0612

High Torque Servo Motor Series

Manual

PUSHCORP, INC.

Dallas, Texas

March, 2023

! CAUTION !

Do NOT apply air pressure to release the Collet while the servo motor is rotating. The servo motor spindle must be *FULLY STOPPED* before actuating the Collet.

Do NOT overheat the servo motor. Supply the motor cooling water to maintain a temperature below 176 ˚F (80 ˚C).

Do NOT start or stop the servo motor instantaneously. Doing so will damage the motor and power amplifier.

All *PushCorp, Inc.* electrical cables are rated for high twist and flex robotic applications with a minimum cable bending radius specification of 125mm (5 in). Cable damage resulting from failure to abide by this specification will not be covered under warranty.

Do NOT use safety rated IO. These pulse at an extremely high rate and the servo amplifier will turn off the IO as a result.

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1.0 Limited Warranty

Duration:

One year from date of delivery to the original purchaser.

Who gives this warranty (warrantor):

PushCorp, Inc.
Telephone: (972) 840-0208

Corporate Address:
P. O. Box 181915
Dallas, Texas 75218

Shipping Address:
3001 W. Kingsley Rd.
Garland, Texas 75041

Who receives this warranty (purchaser):

The original purchaser (other than for purposes of resale) of the *PushCorp, Inc.* product

What products are covered by this warranty:

Any *PushCorp, Inc.* industrial equipment or accessory supplied or manufactured by the Warrantor.

What is covered under this warranty:

Defects in material and/or workmanship which occur within the duration of the warranty period.

What is NOT covered in this warranty:

A. IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED TO ONE YEAR FROM THE DATE OF ORIGINAL PURCHASE. Some states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.

B. ANY INCIDENTAL, INDIRECT, OR CONSEQUENTIAL LOSS, DAMAGE or EXPENSE THAT MAY RESULT FROM ANY DEFECT, FAILURE, MALFUNCTION OF THE *PUSHCORP, INC.* PRODUCT. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you.

C. Any failure that results from an accident, purchaser's abuse, neglect, unauthorized repair or failure to operate the products in accordance with the instructions provided in the owner's manual(s) supplied with the product.

Responsibilities of the Warrantor under this warranty:

Repair or replace, at Warrantor's option, products or components which have failed within the duration of the warranty period.

Responsibilities of the purchaser under this warranty:

A. Deliver or ship the *PushCorp, Inc.* product or component to PushCorp, Inc. Service Center, Dallas, TX. Freight and insurance costs, if any, must be borne by the purchaser.

B. Use reasonable care in the operation and maintenance of the product as described in the owner's manual(s).

When warrantor will perform repair or replacement under this warranty:

Repair or replacement will be scheduled and serviced according to the normal work flow at the service center, and depending on the availability of replacement parts. Purchasers requiring quicker repair may receive such with payment of a *PushCorp, Inc.* predetermined expediting fee.

This Limited Warranty gives you specific legal rights and you may also have other rights which vary from state to state.

2.0 General Overview

The PushCorp 0612 Servo Motor is capable of continuously producing 12 horsepower, and spinning up to 6000 rpm. The 0612 series includes three versions; an SM0612 manual collet, an automatic version with a collapsing collet (STC0612) and another automatic version which clamps a BT40 toolholder (STC0612-BT40). The 0612 series utilizes identical motor windings, and power amplifiers. Differing only in a few physical dimensions and how they secure the media. Each of these motors provide a convenient and effective means to spin and/or change any number of different media types to support a fully automated workcell.

The SM0612 has a manually tightened collet that is a cost-effective alternative to the automatic version. The SM0612 uses the same motor winding and housing as the STC0612, but without the automatic clamping mechanism. The manual Collet is a standard ER-40 series collet designed to clamp a 1 inch (25.4 mm) diameter Tool Shaft. The user may choose different sized collets in the ER-40 series, ranging from 1/8 - 1 inch (2 - 30 mm).

The STC0612 Series has two automatic tool changing versions, each actuating pneumatically to clamp the shaft or toolholder. They are comprised of four primary components: a high-torque Servo Motor, a pneumatic actuator, high force Bellville springs, and a component to clamp a Tool Shaft/Toolholder. The STC version uses a drawbar to pull the Collet/Gripper in. High force Bellville springs located at the back of the Servo Motor Housing tension the drawbar. Energizing the large pneumatic actuator, located in the Clamping Housing, opens the Collet/Gripper. During pressurization the cylinder contacts the Bellville springs and compresses them to drive the Collet/Gripper out, releasing the Tool Shaft/Toolholder. There is no mechanism to forcibly eject the Tool Shaft/Toolholder from the Collet, so gravity or a capturing mechanism must be used.

The STC0612 version uses a PushCorp proprietary collapsing Collet to lock around a Tool Shaft. The STC0612-BT40 uses a 40 taper to grip a standard BT40 toolholder. This design locks the toolholder in the 40 tapered shaft and resists large pull out forces. Neither shaft has locking keys, so motor indexing for tool change is not required. The STC0612 motors are fail-safe, in that no air pressure is required to clamp the Tool Shaft/Toolholder. Therefore the Tool Shaft/Toolholder will remain held in the Collet/Gripper even when the air pressure is un-expectantly lost. Likewise, applying air pressure to a single input port via a simple manual or electrically operated valve opens the Collet/Gripper and releases the Tool Shaft/Toolholder. Finally, clever mechanical design always isolates the motor bearings from the drawbar tension. This greatly improves reliability by allowing the motor bearings to never be subject to any clamping forces. Each member of the 0612 Series uses sealed bearings to insure a long life. The 0612 bearings have additional contamination protection from a PushCorp proprietary contact shaft seal. This special seal eliminates the need for constant purge air.

During operation the 0612 generates considerable heat due to the high torque and compact size of the motor. Water-cooling is required to keep the unit within the internal temperature operating range. Excessive operating temperatures will significantly reduce the life of the motor. The motor should never be allowed to

exceed a temperature of 176 ˚F (80 ˚C). Continuously operating the unit above 176 ˚F (80 ˚C) will cause the rotor to de-magnetize and the bearings to fail. High temperatures will also cause the O-rings that seal the cooling water channels to fail, possibly filling the motor with water. PushCorp has provided flow through water cooling on the motor to allow high duty cycles without overheating.

Simple reliable construction combined with high torque and precision speed controlled servo technology make the *PushCorp* 0612 Servo Motors a rugged, state-of-the-art tool capable of providing flexible, cost-effective operations.

3.0 Installation & Operation

3.1 Mounting the 0612

3.1.1 Mounting to an AFD1100/80

The 0612 Series motors are designed to attach directly to the Carriage of any *PushCorp* AFD620/1100/80 or AFD1240/1200/90 Force Device. There are three standard attachment options.

For the Parallel-Axis configuration, shown in Figure 1, the 0612 attaches to the AFD Carriage with two brackets and four (4), M8x1.25x25mm, Socket Head Cap Screws. The 0612 is positioned on the Carriage with the Foot Bracket while the Front Bracket is attached to the forward mounting holes. The Clamping Screw on the Front Bracket should be loose to allow sliding movement along the motor. Attach the Foot Bracket to the Clamping Housing (Mounting Plate for the SM0612) using two (2), M8x1.25 Socket Head Cap Screws. When the desired position is achieved secure the brackets to the Carriage, and tighten the Clamping Screw. The M8x1.25, Socket Head Cap Screws, must be the proper length and tightened to the torque specified in Section 4.0.

By rotating the 0612 90 degrees to the Carriage, a Cross-Axis configuration can be achieved as shown in Figure 2. The unit is attached using the same fasteners and methodology as the Parallel-Axis configuration.

To attach the 0612 to an AFD in a Perpendicular-Axis configuration, position the Clamping Housing/Mounting Plate over the Carriage as shown in Figure 3. Then secure the unit using four (4), M8x1.25 Socket Head Cap Screws. Tighten the fasteners to the torque specified in Section 4.0.

CAUTION: Make sure that the M8x1.25 fasteners do not exceed a depth of 0.52" (13.3 mm) into the AFD Carriage Helicoils or damage will occur.

