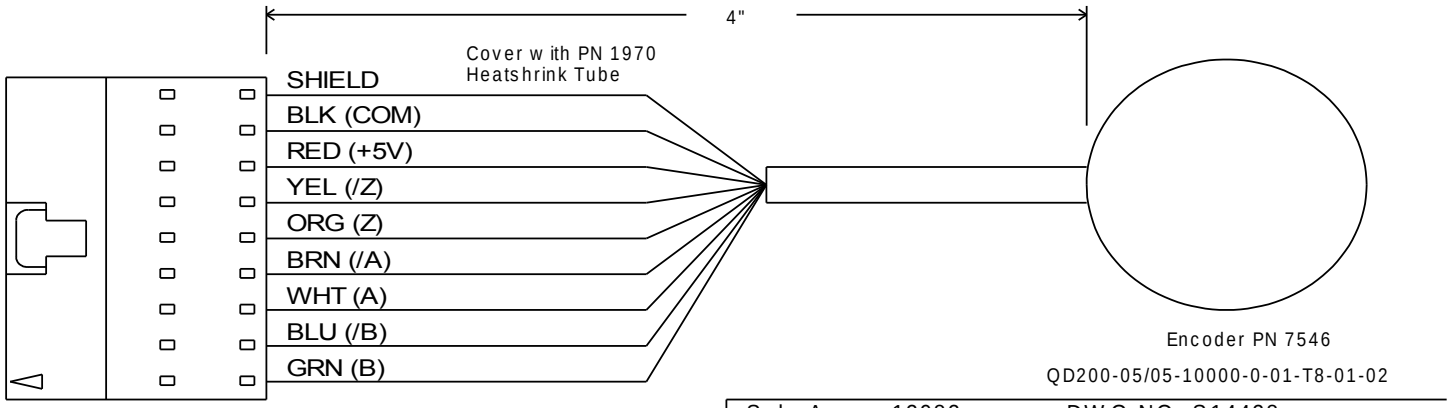
Pin	Signal	Color
A	B	BLU
B	W	WHT/YEL
C	/B	GRN
D	/W	WHT/ORG
E	A	BRN
F	/A	WHT
G	Z	ORG
H	/Z	YEL
J	0V	BLK
K	/U	VIO
L	V	WHT/RED
M	U	GRY
N	5V	RED
P	/V	WHT/BRN
R	SPARE	
S	TEMP SW	
T	TEMP SW	

Standard Centroid AC pigtail wiring with modified connector holes.

Sub. Assy.: 12892	DWG NO: S13360	
Title: QR12 Pigtail for Fanuc Gen. 1 and 2		
Size: A	Revision: 130905	
Date: Thursday, September 05, 2013	Sheet 1 of 1	
Filename: fanuc_cables.dsn	Drawn By: MRR	



Fill all connector locations w ith pins w hen using the crimp style connector.



Pin	Signal	Encoder Color	MS Color
A	B	BLU	BLU
B	W		
C	/B	GRN	BLK/BLU
D	/ W		
E	A	BRN	WHT
F	/A	WHT	BLK/WHT
G	Z	ORG	GRN
H	/Z	YEL	BLK/GRN
J	0 V	BLK	BLK/RED
K	/U		
L	V		
M	U		
N	5V	RED	RED
P	/ V		
R	SPARE		
S	N/C		
T	SHIELD	SHIELD	GRY

