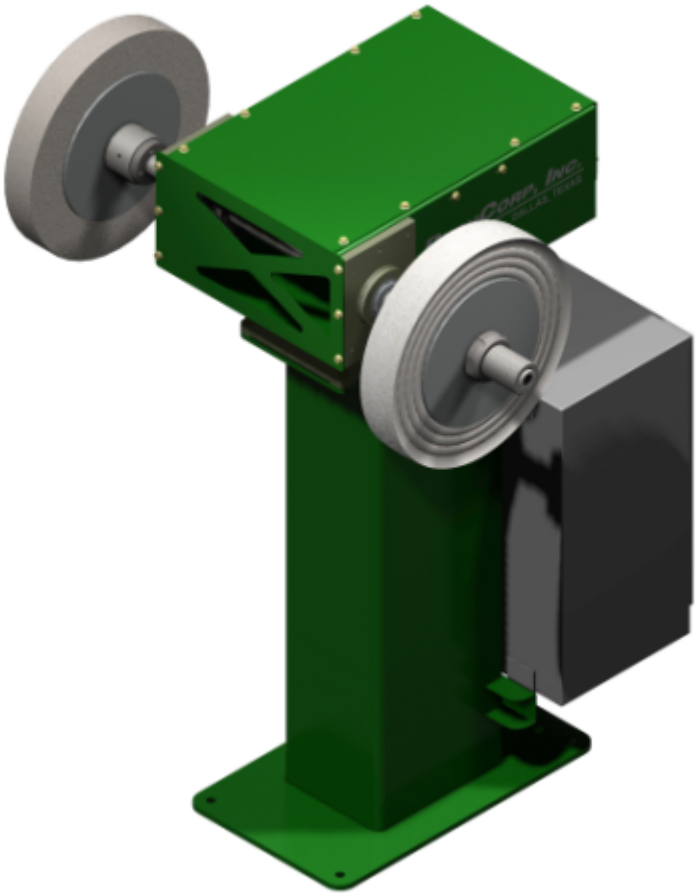
SFS81 Series

Servo Finishing Stand



PUSHCORP, INC.

Dallas, Texas

Febuary, 2008

NEVER OPERATE THE SFS81 MANUALLY

NEVER OPERATE THE SFS81 WITH PERSONEL IN THE WORKCELL

DO NOT USE LUBRICATED AIR.

This device requires a dry, non-lubricated 100 psi (6.9 bar) maximum air supply filtered to 5 µm and a 0.3 micron oil mist separator.

Non-compliance with these requirements will void the manufacturer's warranty.

(See Section 3.4)

All fasteners, mounting holes and pipe threads on this tool are METRIC.

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.

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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.* Adjustable Force Device or Adjustable Force Device 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 SFS81 Series Servo Finishing Stand combines passive compliant force control and closed-loop servo motor speed control technology. The SFS81 has been designed from the ground up as a Finishing Stand for robotic applications with many new and unique features. Accurate force and speed control allows you to achieve unprecedented levels of quality and consistency. The SFS81 enables maximum flexibility for any part-in-hand grinding, sanding, buffing or polishing application. Linear compliance with 1.6 inches (40 mm) of travel and excellent access allow a robot to easily manipulate parts over the Media. An important feature of the SFS81 Finishing Stand is the high torque servo motor and belt drive. The belt drive system provides a 2:1 increase in torque at the Media for heavy material removal.

The force control technology in the SFS81 is based on the *PushCorp* Passive AFD80 Series Force Devices. This technology has proven itself in thousands of hours of production robotic applications. The standard regulator supplied in the SFS81 Control Box allows the SFS81's force to be varied from 2 to 100 lbs. (8 to 445 N). This regulator has a coarse adjustment and must be manually set to the desired force output. If the force must vary during the finishing process, then an electrically controlled proportional regulator is required. Very accurate force output requires a precision regulator that operates in a narrow pressure range.

In most any finishing process, consistency is of paramount importance. For this reason the SFS81 is powered by a high torque servo motor with adjustable speed control that can be varied at any time during the finishing process. The SFS81 has a 5.7 horsepower (4.28 kW) motor that supplies 14.7 lb•ft (20 N•m) of torque and a maximum speed of 3000 RPM at the Media. With dual 30mm Output Shafts the user can mix & match their Media allowing multiple finishing operations at the same piece of equipment. This flexibility allows the SFS81 to perform a wide variety of finishing applications.