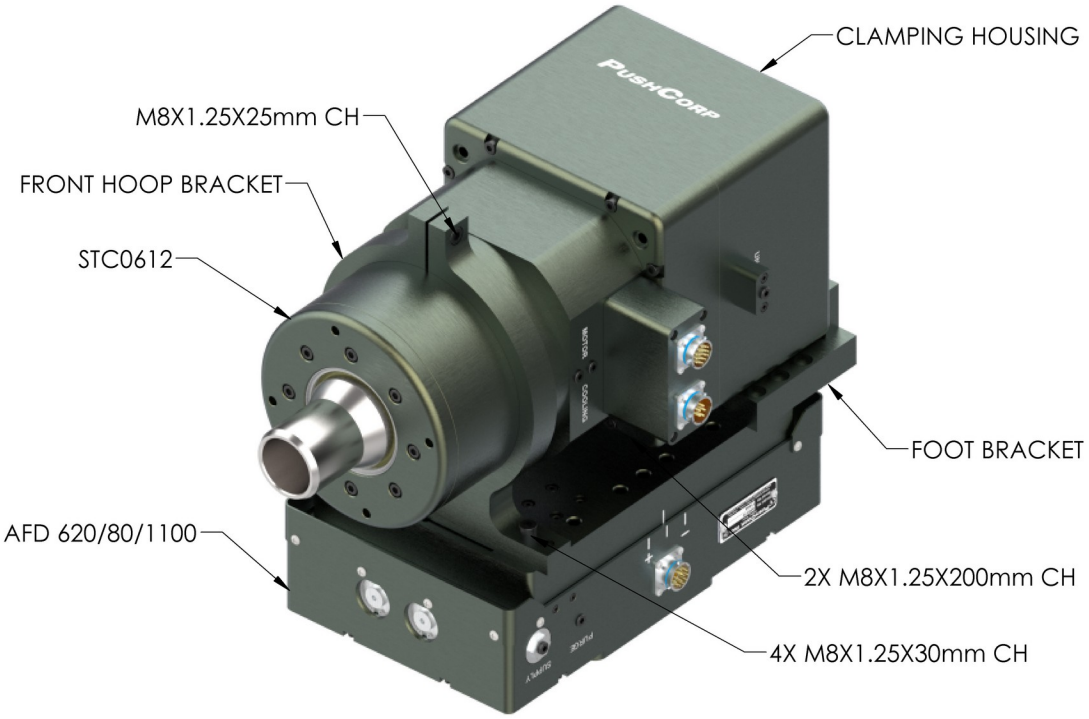


Figure 1: 0612 Parallel-Axis Configuration

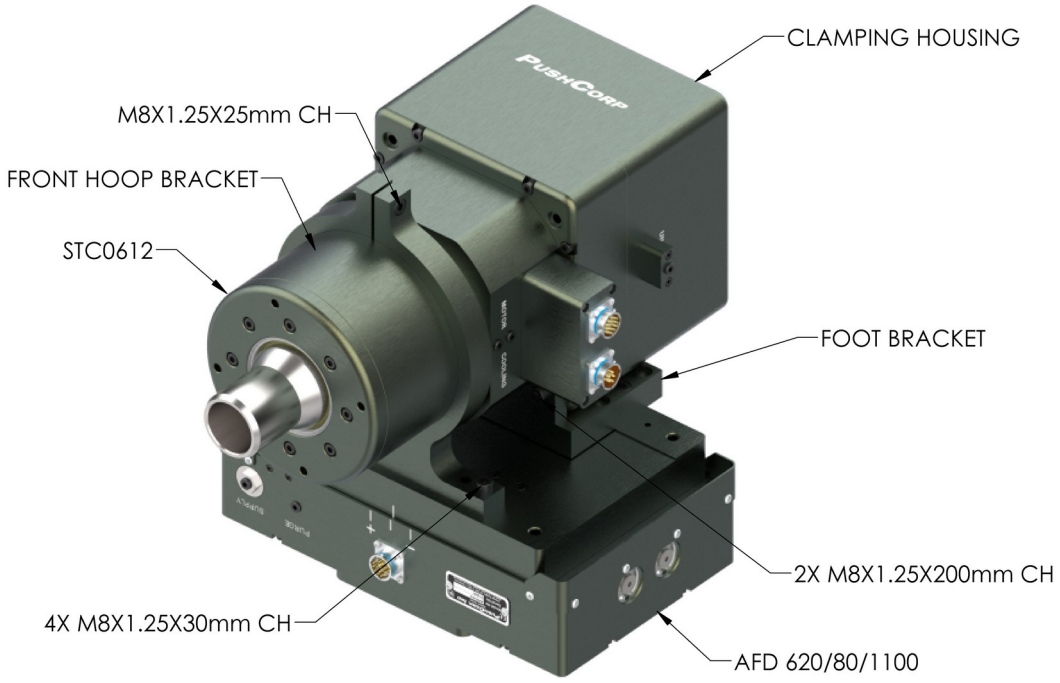


Figure 2: 0612 Cross-Axis Configuration

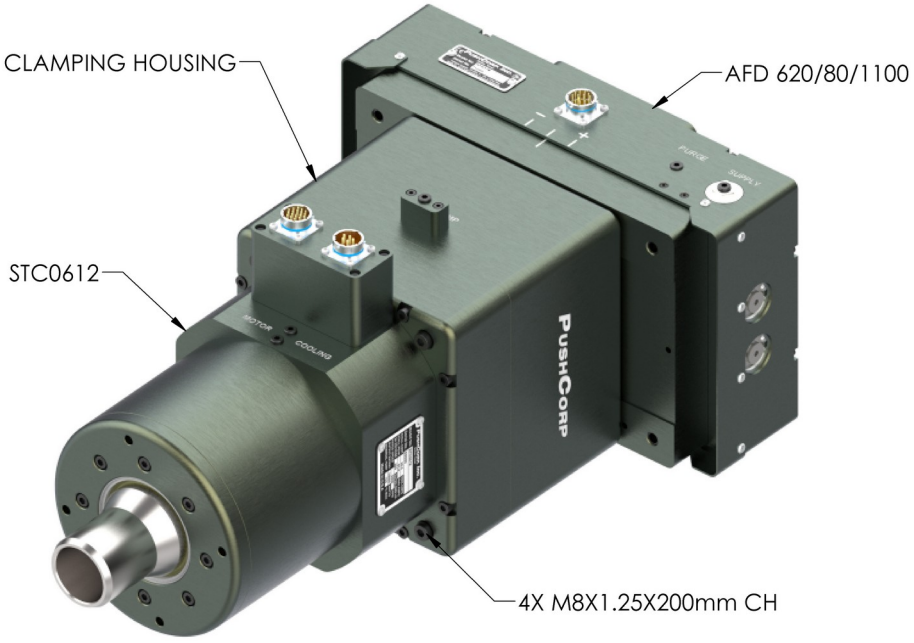


Figure 3: 0612 Perpendicular-Axis Configuration

3.1.2 Mounting Directly to a Robot

For some processes compliance and force control are not required. The 0612 can be mounted directly to the robot and the system can be operated in position mode. This robotic system is equivalent to a 5-axis machining center with a very large work volume and lower positional accuracy. Certain product types and processes are well suited for a Robotic Machining Center (RMC).

The 0612 Series can be attached to the robot mounting flange using an intermediate mounting plate. For direct mounting it is recommended that a breakaway clutch is installed. The breakaway clutch will help protect the motor in the event of a robot crash. Loads on the motor shaft of over 2500 lb (11200 N) radially and 1260 lb (5600 N) axially will damage the bearings.