Sub. Assy.: 12982 DWG NO: S14428

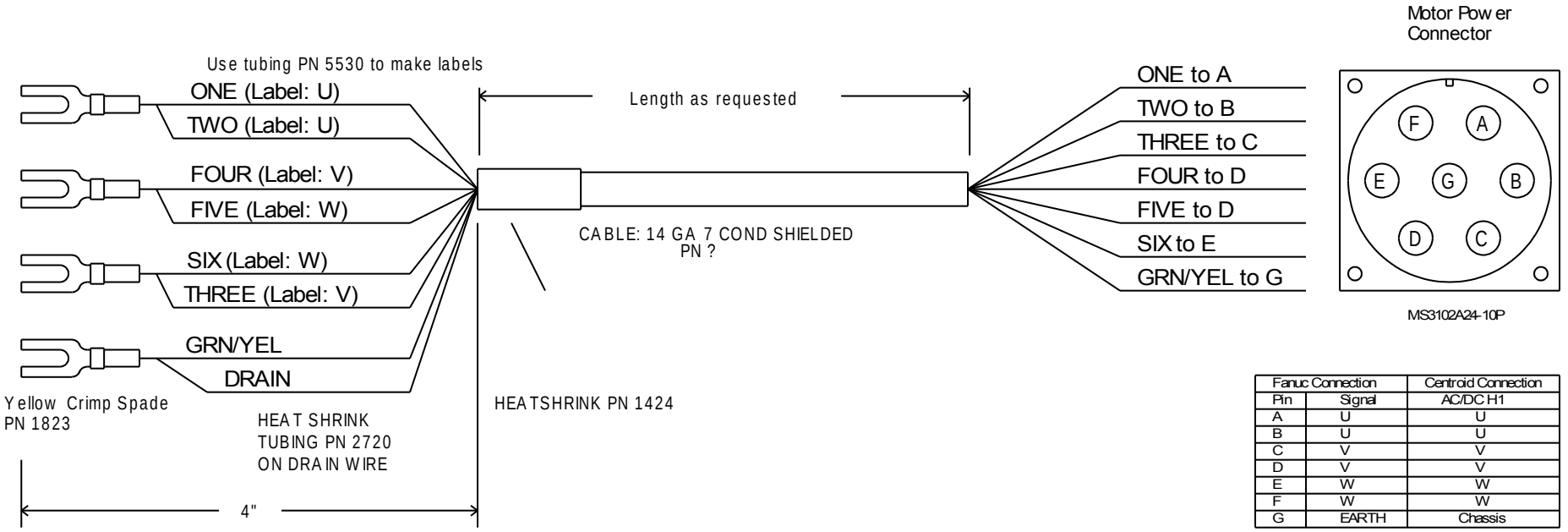
Title

QD200 Wiring for Fanuc Yellow Cap with AC/DC

Size A | Revision 140317

Date: Monday, March 17, 2014 | Sheet 1 of 1

Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN | Auth: MRR

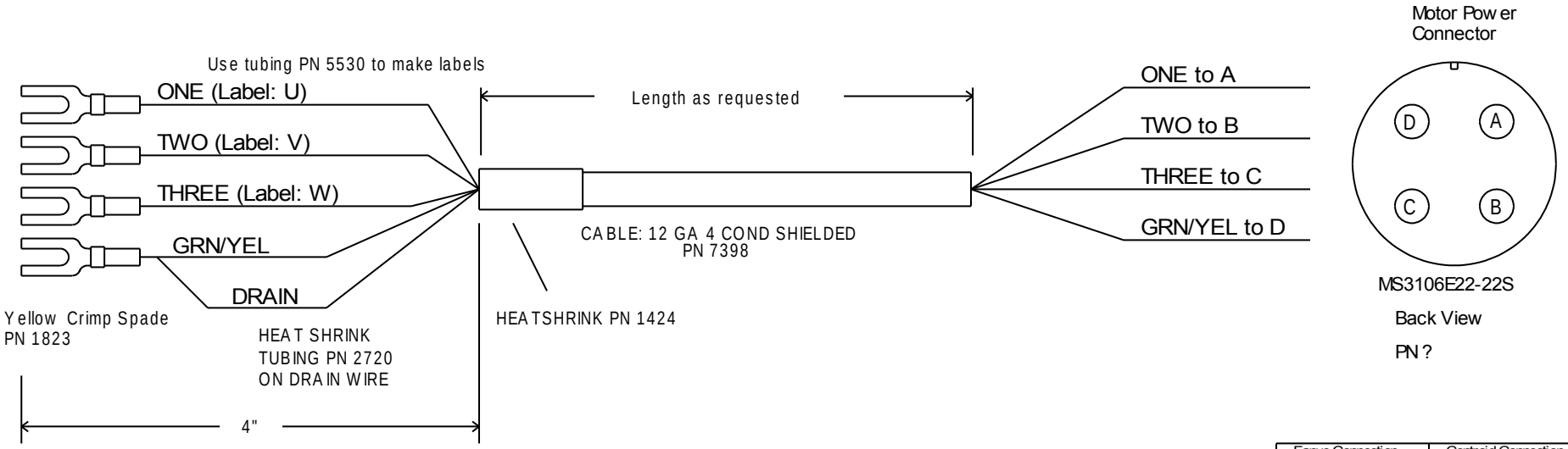


Fanuc Connection		Centroid Connection
Pin	Signal	AC/DC H1
A	U	U
B	U	U
C	V	V
D	V	V
E	W	W
F	W	W
G	EARTH	Chassis

Cable: ALPHA 65407CY or ALPHA SF61221CY OR005

Motor cable for Fanuc Red Cap 30R, Alpha 22, Alpha 30/2000, Alpha 30/3000, Alpha 40

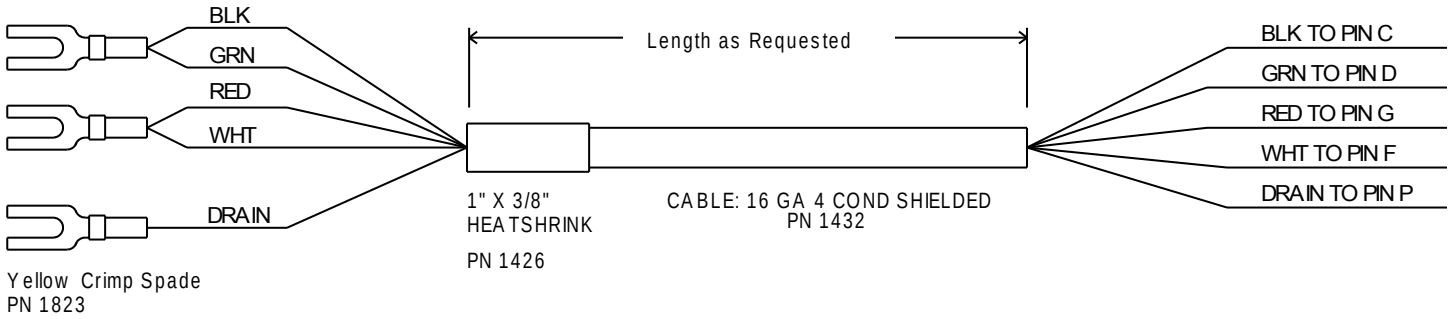
Sub. Assy.: ?	DWG NO: S13371
Title: Fanuc Extra Large AC Motor Cable	
Size: A	Revision: 130916
Date: Monday, September 16, 2013	Sheet 1 of 1
Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN	Auth: MRR