3.0 Installation

3.1 Mounting the SFS81

The SFS81 Servo Finishing Stand is secured by four (4) fasteners passing through mounting holes located in the Base Plate (See Figure 2). The Base Plate mounting hole locations are shown in Figure 1. The SFS81 must be securely mounted to keep the unit from moving during operation, and must be mounted level to achieve the desired force output. A spirit level can be place on the top of the Finishing Stand and shims can be inserted under the Base Plate as required.

WARNING: Do NOT operate the unit without first mounting it securely.

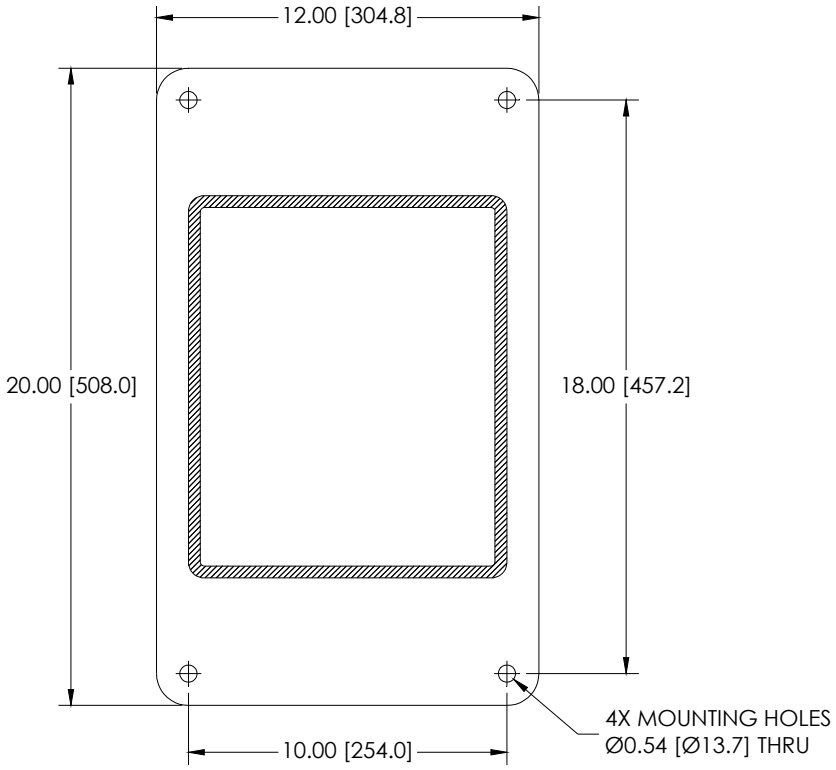

Figure 1. SFS81 Base Plate mounting holes

The SFS81 attaches with four (4) fasteners, 1/2 inch (12 mm) in diameter. These fasteners are to be provided by the installer.