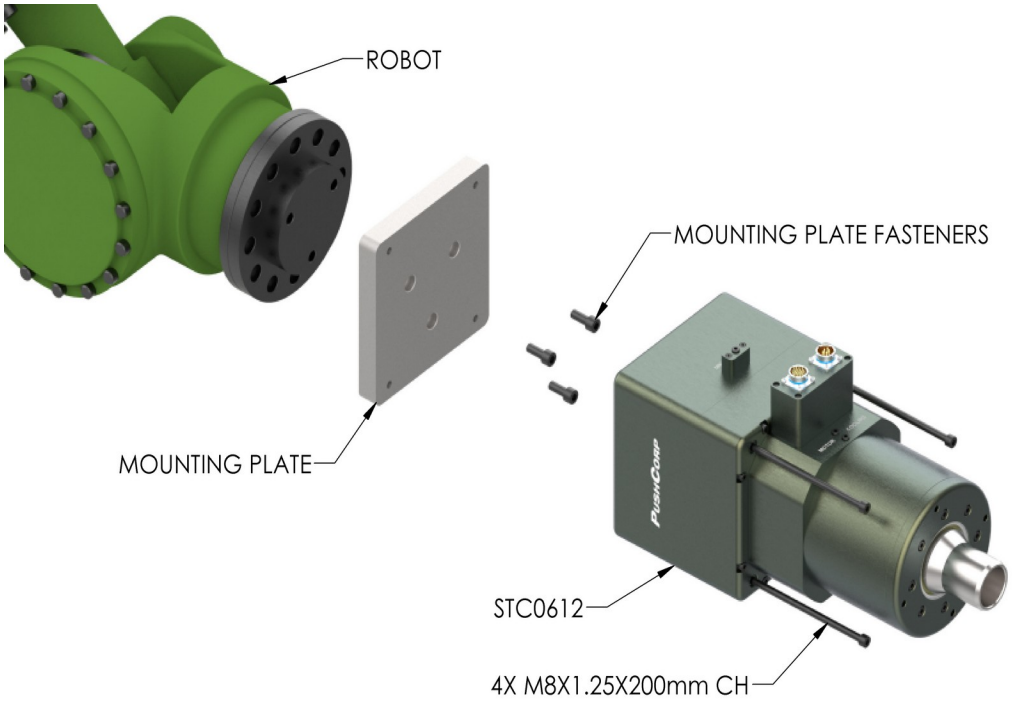


Figure 4: STC0612 Direct Mounting

To mount the 0612 Series, first attach the Intermediate Mounting Plate to the Robot Mounting Flange or to the Breakaway Clutch, per the manufacturer's specifications. Once the Mounting Plate is secured, place the 0612 Series against the Intermediate Mounting Plate and install (4) four, M8x1.25 Socket Head Cap Screws. (See Figure 4) Tighten the fasteners to the torque specified in Section 4.0.

3.2 Media and Tool Presentation

Media and tool presentation refers to how various disks, drill bits, router bits, etc. are presented so that a robot may maneuver the STC0612 into position to grasp the Tool Shaft/Toolholder reliably. It is ultimately the user's responsibility to provide a means to present the media and/or tooling in an effective and repeatable way for a given application.

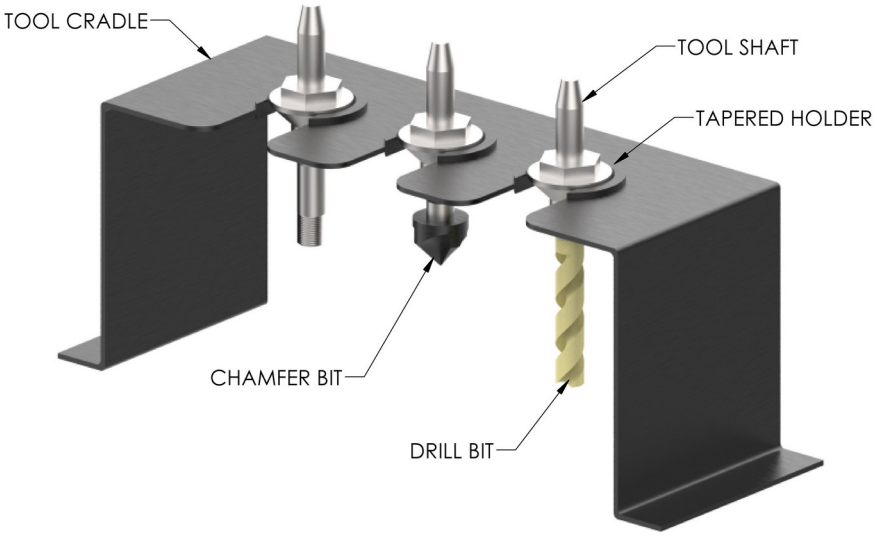


Figure 5: Sample media and tooling presentation scheme

As shown above, in Figure 5, many types of media and tools may be accurately located in a Tool Cradle. A robot can then be taught approach paths and docking locations to reliably bring the STC0612 down over the Tool Shafts and grasp them. The STC0612 Collet allows 0.015 in. (0.38 mm) diametral clearance around the Tool Shaft when open. The Tool Shaft must have a taper that mates to a Tapered Holder mounted in the Tool Cradle. The Tapered Holder requires a slot to allow the Tool Shaft to pass through.

3.3 Tool and Media Specification

3.3.1 STC0612 & SM0612 Tool Shaft Specification

The STC0612 and SM0612 are designed to grasp a 1 inch (25.4 mm) diameter steel shaft. Figure 8 shows the Tool Shaft dimensions required for the STC0612 and SM0612 to operate properly. Notice that the end of the Tool Shaft can be tailored to any needed configuration to attach to various disk back-up pads, drill bits, router bits, grinding stones, etc. To prevent interference between the Tool Shaft and the STC0612 Collet an 11° taper must be included. Tool Shafts should be manufactured from carbon or stainless steel with a hardness less than Rc40. The surface finish on the Tool Shaft Clamping Surface should be Ra 16 – 32. To accurately locate the Tool Shaft axially the front flat surface of the Collet can be used. This means that the Tool Shaft Clamping Surface and taper must be shorter than the Collet depth. When using the Collet face for positioning some form of compliance must be used on the Tool Cradle to prevent wedging the Collet in too tightly, or damaging the motor bearings.