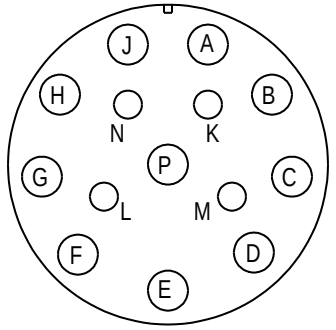
Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
A	U	U
B	V	V
C	W	W
D	EARTH	Chassis

Motor cable for Fanuc Red Cap 10, 20, 20M, 30, Beta 22is, Alpha 12, Alpha 22, Alpha 30/1200

Sub. Assy.: 12894	DWG NO: S13362
Title: Fanuc Large AC Motor Cable	
Size: A	Revision: 130830
Date: Thursday, September 12, 2013	Sheet 1 of 1
Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN	Auth: MRR



10M, 20M, 30M Motor Power Connector



MS3106E28-20S

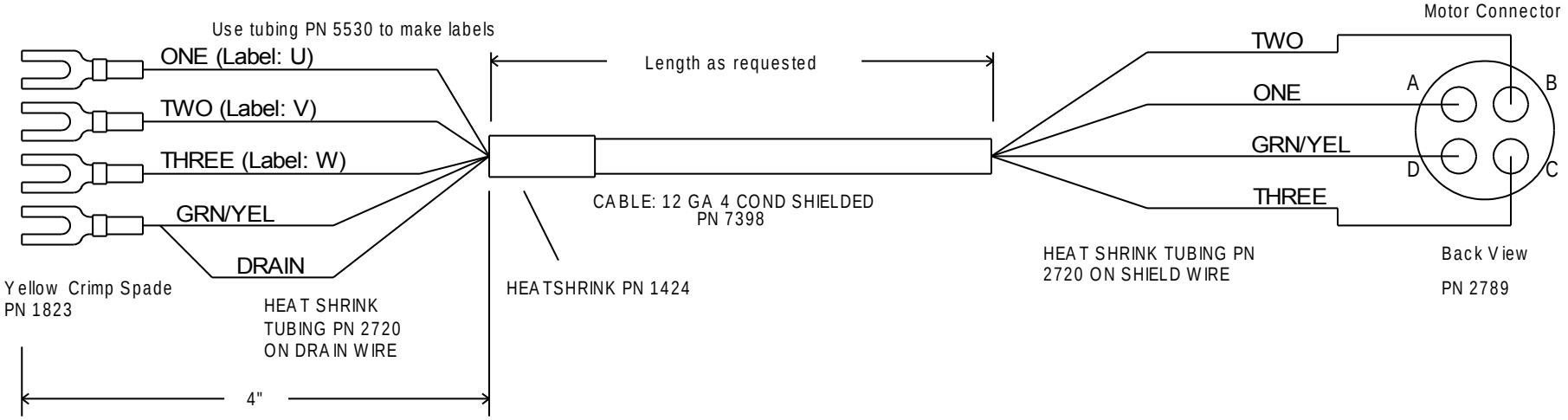
Back View

PN ?

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
C	-	V
D	-	V
G	+	W
F	+	W
P	EARTH	Chassis
K	BRAKE	
L	BRAKE	
M	FAN	
N	FAN	

Motor cable for Yellow Cap 10M, 20M, 30M and Black Cap 10, 20, 30, 10L (no brake)

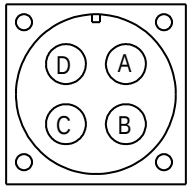
Sub. Assy.: 12895	DWG NO: S13361	
Title: Fanuc Large DC Motor Cable		
Size: A	Revision: 130903	
Date: Thursday, September 12, 2013	Sheet 1 of 1	
Filename: svn://software/hardware/Cables/FANUC_CABLES.DSN	Auth: MRR	



Motor cable for Fanuc Red Cap 0, 5, Beta 8is, Beta 12is, Alpha 3, Alpha 6, Yellow Cap 0M, 5M, Black Cap 0, 5, 0L, 5L, most Centroid AC motors

Sub. Assy.: ?	DWG NO: S13370
Title: AC/DC Medium Weight Motor Power Cable	
Size: A	Revision: 130912
Date: Thursday, September 12, 2013	Sheet 1 of 1
Filename: svn://software/hardware/Cables/MOTOR_CABLES.DSN	Auth: MRR

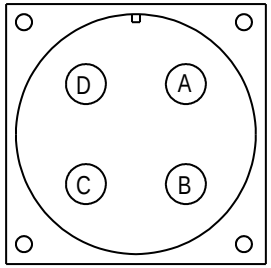
Motor Power Connector
0, 5, Beta 1, Beta 2, Beta 3, Beta 6, Beta 8is, Beta 12is, Alpha 3/3000, Alpha 6/2000, Alpha 6/3000, Alpha M6/3000, Alpha M9/3000, Alpha L6/ 3000, Alpha L9/3000, Alpha C3/2000, Alpha C6/2000, Alpha 3/ 3000HV, Alpha 6/3000HV, Alpha M6/3000HV, Alpha M9/3000HV



MS3102A18-10P

Fanuc Connection		Centroid Connection
Pin	Signal	AC/DC H1
A	U	U
B	V	V
C	W	W
D	EARTH	Chassis