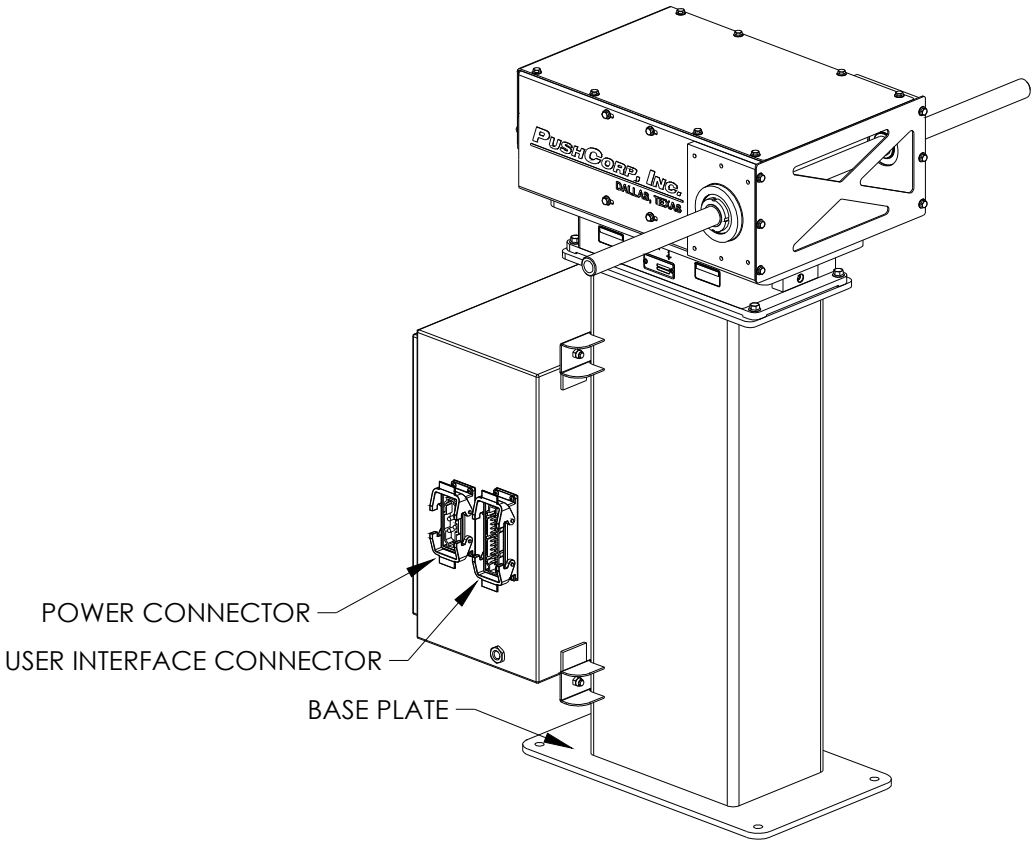

Figure 2. SFS81 Finishing Stand

3.2 Electrical Connections

The SFS81 requires 210-264 VAC 3-Phase 50-60 Hz. power to operate. This should be supplied to the Power Connector on the Control Box. The electrical connection for servo motor speed control and AFD position feedback pass through the User Interface Connector. Figure 3 shows a typical manual interface schematic, which could be implemented. The unit is supplied with plugs for both the Power Connector and User Interface Connector. The locations of the Power and User Interface Connectors on the Control Box are shown in Figure 2.