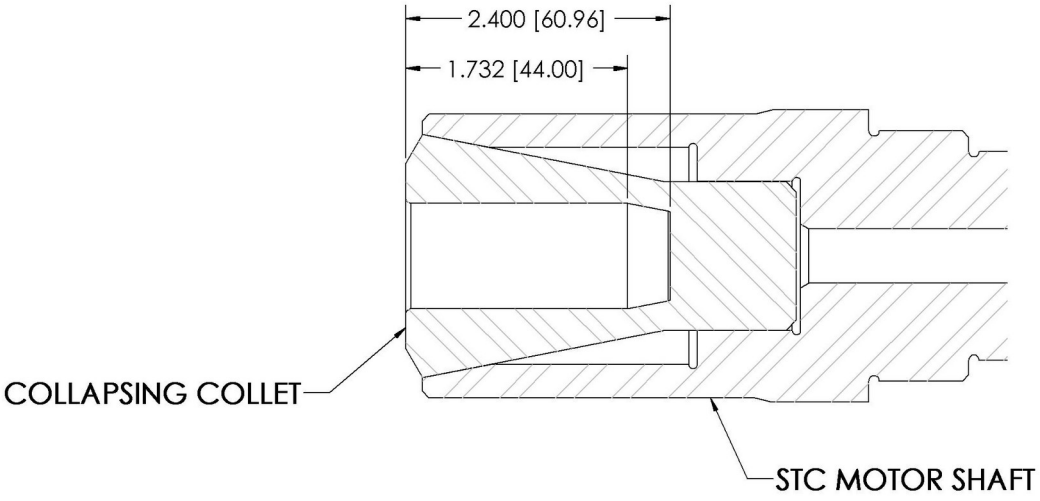


Figure 6: STC0612 Collet Drawing

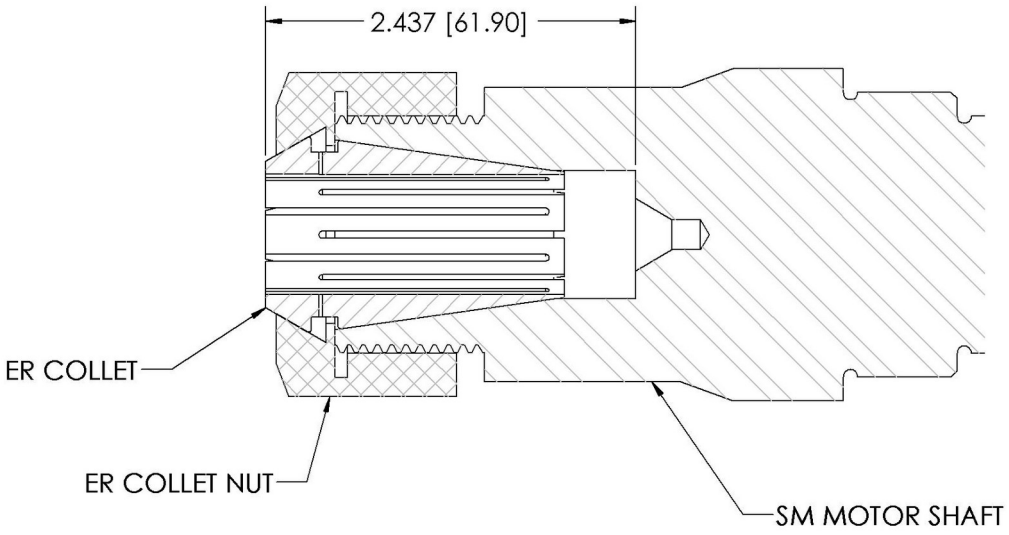


Figure 7: SM0612 Collet Drawing

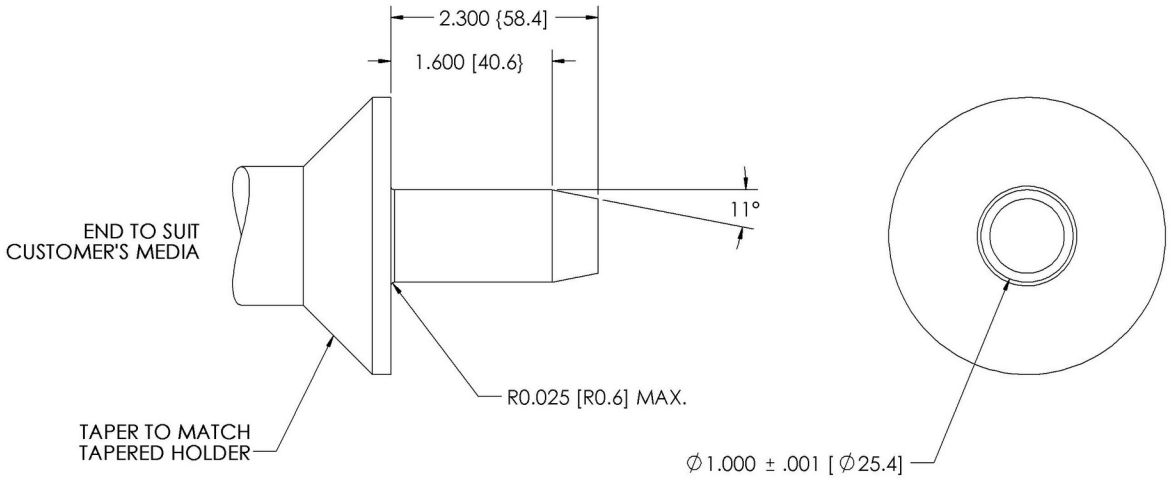


Figure 8: STC0612 & SM0612 Tool Shaft Drawing

3.3.2 STC0612-BT40 Toolholder Specification

The STC0612-BT40 is designed to grip a BT40 toolholder without using the shaft locking keys. The motor relies on the frction in the taper to secure the Toolholder. No shaft locking keys means that the shaft does not needd to be indexed to a specific position to perform a tool change. The BT40 toolholder is a standard machine tool style and may be purchased from several sources including, MSC (www.msc.com), and J & L Industrial Supply (www.jlindustrial.com). The Customer can also make their own BT40 toolholder to handle special media (See Figure 9 for toolholder dimensions). The toolholder **must** be equipped with a Parlec (www.parlec.com) retention knob, part number 4020TRK, or equivalent. Figure 10 shows the Parlec retention knob with the required dimensions.

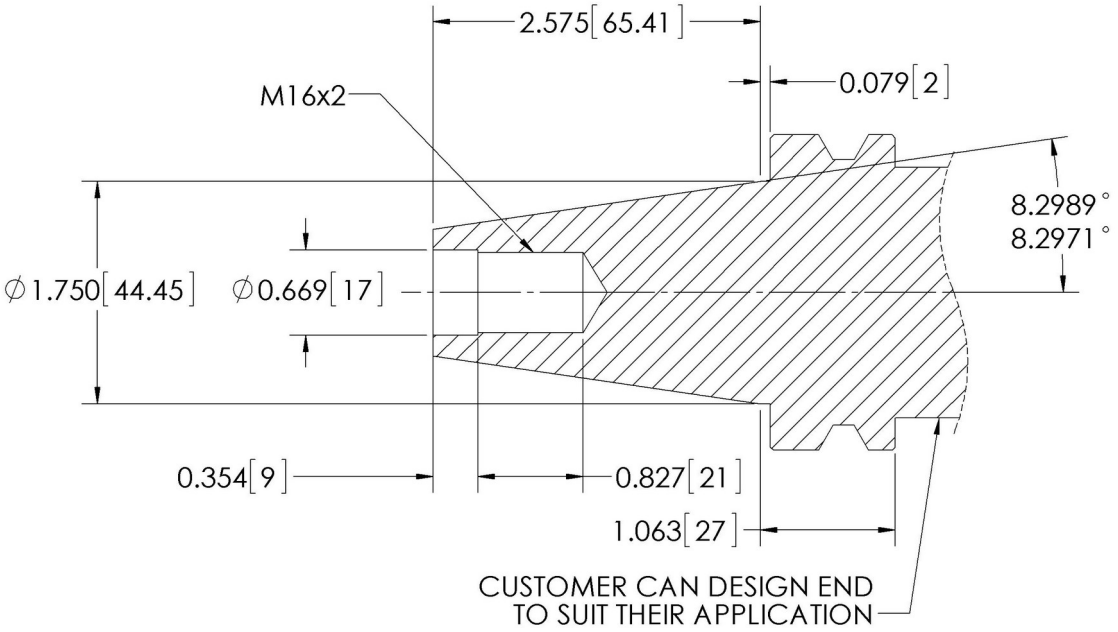


Figure 9: BT40 Toolholder Dimensions

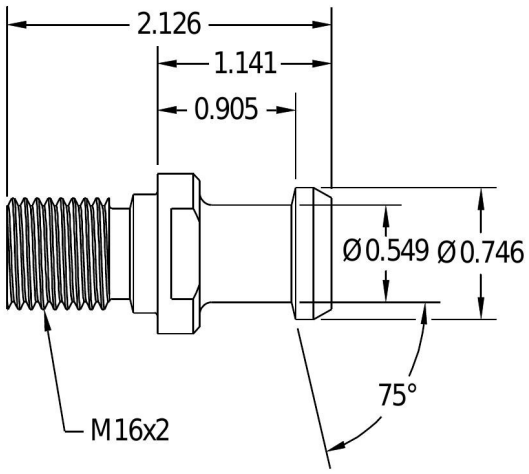


Figure 10: BT40 Retention Knob

3.4 SM0612 Collet Operation

The Collet for the SM0612 is tightened and loosened manually. The Motor Shaft must be held using the Motor Shaft Flats, while the Collet Nut is turned, see Figure 13. Turning the Collet Nut forces the Collet into the Motor Shaft causing it to clamp around the Tool Shaft. Rotating the Collet Nut clockwise will tighten the Collet. To loosen the Collet, rotate the Collet Nut counter-clockwise. If the Collet is to be removed, continue rotating the Collet Nut counter-clockwise and the Collet Nut and Collet will come off together. The Collet is an ER Series (DIN 6499 Form B) Size 40. The recommended tightening torque for the Collet Nut is 128 lb.-ft. (175 N·m).

CAUTION: Tightening toques greater than 160 lb.-ft. (220 N·m) will permanently deform the collet cavity of the toolholder.

NOTE: A collet wrench RegoFix P/N 7111.40000, or equivalent, should be used to tighten the Collet Nut.

3.4.1 SM0612 Collet Assembly and Removal

To assemble the Collet insert the Collet Groove into the Eccentric Ring of the Collet Nut at the mark on the bottom of the Collet Nut. Push the Collet in while rotating the Collet up, until it clicks in. See Figure 11.

To remove the Collet, first unscrew the Collet Nut from the Motor Shaft. After the Collet Nut is unscrewed, press on the face of the Collet while simultaneously pushing sideways on the back of the Collet until it disengages from the Collet Nut. See Figure 11.