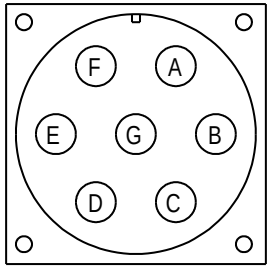
Motor Power Connector
10, 20, 20M, 20S/2000, 30, Beta 22is, Alpha 12/2000, Alpha 12/3000, Alpha 22/1500, Alpha 22/2000, Alpha30/1200, Alpha C12/2000, Alpha C22/1500, Alpha 12/3000HV, Alpha 22/3000HV, Alpha 30/3000HV, Alpha M22/3000HV, Alpha M30/3000HV



MS3102A22-22P

Fanuc Connection		Centroid Connection
Pin	Signal	AC/DC H1
A	U	U
B	V	V
C	W	W
D	EARTH	Chassis

Motor Power Connector
30R, Alpha 22/3000, Alpha 30/2000, Alpha 30/3000, Alpha 40/2000

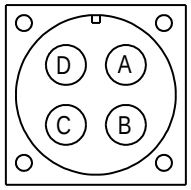


MS3102A24-10P

Fanuc Connection		Centroid Connection
Pin	Signal	AC/DC H1
A	U	U
B	U	U
C	V	V
D	V	V
E	W	W
F	W	W
G	EARTH	Chassis

Red End Cap Connectors

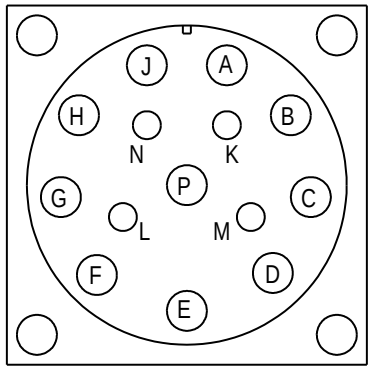
0M, 5M Motor Power Connector



MS3102A18-10P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
A	+	W
B	-	V
C	N/C	
D	EARTH	Chassis

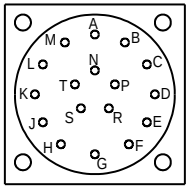
10M, 20M, 30M Motor Power Connector



MS3102A28-20P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
C	-	V
D	-	V
G	+	W
F	+	W
P	EARTH	Chassis
K	BRAKE	
L	BRAKE	
M	FAN	
N	FAN	

Encoder Connector

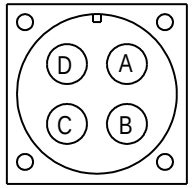


MS3102A20-29P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC ENCODER (P1)
A	A	1
B	B	2
C	+5V	12
D	/A	6
E	/B	7
F	Z	3
G	/Z	8
H	SHIELD	
J	+5V	12
K	+5V	12
L	N/C	
M	N/C	
N	0V	11
P	0V	11
R	THERMAL SW	
S	THERMAL SW	
T	0V	11

Yellow End Cap Connectors

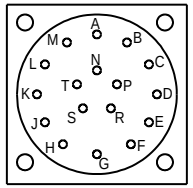
0, 5, 0L, 5L Motor Power Connector



MS3102A18-10P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
A	+	W
B	-	V
C	N/C	
D	EARTH	Chassis

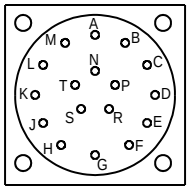
Encoder Connector



MS3102A20-29P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC ENCODER (P1)
A	A	1
B	B	2
C	+5V	12
D	/A	6
E	/B	7
F	Z	3
G	/Z	8
H	SHIELD	
J	+5V	12
K	+5V	12
L	N/C	
M	N/C	
N	0V	11
P	0V	11
R	THERMAL SW	
S	THERMAL SW	
T	0V	11