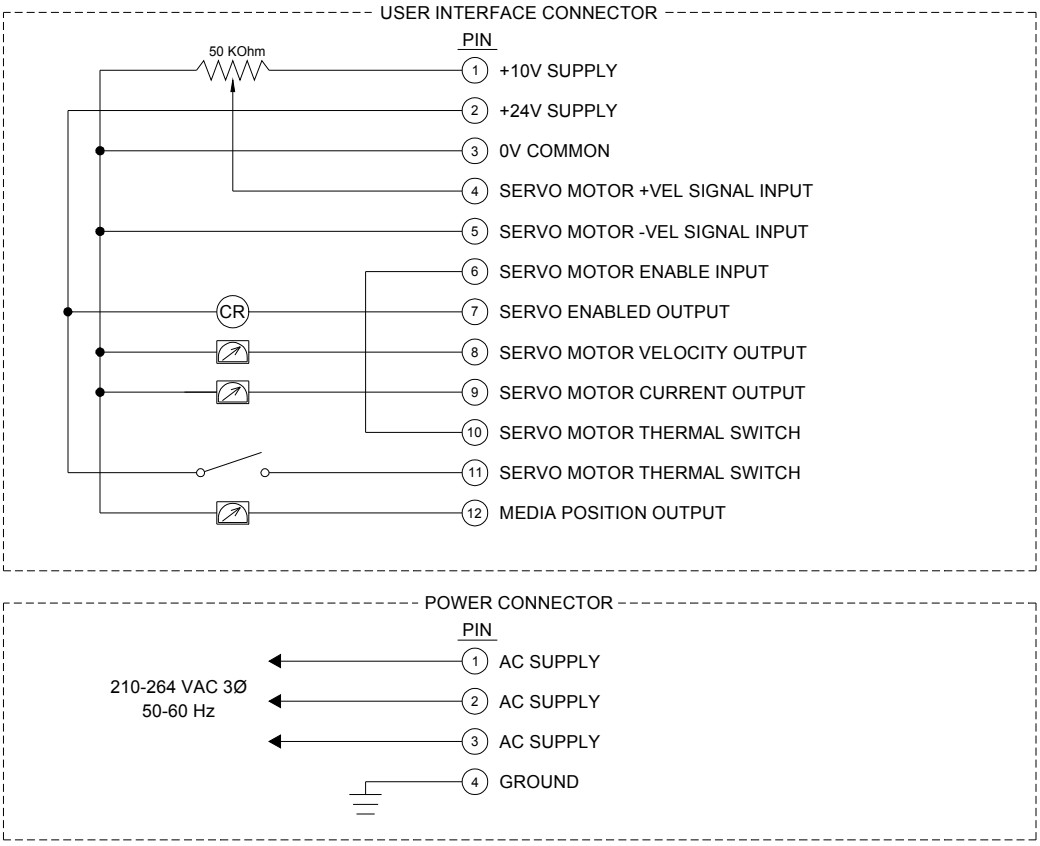

Figure 3. SFS81 Typical User Interface Schematic

The circuit diagram in Figure 3 shows the SFS81 wired for stand-alone panel operation. **All digital I/O on the SFS81 is designed for 24 VDC control voltages.**

The Media speed is controlled via a +/- 10 VDC analog signal applied to Pins 4 and 5. Providing a positive analog voltage will rotate the Output Shafts in a downward direction when facing the unit from the front. The SFS81 is normally rotated in this direction to direct dust to the floor or into a user supplied dust collection system. The analog input is a true floating differential signal connected directly to the servo amplifier. The circuit shown in Figure 3 is an example of how the Output Shaft speed may be controlled with a simple panel mount linear potentiometer. If remote robot teach pendent adjustment is desired, the potentiometer would be replaced with an analog signal from a robot analog output card connected directly to Pins 4 and 5.

WARNING: The differential voltage applied to Pins 4 and 5 should not exceed +/- 10 VDC or damage will occur to the servo amplifier.

Pin 6, shown in Figure 3 provides the servo amplifier enable signal. Connecting Pin 6 to Signal Ground on Pin 3 enables the servo amplifier and applies voltage to the servo motor. Disconnecting Pin 6 from Signal Ground (Pin 3) disables the amplifier.

WARNING: The servo amplifier should be enabled only when the Velocity Signal Input (Pins 4 and 5) is zero volts. Once the amplifier is enabled, the Velocity Signal Input may be slowly ramped up to the desired speed. Starting or stopping the servo motor too quickly will cause premature failure of the servo amplifier.

The circuit in Figure 3 demonstrates the recommended practice of connecting the Servo Motor Enable Input signal in series with the Servo Motor Thermal Switch. The Servo

Motor Thermal Switch is a normally closed bi-metal switch that opens when the internal motor temperature exceeds 100°C. The Servo Motor Thermal Switch leads are brought out to Pins 10 and 11. Placing the switch in series with the Enable signal ensures that the Servo Amplifier will be disabled if an over temperature condition occurs. Alternatively, the Servo Motor Thermal Switch may be monitored by an external PLC or robot controller if more elaborate fault detection is desired. **In any case, it is required that the servo amplifier MUST be disabled immediately if an over temperature condition occurs!**

Servo amplifier status may be monitored through Pins 8 and 9. Whenever the servo amplifier is enabled, these terminals will be shorted together. A fault condition is indicated if the amplifier is enabled and Pins 8 and 9 still remain open circuit.

Servo motor current, velocity, and Media position may be monitored via the +/- 10 VDC analog output signals available on Pins 8, 9 and 12, respectively. These signals are provided for information only and monitoring them is optional.

It is the responsibility of the System Integrator and/or End-user to follow all applicable electrical codes and OSHA safety standards when wiring the SFS81. This includes the proper and judicious use of fuses, contactors, cut-off switches, lock-out switches, and Emergency Stop circuits. PushCorp, Inc. assumes no responsibility or liability for the electrical system design and implementation of the SFS81 in the End-user application. Refer to OSHA rules and regulations, as well as the CE Machinery (IEC 204-1), when designing systems that include motors and drives to ensure that the user is protected.

PushCorp will provide answers to any questions regarding the servo drive system and will be responsible for any warranty issues.