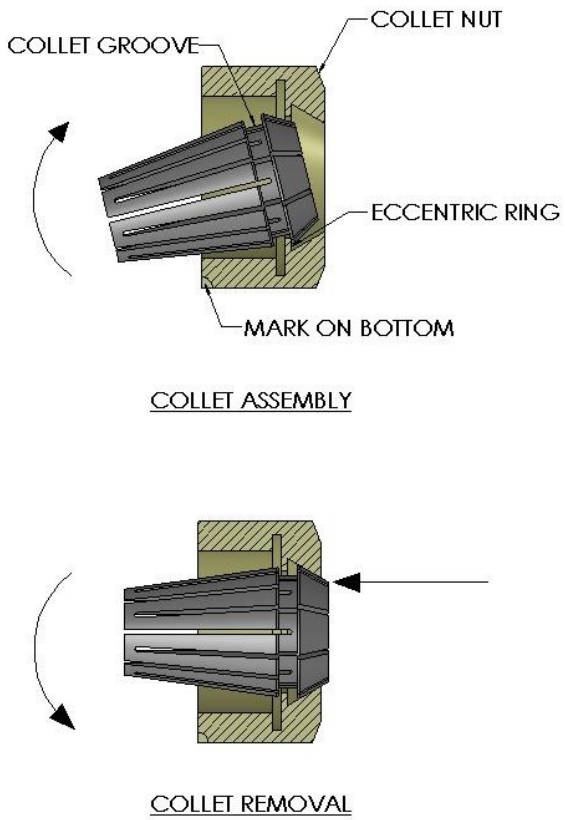


Figure 11: SM Collet Assembly and Removal

Improper assembly or removal of the Collet can permanently destroy the concentricity of the Collet and may result in a damaged Collet Nut.

NOTE: Only attach Collet Nuts with correctly assembled Collets, to the Motor Shaft! Never place the Collet into the Motor Shaft without first assembling the Collet into the Collet Nut.

NOTE: Never clamp oversized, or undersized, Tool Shafts! E.g., never use a ⌀11-12mm Collet to clamp a ⌀12.2mm Tool Shaft. Always use the corresponding Collet for the Tool Shaft being used.

NOTE: Insert the Tool Shaft the full length of the Collet for best results, if possible. However, never insert the Tool Shaft less than 2/3 of the Collet bore length. Improper tool insertion can permanently deform the Collet and will result in excessive run-out.

3.5 Pneumatic Connection

All STC versions of the 0612 require a dry, non-lubricated, filtered air supply, with a minimum pressure of 90 psi (6.2 bar) and a maximum pressure of 100 psi (6.9 bar). Failure to provide supply air to these specifications can degrade performance and will void any warranty repairs concerning pneumatic components. If the supply air pressure is too low then the unit will be unable to fully release the Tool

Shaft/Toolholder. Exceeding the maximum air pressure could result in permanent damage to the STC.

The pneumatic supply system should be configured as shown in Figure 12. A manual or electrically operated valve may be used to energize the STC for Tool Shaft/Toolholder release, but the valve must exhaust **ALL** line pressure when unenergized. An electrically operated pneumatic valve is normally used in an automated workcell. PushCorp highly recommends the installation of a Pressure Switch in the Supply Line to the STC. This switch should not allow the unit to start if there is any pressure in the Supply Line. Pressure in the line will cause internal components to come into contact. This will either cause the motor not to spin, or cause very high internal forces, eventually friction welding components together.

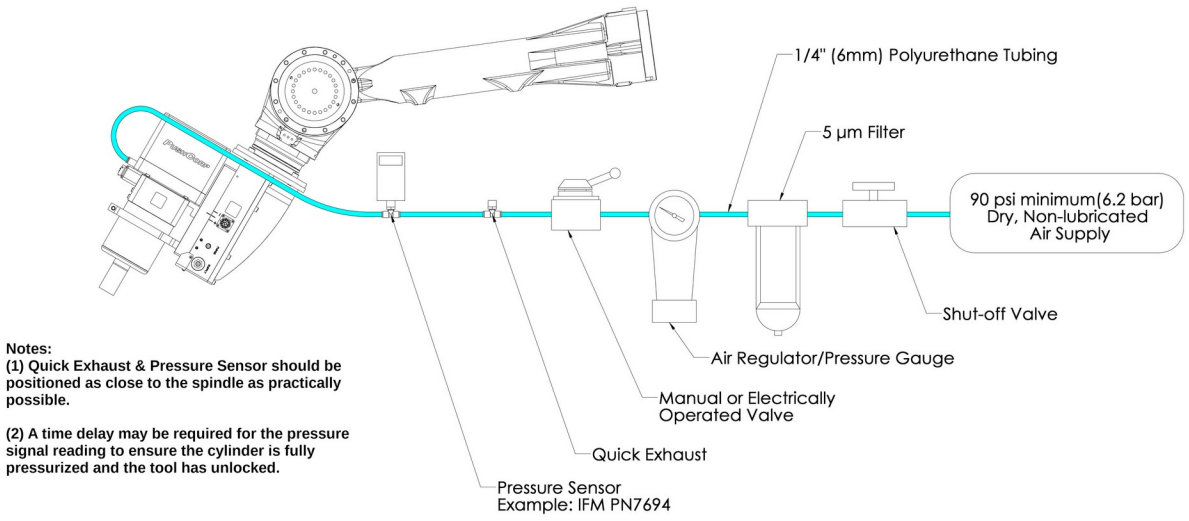


Figure 12: Pneumatic Connections

The STC0612 and STC0612-BT40 are provided with ¼ inch and 6 mm diameter tubing push-lock fittings for installation in the R 1/8 (Metric) Collet Unclamp Port located on the top of the Clamping Housing (See Figure 13). Remove the shipping plug and install the desired size push-lock fitting. If another type of fitting is desired, unscrew the existing fitting and replace it with any fitting having an R 1/8 (Metric) thread. Be sure to use a thread seal product and do not over tighten the fitting.

The Unclamp Supply Line to the device should be 1/4 inch or 6 mm diameter flexible polyurethane tubing. The tubing should be routed to the device such that there are no kinks and that there is plenty of slack to allow for manipulator motion. Before inserting the tubing into the STC air fitting, open the Shut-Off Valve to blow out any contaminates which may be in the Unclamp Supply Line. The tubing can now be pushed into the self-locking fitting located on the Clamping Housing as shown in Figure 13. Charge the Unclamp Supply Line with compressed air and verify that there are no air leaks and that there is a minimum of 90 PSI (6.2 bar) at the STC. If a minimum air pressure cannot be achieved, then an auxiliary air compressor or booster pump must be installed.

NOTE: PushCorp highly recommends the use of flexible polyurethane tubing as opposed to nylon tubing. This is because nylon tubing tends to crimp shut when it is bent.

To remove the Unclamp Supply Line for service, make sure the air pressure is discharged, then while pushing inward on the fitting's plastic ring, simultaneously pull the tubing out. Cover or plug the self-locking fitting any time the Unclamp Supply Line is not connected. This will keep contaminants from entering.

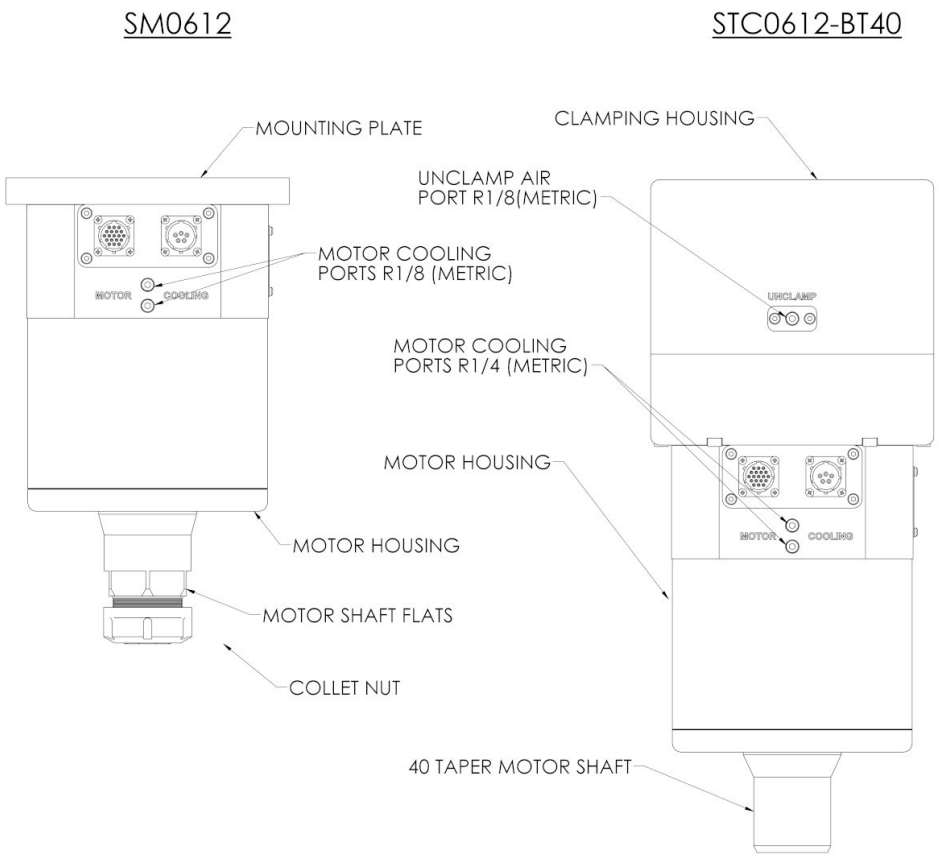
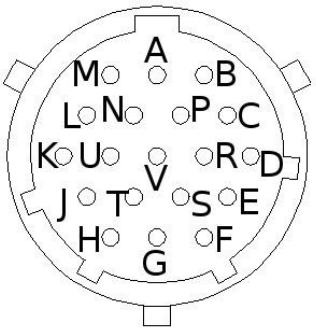