Encoder Connector



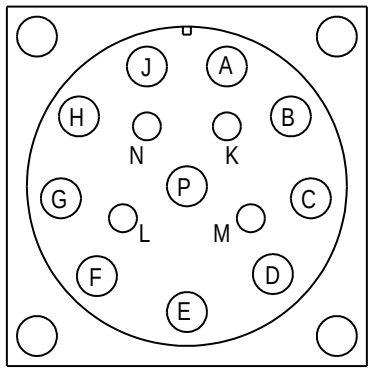
MS3102E20-29P

PN 5112

Pin	Signal
A	B
B	W
C	/B
D	/ W
E	A
F	/A
G	Z
H	/Z
J	0 V
K	/U
L	V
M	U
N	+5V
P	/ V
R	SPARE
S	SPARE
T	SHIELD

Centroid Encoder Connector

10, 20, 30, 10L Motor Power Connector



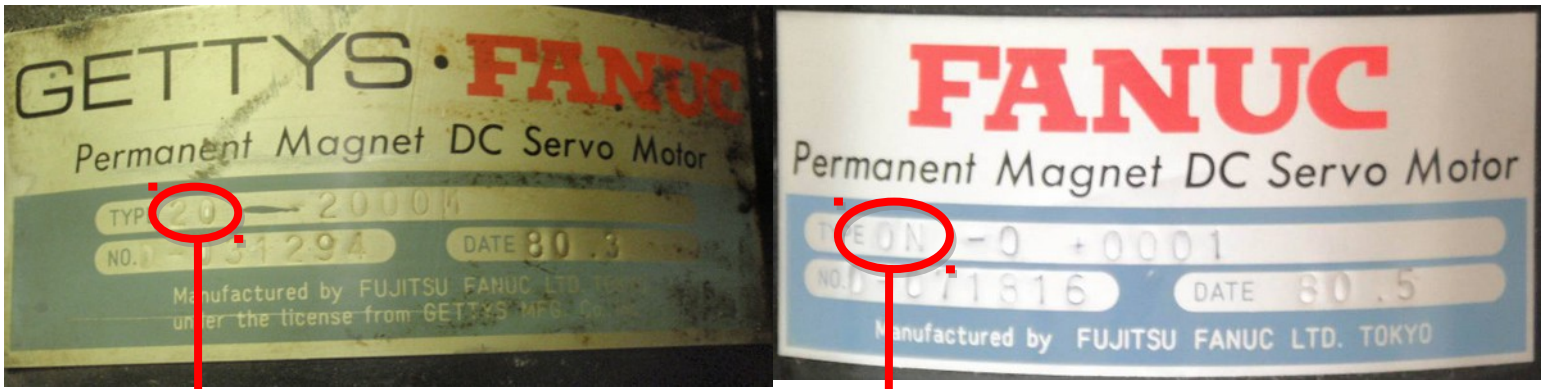
MS3102A28-20P

Fanuc Connection		Centroid Connection
Pin	Signal	ACDC H1
C	-	V
D	-	V
G	+	W
F	+	W
P	EARTH	Chassis
K	BRAKE	
L	BRAKE	
M	FAN	
N	FAN	