3.4 Pneumatic Connections

The SFS81 Finishing Stand requires a dry, non-lubricated, 5 micron filtered, 80 to 100 psi (5 to 7 Bar) air supply with a 0.3 micron oil mist separator. Failure to provide supply air to these specifications can degrade performance and will void any warranty repairs concerning pneumatic components. Additionally, a *minimum* 80 psi (5 Bar) air pressure must be maintained for the device to operate within published specifications. Low air pressure will cause inferior force control performance.

The pneumatic supply system should be configured as shown in Figure 4.

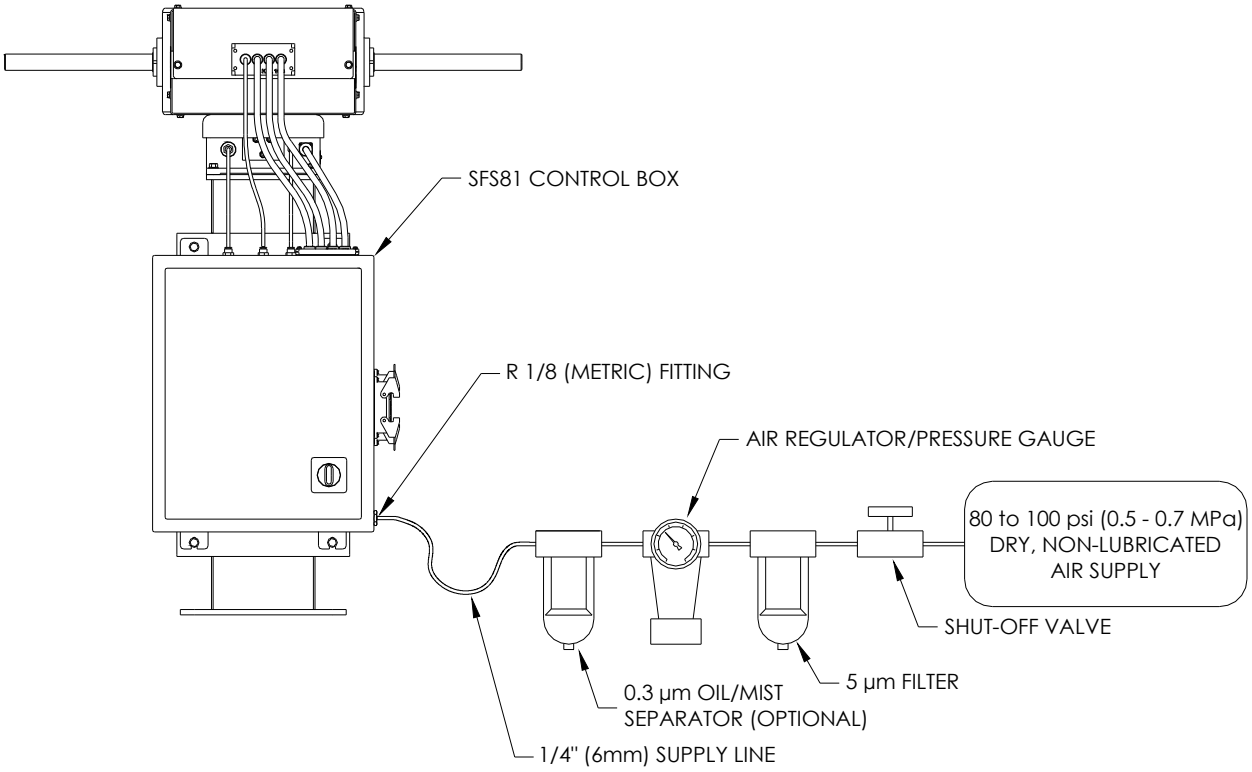

Figure 4. Pneumatic configuration

WARNING: If water condensation is present in your air supply system, an air dryer device is highly recommended. Moisture inside the device will cause premature failure that will not be covered under warranty.

The SFS81 Finishing Stand AFD maintains a positive air pressure to impede the infiltration of contaminate materials. It is important to provide a continuous compressed air supply to the device at all times if the work environment contains airborne contaminates. If the environment is clean during non-operational periods, the air supply to the device may be shut off.