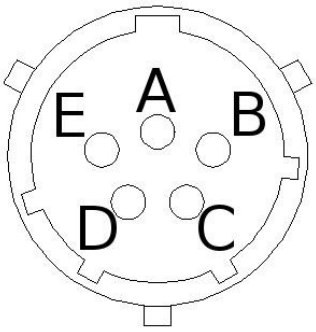
Figure 13: 0612 External Features

3.6 Electrical Connections

The 0612 servo motor has two electrical connections, the Motor Power and Motor Feedback (See Figure 14). If PushCorp supplies the cables and amplifier the tool should be easily connected to the amplifier. If the customer wishes to use their own cables and/or amplifier the pin-outs for the Motor Power and Motor Feedback connectors are shown below in Figure 14. The Collet release mechanism of the STC0612 relies solely on air pressure to operate; it requires no electrical connections.



FEEDBACK CONNECTOR



POWER CONNECTOR

FEEDBACK PIN-OUTS

PIN	SIGNAL
A	HALL + SUPPLY
B	HALL - SUPPLY
C	HALL C
D	HALL B
E	HALL A
F	THERMISTOR
T	THERMISTOR
V	SHIELD

POWER PIN-OUTS

PIN	SIGNAL
A	MOTOR A
B	MOTOR B
C	MOTOR C
D	GROUND
E	SHIELD

Figure 14: Electrical Connector Pin-outs

CAUTION: Do not run the Motor Power Cable in close proximity to any feedback or control cables because of possible electrical noise problems.

3.6.1 AKD2G Servo Amplifier – Default Electrical Connections

This amplifier is already properly configured for a PushCorp spindle. No further configuration is required if the below settings will work for your application.

Analog Interface

Connector	Pin	Function
X21	A1	Analog-In 1+ : +/-10VDC Command Velocity
X21	A2	Analog-In 1- : +/-10VDC Command Velocity
X21	B1	Analog-Out 1 : 0 - 10VDC Velocity Monitor
X21	B2	AGND : Analog GND
CASE		Shield

Digital Interface

Connector	Pin	Function
X21	A3	Digital-In 1 : Fault Reset Input
X21	A4	Digital-In 2 : Run Input
X21	A5	Enable : Enable Drive Input
X21	B3	+24VDC : Digital Output Supply
X21	B4	DGND : Digital I/O Common
X21	B5	BTB/RTO : Ready To Operation (Dry Contact)
X21	B6	BTB/RTO : Ready To Operation (Dry Contact)
X21	B7	Digital-Out 1 : Motor Overload Warning
X21	A11	STO-A-A1 : Safety Torque Off A Input
X21	B11	STO-B-A1 : Safety Torque Off B Input

For more information an instruction manual is available at:
http://www.pushcorp.com/Manuals/Kollmorgen_AKD2G_Instruction_Manual.pdf

3.6.2 S724 Servo Amplifier – Default Electrical Connections

This amplifier is already properly configured for a PushCorp spindle. No further configuration is required if the below settings will work for your application.

Analog Velocity Mode
+/-10VDC Analog Input for command velocity

Analog Interface

Connector	Pin	Function
X3B	9	-Analog-In 1 – Command Velocity
X3B	10	+Analog-In 1 – Command Velocity
X3B	13	AGND - Shield

Digital Interface

Connector	Pin	Function
X3A	1	Enable – Enable Drive Output
X3A	2	Digital-In 1 – Fault Reset
X3A	6	Digital-Out 1 – Fault Present
X3A	7	Digital-Out 2 – At Zero Speed
X3B	14	BTB/RTO – Ready To Operation (Dry Contact)
X3B	15	BTB/RTO – Ready To Operation (Dry Contact)
X3B	16	DGND – Digital 0VDC Common

Optional Analog Output (MUST HAVE ANALOG CARD INSTALLED IN SLOT 3)

Connector	Pin	Function
X3C	17	Analog Out 1 - Velocity Feedback
X3C	18	AGND
X3X	19	Analog Out 2 - Motor Load Feedback
X3C	20	AGND

For more information an instruction manual is available at:
http://www.pushcorp.com/Manuals/Kollmorgen_S724_Instruction_Manual.pdf
For all other questions please contact:
PushCorp Tech Support: 1.972.840.0208, 8am – 5pm Central Time
Kollmorgen Tech Support: 1.540.633.3545, 8am – 5pm Eastern Time

3.6.3 Hall Motor Timing Chart

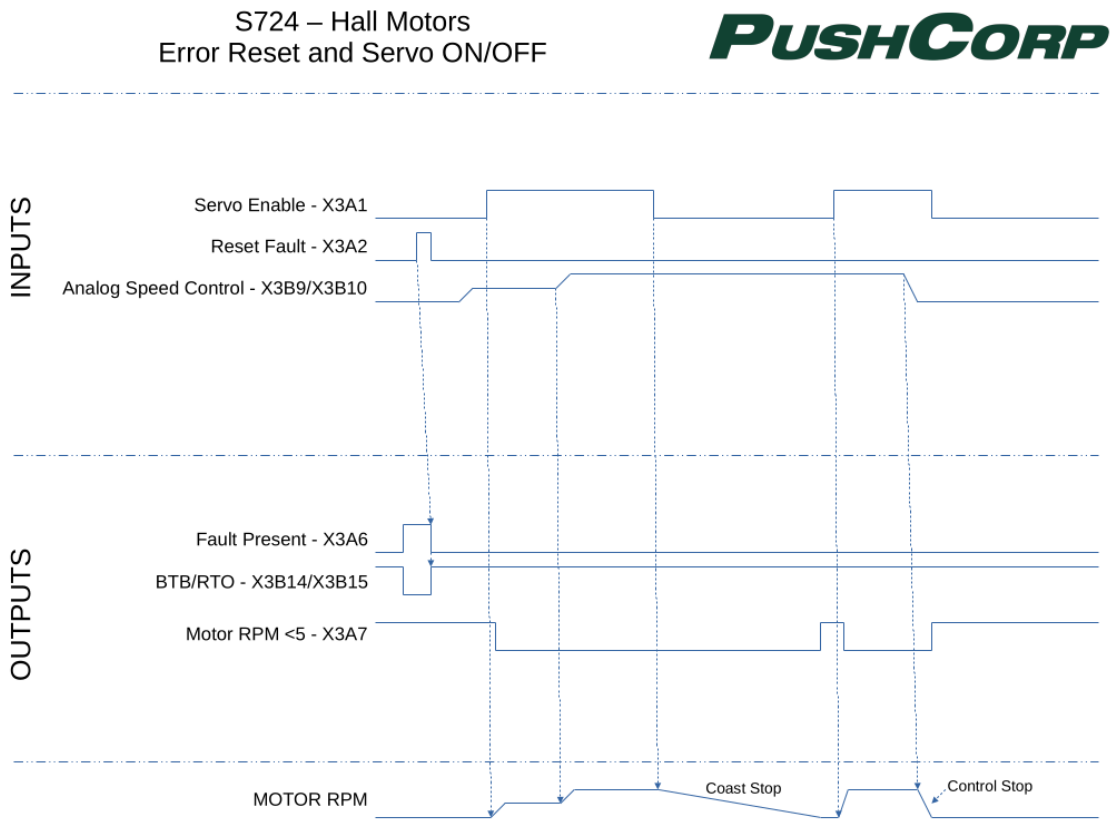


Figure 15: Hall Motor Input/Output

3.7 Motor Cooling

The 0612 Series has a compact, high torque, 12.0 Hp (9 kW) Servo Motor which requires water cooling. The motor is designed to operate below a temperature of 176 ˚F (80 ˚C). The optimal motor temperature range is 122 – 140 °F (50 – 60 °C). The 0612 contains cooling channels in the Motor Housing surrounding the motor stator. These channels allow efficient removal of the heat. The coolant enters and exits the Motor Housing through two Motor Cooling Ports as shown in Figure 13. Either of these Motor Cooling Ports can be used as an input, the other would then become an output.