Black End Cap Connectors

Appendix C - Understanding Fanuc Motor Labels

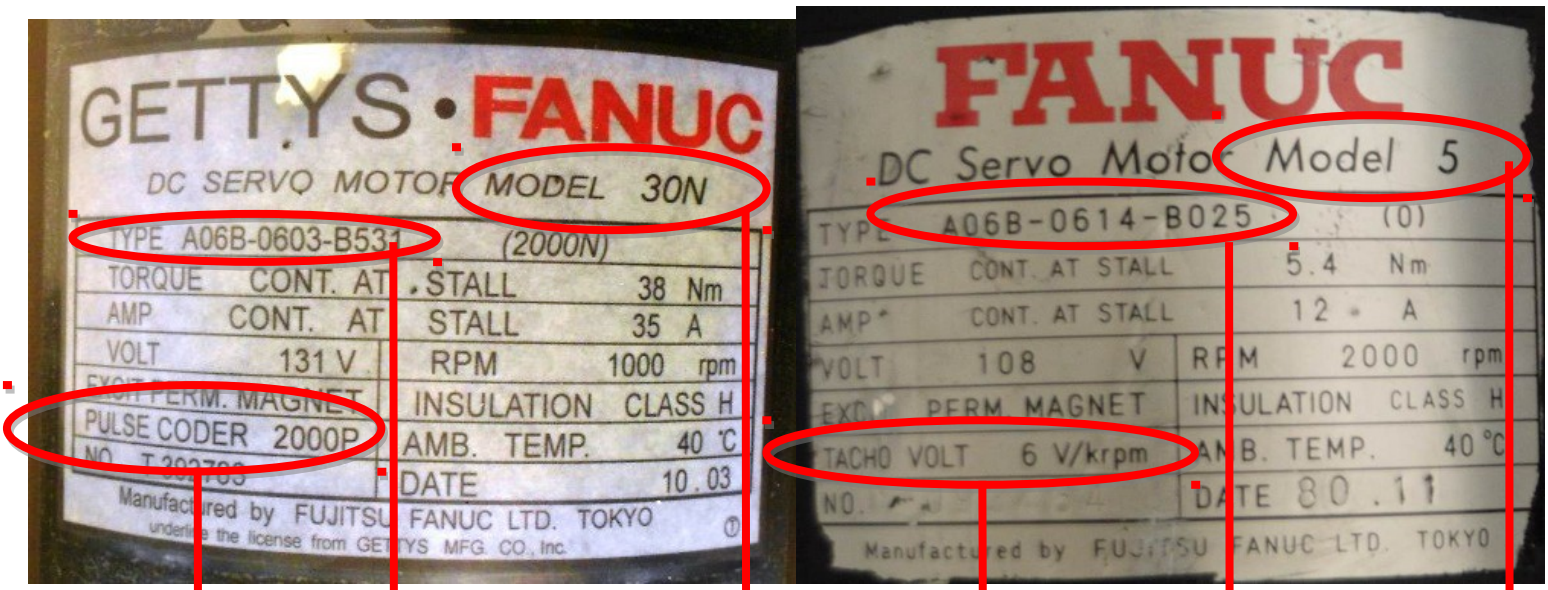
Early Gettys/Fanuc Black Cap Motors



Model Number

Model Number

Gettys/Fanuc Black Cap Motors



Rotation Measurement Technology

Type

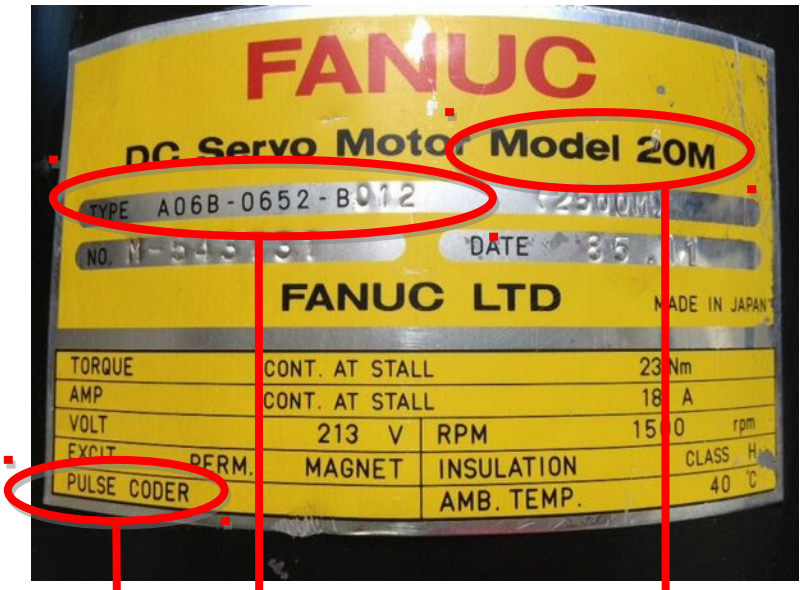
Model Number

Rotation Measurement Technology

Type

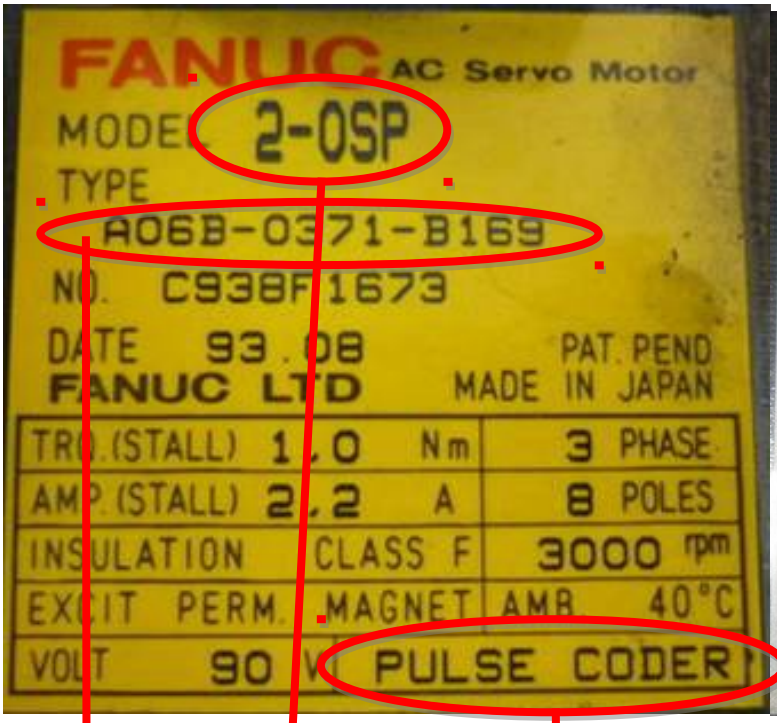
Model Number

Fanuc Yellow Cap Motors



Fanuc Red Cap Motors

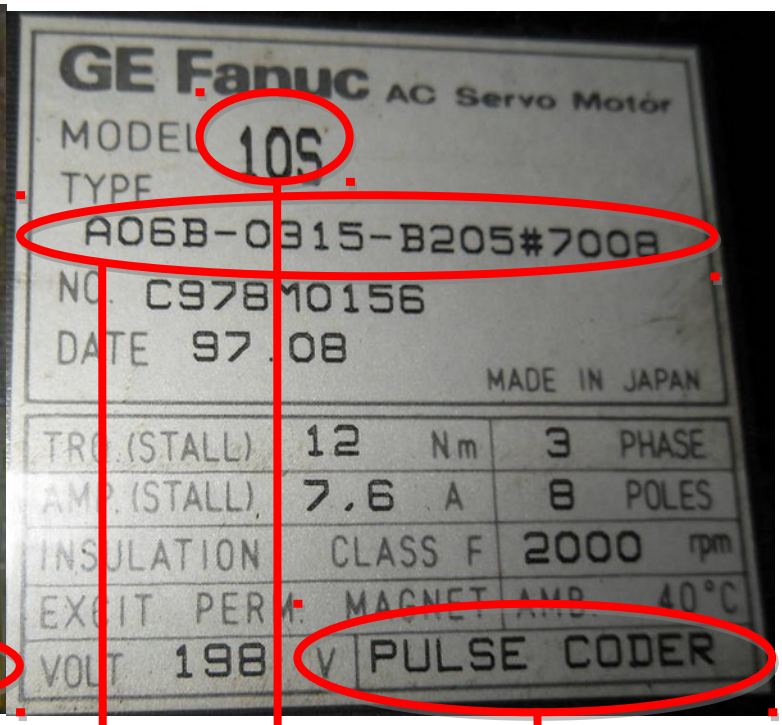
Fanuc S Series Red Cap Motors



Type

Model

Rotation Measurement Technology



Type

Model

Rotation Measurement Technology