The SFS81 has one pneumatic input, an R 1/8 (Metric) port located on the SFS81 Control Box (Figure 4). This port supplies all the air needed to operated the Finishing Stand. Before connecting the supply to the air fitting, open the supply valve to blow out any contaminates which may be in the line. Charge the supply line with compressed air and verify that there are no air leaks and that there is a minimum of 80 psi (5 Bar). If a minimum air pressure of 80 PSI cannot be achieved, then an auxiliary air compressor or booster pump must be installed.

4.0 Operation

4.1 Media Mounting

The SFS81 has dual 30mm Output Shafts that are a constant diameter and protrude 10.6 in. (271 mm) to allow flexibility in mounting the Media. The user is responsible for how they choose to mount their Media to the Output Shafts. An option PushCorp recommends is the use of an SKF 30mm Shaft Hub (SKF Part # SHT30, PushCorp Part #PAR02456). These may be purchased directly from SKF or through PushCorp. The hubs securely lock the Media Adapter Arbor to the Output Shaft in a way that keeps the Media concentric to the Output Shaft.

Figure 5, below, illustrates one method of mounting utilizing the SKF Shaft Hubs.

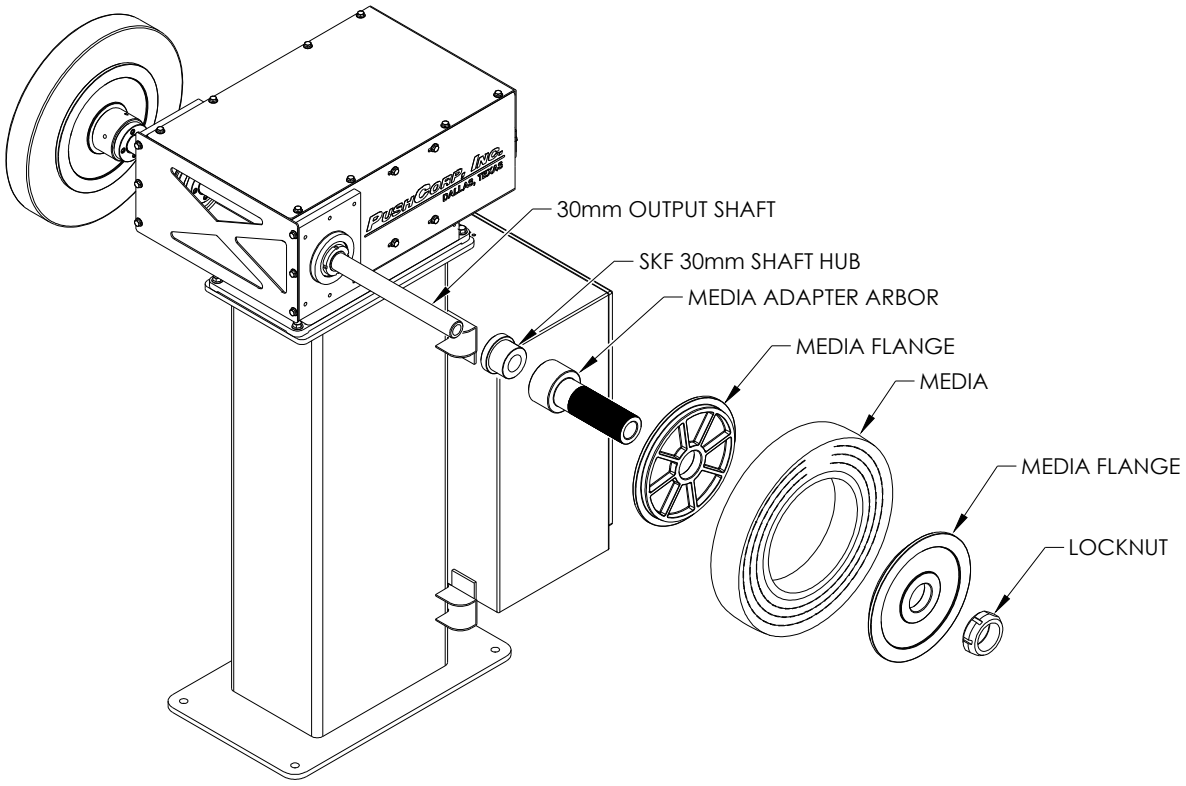

Figure 5. Example of Media mounting

4.2 Achieving Desired Force

The SFS81 uses a modified passive *80 Series* AFD to supply a compliant force from 2 to 100 lbs. (8 to 445 N). The passive force device requires the user to provide regulated air pressure to achieve a desired force output at the Media. Use the following equations to determine the pressure required to achieve the desired output force:

$$F_a = (1.4 \times P_s) \quad \text{English units}$$

$$F_{am} = (89 \times P_s) \quad \text{Metric units}$$

Where:

F_a = Net applied force (lbs.) at Media

F_{am} = Net applied force (N) at Media

P_s = Supply pressure (psi or bar)

PushCorp has included a manual regulator in the SFS81 Control Box to allow for quick set-up. This manually adjustable pressure regulator may be sufficient, but if remote operation of the force output is needed, then an electrically controlled proportional air regulator will be required. The accuracy of the force output is directly related to the precision and quality of the pressure regulator. A regulator that operates in a limited range (i.e., 0-15 psi) is required for the most precise force output.

4.3 Achieving Desired Media Speed

The Media rotational speed is controlled via a +/- 10 VDC analog signal applied to Pins 4 and 5 of the User Interface Connector. The user must scale the command voltage to the servo motor amplifier from 0 to 10 Volts, which equates to a Media rotational speed of 0 to 3000 rpm. The user is responsible for determining the maximum speed for their Media. The SFS81 is factory limited to operate at a maximum Output Shaft rotational speed of 3000 rpm. Figure 3 shows a simple circuit using a linear potentiometer to control Media speed, however most installations will require a remote voltage command to vary the rotational speed and control the acceleration/deceleration of the Media.

4.4 Drive Belt Replacement

The SFS81 uses a 2:1 reduction timing belt drive to transfer power from the Servo Motor to the Output Shaft. This drive incorporates a high-strength Gates Poly Chain GT2 belt, PushCorp Part No. PAR01889-1. Should this Drive Belt ever require replacement, contact PushCorp for the proper procedure.

4.5 Media Position Feedback

The SFS81 comes equipped with an internal potentiometer that provides a voltage signal based on the linear position of the Media. The voltage signal is at a minimum value when the Media are pushed back against the rubber stops, and a maximum value when the Media are pulled forward against the rubber stops. The total linear compliant stroke is 1.6 in. (40 mm).

The linear position signal must be calibrated for each installation. User calibration is easily accomplished using the following steps.

1. Turn off the supply air to the SFS81
2. Move the Media to the rearward (negative) position.
3. Read the voltage signal on Pin 12 of the User Interface Connector. Record this voltage for future reference. This will be referred to as V_{neg}.
4. Move the Media to the forward (positive) position.
5. Read the voltage signal on Pin 12 of the User Interface Connector. Record this voltage for future reference. This will be referred to as V_{pos}.
6. The position of the Media can now be determined by measuring the voltage (V_m) on Pin 12 of the User Interface Connector, and inserting the value into the following equation:

$$p = 1.6\ in. \times \left(\frac{Vm - V_{neg}}{V_{pos} - V_{neg}} \right) (English\ units)$$

$$p = 40\ mm \times \left(\frac{Vm - V_{neg}}{V_{pos} - V_{neg}} \right) (Metric\ units)$$

Where,

p = *Media Wheel Position (in., mm)*

Vm = *Voltage measured on POSN signal wire (V)*

V_{neg} = *Calibrated voltage at completely rearward position (V),* $(0\ inch, 0\ mm)$

V_{pos} = *Calibrated voltage at completely forward position (V),* $(1.6\ inch, 40\ mm)$

5.0 Technical Specifications

Maximum Applied Force: 100 lbs. (445 N)
Weight: 370 lbs. (168 kg)
Force Scale Factor: 1.4 lbs/psi (890 N/MPa)
Compliant Stroke: 1.6 in. (40 mm)
Supply air: Non-lubricated, Dry, 5µm Filtered, 100 psi (0.7 MPa) Max.
Supply Voltage: 240 VAC, 3-Phase
Max. Cont. Current: 30 Amps
Max. Peak Current: 60 Amps (2 Seconds)

Specifications subject to change without notice.

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