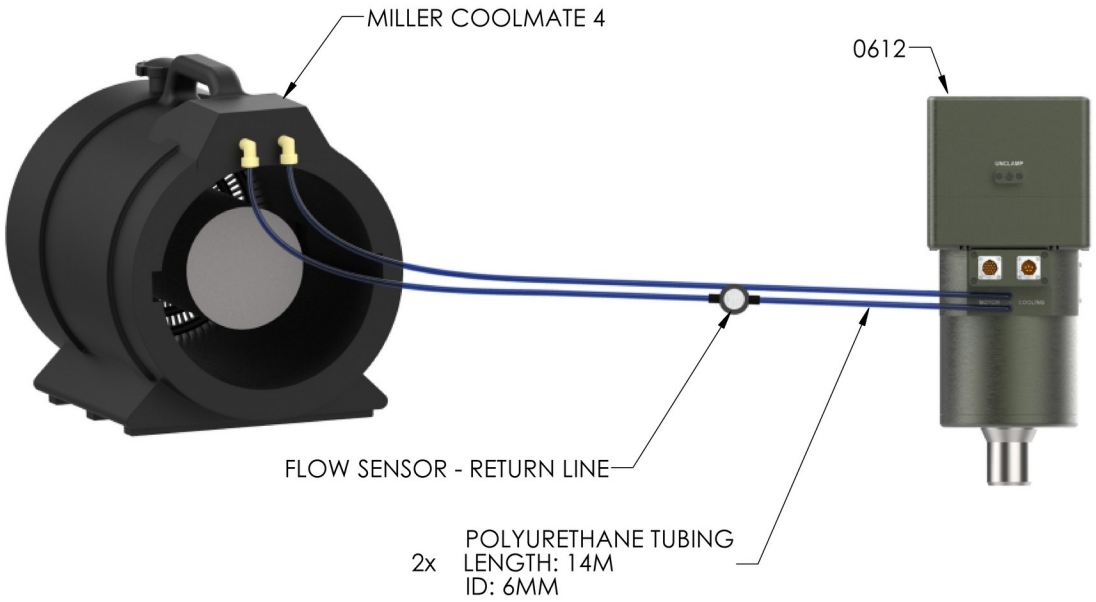


Figure 16: Spindle Cooling with Cooling Unit

A closed-loop water cooling system must be used and requires a separate cooling unit per spindle that circulates water through the Motor Housing to remove the heat. Typical cooling units are comprised of a pump, liquid to air heat exchange, and a fan. These units are commercially available from several manufacturers (e.g. Miller Coolmate 4, www.millerwelds.com). The cooling unit should be sized based on the motor power output of the motor being used with an overall motor efficiency of 90% and the motor load conditions. See section 4.0 of this manual for motor output ratings for the motor being used. In the case of a closed-loop water cooling system, all of the coolant is recirculated in the system, and no continuous supply of discharge is required. Our standard offering is the Miller Coolmate 4, which you can see in Figure 16 PCI PN PAR04922. In this case the return line is the bottom connection; it is recommended that a flow sensor is installed inline with this port and wired back as part of the control circuit. PushCorp recommends the IFM flow sensor (PN SBG12IF0FRKG). This will ensure the coolant is circulating completely through the motor and back to the cooler. Domestically, PushCorp provides Miller's pre-mixed glycol base aluminum protecting coolant (Miller PN 043-809 – PCI PN PAR04028). Any coolant which matches the parameters of this coolant may be used.

NOTE: Connecting two motors to a single Coolmate could yield inadequate cooling and reduce the life of the servo unit. The life of the motor is directly related to the operational temperature, so proper cooling is critical.

Again, it is recommended to constantly monitor the motor temperature during operation to ensure that it does not overheat. In addition, PushCorp recommends that one Miller Coolmate 4 (or equivalent) should be used per motor.

3.8 Monitoring Motor Temperature

As previously stated, the 0612 Series is designed to operate below a temperature of 176 °F (80 °C) and within an optimal range of 122-140 °F (50-60 °C). In many situations it is desirable to monitor the internal motor temperature to ensure that the maximum temperature rating is not exceeded, and that the optimal temperature range is maintained. To facilitate this, the 0612 Series has a thermistor that is imbedded in the motor windings. The thermistor connection is provided on the Motor Feedback Connector as shown in Figure 14. The thermistor temperature signal is a logarithmic function of the output resistance. The graph shown in Figure 17 illustrates the internal motor temperature verses the thermistor output resistance. In the graph, a temperature of 212 ˚F (100 ˚C) corresponds to a resistance of 1000 ohms. If the thermistor indicates a resistance of less than 1000 ohms then the motor should be immediately shut down before thermal damage occurs.

The motor also contains a thermal cutoff switch. If the temperature exceeds 212 ˚F (100 ˚C) the motor will stop running until it has cooled off. This feature should not be used to control the motor temperature. The thermal cutoff is designed to operate only when all other precautions have failed.

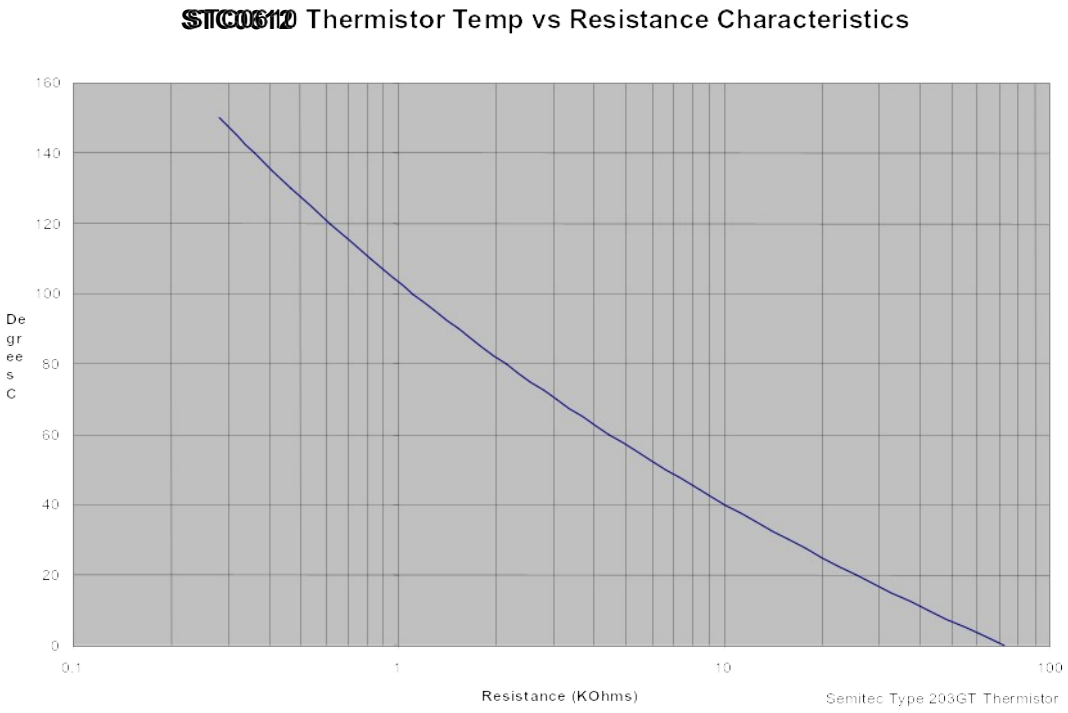


Figure 17: Thermistor Chart

The following equation can be used to calculate the motor temperature based on the measured thermistor resistance:

$$T = \frac{1}{2.656\times10^{-3} + 2.317\times10^{-4}\ln(R) + 1.752\times10^{-7}\ln(R)^3} - 273.15$$

R is resistance in Kohms

$\ln()$ is the natural logarithm function (Base *e)*

T is temperature in ˚C

3.9 STC Spindle Tool Change

PushCorp STC spindles have the ability to switch tool holders out using pneumatic actuation. The STC0612 uses a keyless BT40 toolholder, which provides strong holding torque and tool retention. To properly change out a tool, the following steps are recommended to avoid damaging the spindle, toolholder or gripper fingers.