Fanuc Alpha Series Red Cap Motors

Model

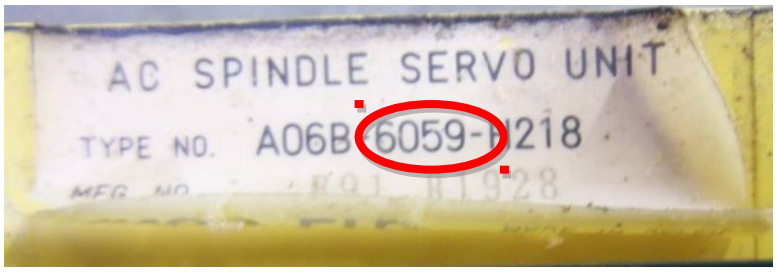
Type

Fanuc Beta Series Red Cap Motors

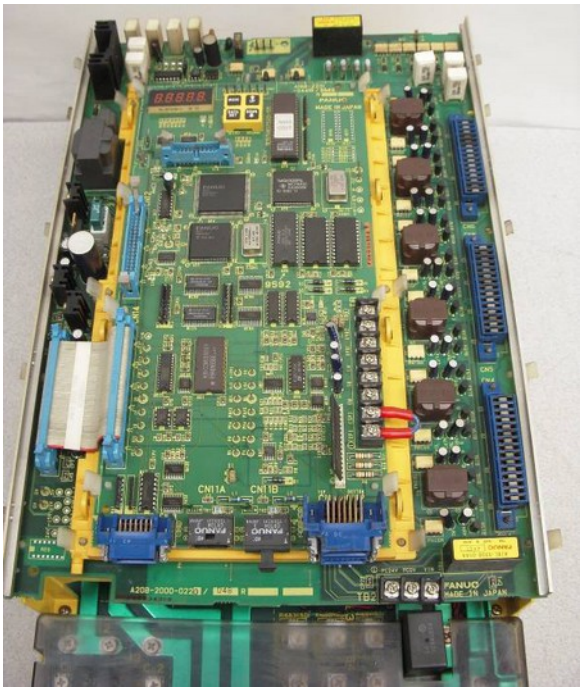
Fanuc 6055/6044 Spindle Drive Inverters Supported, Analog input (Tags on Bottom)

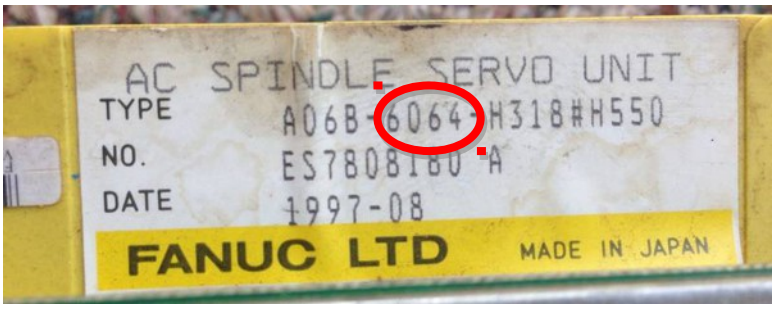
Tag Containing Drive Type

Fanuc 6059 Spindle Drive Inverter Supported, Analog input

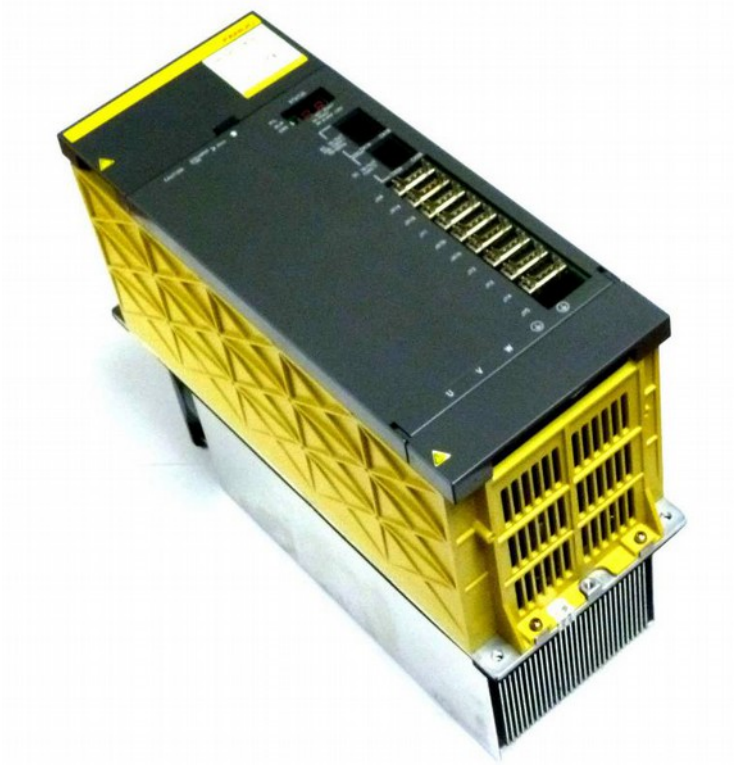


Fanuc 6064 Spindle Drive Inverter
(Not Supported)





Fanuc Alpha Series Spindle Drive Inverter
(Not Supported)



Appendix D

Fanuc Servo Motor Torque, HP, and Wattage on DC Motors[1]