Before Attempting Tool Change, Make Sure:

- Spindle is not rotating - Motor RPM < 5 feedback signal is ON
- If using retention knob not supplied by PushCorp, verify the dimensions match the illustration in section 3.3.2
- Make sure pressure does not remain supplied at the unclamp port for an extended period of time or this will result in damage to the spindle's pneumatic cylinder

Tool Change Sequence:

1. Robot moves the end effector i.e. Servo Tool Changer (STC) to dock toolholder in the gripper/fingers/nest
2. Once fully docked, pressurize the "unclamp" port with at least 90 psi (6.2 bar) not to exceed 100 psi (6.9 bar).
3. Using a pressure sensor, such as IFM PN7694, verify that you have achieved at least 90 psi, again not to exceed 100 psi (refer to Figure 12 for connection set up)
4. Robot moves STC away from toolholder gripper/fingers/nest
5. Robot positions STC above the next tool holder
6. Robot moves STC toward the toolholder until the shaft and toolholder's tapers are fully seated against each other, then depressurize the "unclamp" port
7. Using a pressure switch that can sense below 0 psi such as the IFM PN7694, verify 0 psi (0 bar) at "unclamp" port
8. Robot moves out and away from gripper/fingers/nest removing the tool holder from the gripper/fingers/nest

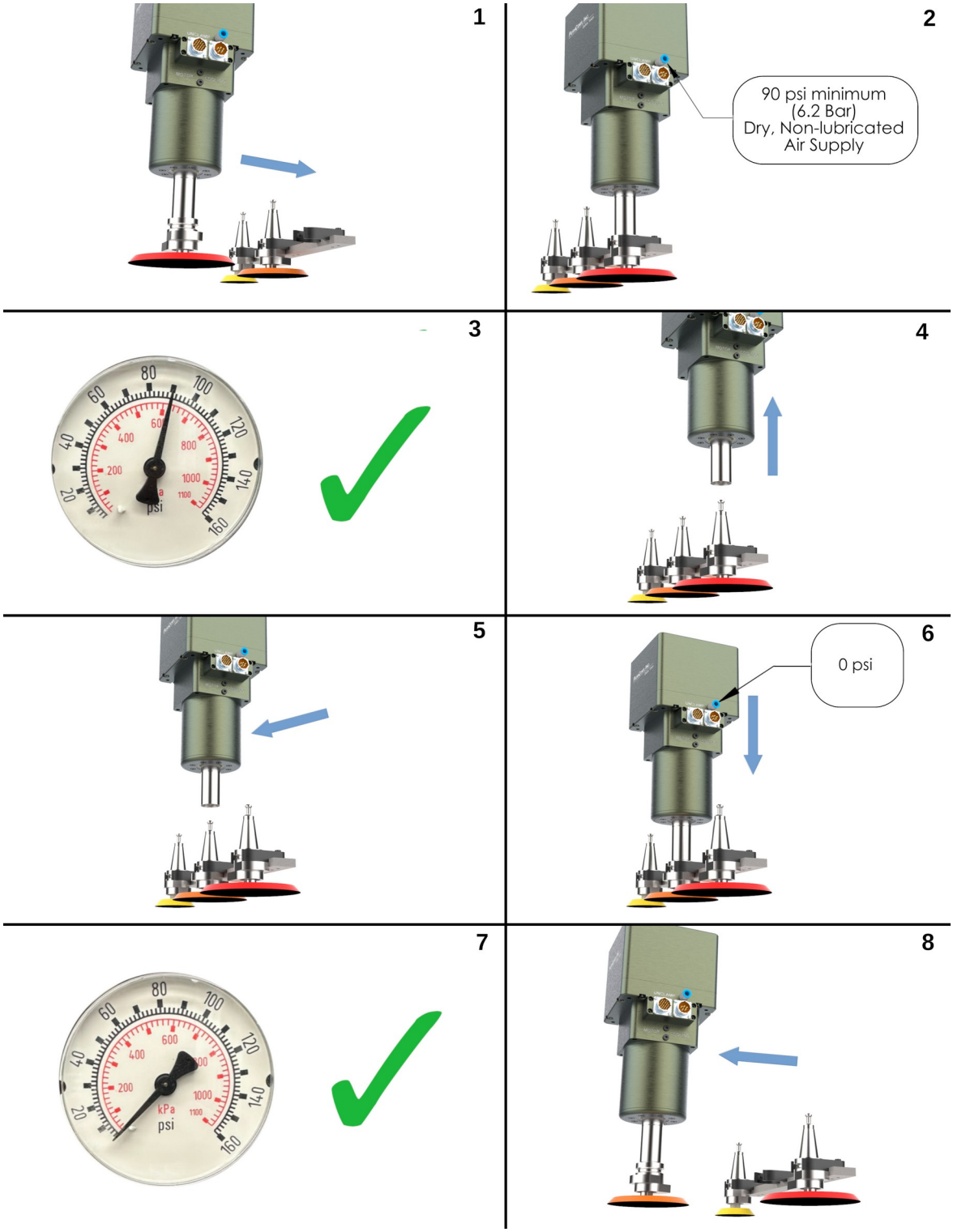


Figure 18: STC Spindle Tool Change Sequence

4.0 Technical Specifications

MOTOR SPECIFICATIONS:

Supply Bus Voltage: 480 VAC, 3-Phase +/-10%
Power: 12.0 hp (9 kW)
Continuous Stall Torque: 11.8 lb.-ft. (16 N·m)
Minimum Speed: 60 RPM
Maximum Speed: 6000 RPM
Speed Regulation: 5% (Reversible)
Weight:
SM0612 - 52 lb (24 kg)
STC0612 – 72 lb (32.6 kg)
STC0612-BT40 – 82 lb (37.2 kg)
Operating Temperature: Optimal: 122 – 140 ˚F (50 – 60 ˚C)
Maximum: 176 ˚F (80 ˚C)
Thermal Cutoff: 212 ˚F (100 ˚C)
Max. Coolant Pressure: 60 psi (4.1 Bar)

Max. Coolant Flow: 1.5 Gal/min (6 L/min)

COLLET SPECIFICATIONS:

Holding Torque:
SM0612 - 22 lb.-ft. (30 N·m) minimum
STC0612 – 22 lb.-ft. (30 N·m) minimum
STC0612-BT40 – N/A
Tool Shaft Diameter/Toolholder:
SM0612 - 1.0 inch (25.4mm) standard
STC0612 - 1.000±.001 inch (25.4mm)
STC0612-BT40 – BT40 toolholder
Clamping Supply Air:
Dry, Non-lubricated, 90 psi (6.2 bar) Min., 100 psi (6.9 bar) Max.
Requires power amplifier and cables.
For specific dimensions see www.pushcorp.com for detail drawings.

TORQUE SPECIFICATIONS:

Fastener Tightening Torque Specs

Fastener Size	Torque			Minimum Depth	
	in.-lbs.	ft.-lbs.	N·m	in.	mm
M4 x .7	50	4.2	5.6	0.17	4.3
M5 x .8	85	7.1	9.6	0.21	5.3
M6 x 1	140	11.7	15.8	0.25	6.3
M8 x 1.25	348	29.0	39.3	0.33	8.4
M10 x 1.5	600	50.0	67.8	0.41	10.5

Specifications subject to change without notice.

5.0 Preventative Maintenance Schedule

It is highly recommended to adhere to the preventative maintenance schedule in order help extend the longevity of the specified PushCorp, Inc. equipment. Failing to do so could cause a loss in functionality as well as a decrease in product life.

PUSHCORP, INC. SPINDLES			
Maintenance	**Weekly**	**Monthly**	**3 Months**
Remove chips from the ID of the shaft	X		
Remove debris from spindle/spindle housing	X		
Check that the connectors are not bent/damaged	X		
Check for flow in the motor cooling and unclamp ports		X	

Agency/Organization:_____

Date Completed:_____