End Cap Color	Drive Model	Drive Type	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)	Power (kW)
Black (Fanuc ● Gettys)	00	A06B-0631-Bxxx	2,000	8.7	18.2	0.2	0.15
	0	A06B-0613-Bxxx	2,000	25.4	50.8	0.5	0.4
	5	A06B-0614-Bxx	2,000	50.8	101.5	1	0.8
	10	A06B-0601-Bxxx	1,500	113.3	226.6	2	1.1
	20	A06B-0602-Bxxx	1,500	222.6	404.6	2.5	1.8
Yellow (M Series)	00	A06B-0632-Bxxx	2,000	8.8	17.6	0.2	0.15
	0M	A06B-0641-Bxxx	2,000	26.9	56.0	0.5	0.4
	5M	A06B-0642-Bxxx	2,000	52.2	104.4	1	0.8
	10M	A06B-0651-B012	1,500	106.2	212.4	1.5	1.1
	20M	A06B-0652-Bxxx	1,500	203.1	406.2	2.5	1.8
	30M	A06B-0653-Bxxx	1,200	333.3	666.6	4	2.8

1. The numbers in this chart are calculated from the Fanuc motor data sheets. Centroid has not verified these numbers.

Fanuc Servo Motor Torque, HP, and Wattage on AC Motors[1]

Series	Model	Type	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)	Power (kW)
S series & Early Red Caps	0-0SP	A06B-0374-Bxxx	3,000	26.2	72.2	0.67	0.5
	0S	A06B-0313-Bxxx	3,000	26.1	68.0	1.0	0.75
	5S	A06B-0314-Bxxx	2,000	51.8	134.1	1.2	0.9
	5S/3000	A06B-0514-Bxxx	3,000	51.5	151.3	1.3	1.0
	6S	A06B-0316-Bxxx	2,000	78.2	220.8	1.26[2]	0.94[2]
	6S/3000	A06B-0320-Bxxx	3,000	78.2	221.3	1.70[2]	1.27[2]
	10S	A06B-0315-Bxxx	2,000	103.6	286.2	2.4	1.8
	10S/3000	A06B-0317-Bxxx	3,000	104.3	306.7	3.1	2.3
	20S/1500 20M	A06B-0505-Bxxx	1,500	198.9	582.0	3.8	2.8
	20S 20	A06B-0502-Bxxx	2,000	198.8	605.4	4.7	3.5
	20S/3000	A06B-0318-Bxxx	3,000	200.9	366.4	4.7	3.5
	30S	A06B-0590-Bxxx	1,200	330.0	951.9	4.4	3.3
	30/2000 30R	A06B-0506-Bxxx	2,000	260.7	547.0	5.4	4.0
	30S/3000	A06B-0319-Bxxx	3,000	261.8	456.7	6.0	4.4
	40	A06B-0581-Bxxx	1,200	494.5	966.5	4.8	3.6
	0	A06B-0511-Bxxx	2,000	25.8	78.4	0.79	0.6
	5	A06B-0512-Bxxx	2,000	51.9	160.4	1.2	0.9
	10	A06B-0501-Bxxx	2,000	105.0	315.1	2.4	1.8
	30	A06B-0503-Bxxx	1,200	324.6	885.3	4.4	3.3
α (Alpha) Series & αC Series[3]	α3/3000	A06B-0123-Bxxx	3,000	26.5	69.0	1.3	0.9
	α6/2000	A06B-0127-Bxxx	2,000	53.5	160.6	1.4	1.0
	α6/3000	A06B-0128-Bxxx	4,000	53.1	159.3	1.9	1.4
	α12/2000	A06B-0142-Bxxx	2,000	105.9	317.8	2.8	2.1
	α12/3000	A06B-0143-Bxxx	3,000	105.6	306.7	3.8	2.8
	α22/1500	A06B-0146-Bxxx	1,500	194.7	579.5	4.0	3.0
	α22/2000	A06B-0147-Bxxx	2,000	193.6	559.2	5.0	3.8
	α22/3000	A06B-0148-Bxxx	3,000	193.2	361.1	5.9	4.4
	α30/1200	A06B-0151-Bxxx	1,200	264.3	792.9	4.4	3.3
	α30/2000	A06B-0152-Bxxx	2,000	264.6	785.9	6.7	4.5
	α30/3000	A06B-0153-Bxxx	3,000	265.5	472.6	7.1	4.8
	α40/2000	A06B-0157-Bxxx (without fan)	2,000	334.6	743.5	7.8	5.9
	αC12/2000	A06B-0141-Bxxx	2,000	106.5	325.0	1.4	1
	αC22/1500	A06B-0145-Bxxx	1,500	194.7	579.5	2.1	1.5
β (Beta) Series & β*is* Series	β3/3000	A06B-0033-Bxxx	3,000	26.3	74.3	0.67	0.5
	β6/2000	A06B-0034-Bxxx	3,000	52.0	139.4	1.2	0.9
	β4/4000*is*	A06B-0063-Bxxx	4,000	31.2	79.7	1	0.75
	β8/3000*is*	A06B-0075-Bxxx	3,000	61.6	184.8	1.6	1.2
	β12/3000*is*	A06B-0078-Bxxx	3,000	97.5	286.8	2.4	1.8
	β22/2000*is*	A06B-0085-Bxxx	2,000	177.0	470.0	3.4	2.5

1. The numbers in this chart are calculated from the Fanuc motor data sheets. Centroid has not verified these numbers.
2. Data sheet information on Hp and Kw power could not be found; instead these numbers are calculated from torque specifications.
3. Most Fanuc documentation lists the αC Series as a member of the α Series, while some Fanuc documentation lists the αC Series as a member of the β series.