THE TENSION CONTROL SPECIALISTS

INSTRUCTION MANUAL

Model C Tension Transducer

DOC 801-0647 R14

Dover Flexo Electronics
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Rochester, NH 03867- 4630
U.S.A.

FOR ASSISTANCE:

TECHNICAL SERVICE - Installations, Start-Up, Troubleshooting, Repairs, Field Service or Returns. **Call (603) 332-6150 and ask for Technical Support or email us at: techsupport@dfe.com**

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SAFETY

This label indicates: “Read The Manual”

Make sure you read and understand all instructions and safety precautions listed in this manual before installing or operating your Model C Tension Transducer. If you have any questions concerning the operation of your device or the information in this manual, please contact us.

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- **Observe all warning labels.**
- **Never remove warning labels.**

WARNING: During installation care should be taken not to drop the Model C transducer, handle the Model C transducer with care, sudden jolts or drops can damage its components and serious injury could result.

WARNING: If this equipment is not connected or operated in the manner specified, the operating safety of this unit or of connected equipment cannot be guaranteed.

WARNING: Do not connect a standard excitation (5V) Model C transducer to a DFE amplifier with the Extended Range (XRE) option enabled (10V), the transducers may be damaged.

Table of Contents

DOCUMENT CONVENTIONS

NOTES - Highlight important concepts, decisions you must make, or the implications of those decisions.

CAUTIONS - Tell you when equipment may be damaged if the procedure is not followed properly.

WARNINGS - Tell you when people may be injured, or equipment may be damaged if the procedure is not followed properly.

Numbered lists indicate tasks that should be carried out in sequence:

1. First do this
2. Then do this

Bulleted lists are used for:

- Tasks that can be carried out in any order
- Itemized information

1 GENERAL DESCRIPTION

The Model C Tension Transducer is an electro-mechanical device that converts web tension into a DC voltage proportional to tension. The voltage is amplified in external electronic circuitry such as a DFE Tension Amplifier, Indicator or Closed-Loop Controller which is calibrated to output and/or display actual web tension. The tension reading is expressed in pounds, ounces, grams, kilograms, newtons or any other desirable units. It can also be supplied to a regulator circuit to control tension automatically.

The information in this section will help give a clear understanding of the Model C Transducer, how it works and how it is used.

1.1 CONSTRUCTION AND MECHANICAL OPERATION (SEE FIGURES 1 & 2)

In a typical installation, a transducer is mounted on each end of a standard idler roll. The roll shaft may be stationary (non-rotating or dead) in which case the transducer is known as the dead-shaft, or D version. Or the roll shaft may be rotating (live) and the transducer is known as the live-shaft, or L version. The D version has a split coupling that clamps the shaft and allows removal of the idler roll from the transducers without removing the transducers from the machine. The L version has a special tapered shaft bushing and precision, self-centering coupling which eliminates shaft run-out.

The shaft coupling assembly contains a self-aligning bearing which allows the coupling to compensate for misalignment and deflection of the idler roll shaft. This compensation is extremely important because it prevents mechanical pre-loading of the transducer which causes inaccurate tension measurement and may damage the transducer. A small amount of axial movement is built into the shaft coupling to compensate for variations in shaft length caused by temperature fluctuations and shaft bending.

Inside the transducer is a dual cantilever beam with strain gages mounted on the top and bottom surfaces. The shaft coupling is attached to the free end of the beam. When web tension is applied the beam deflects a small amount, causing an electrical output from the strain gages.

A mechanical stop prevents damage from accidental overloads. The stop is functional through 360 degrees, so the overload condition may occur from any direction, not just the load direction. In all cases, the beam is prevented from deflecting far enough to cause any damage.

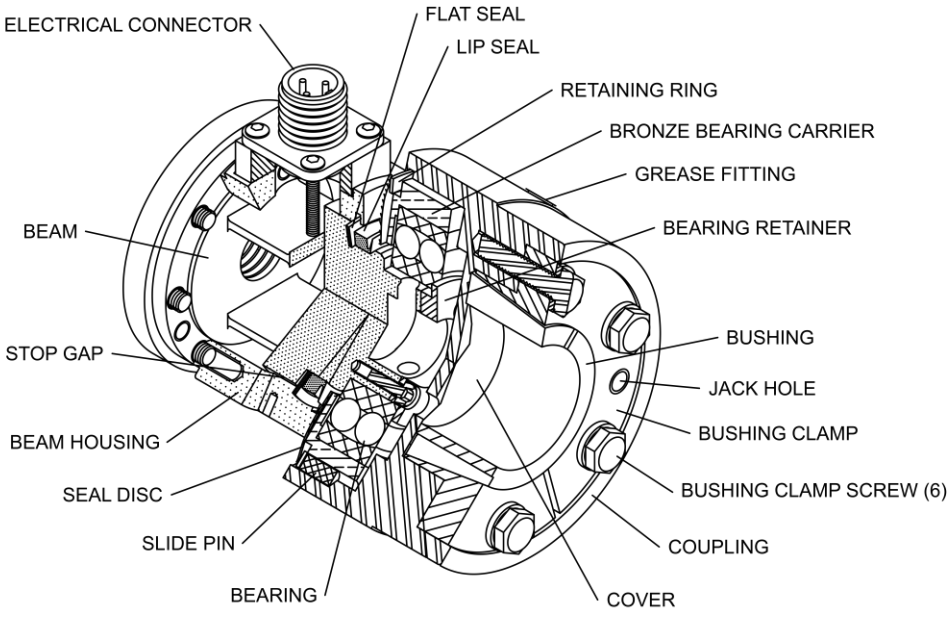


Figure 1 **- LIVE SHAFT VERSION CUT-AWAY VIEW**

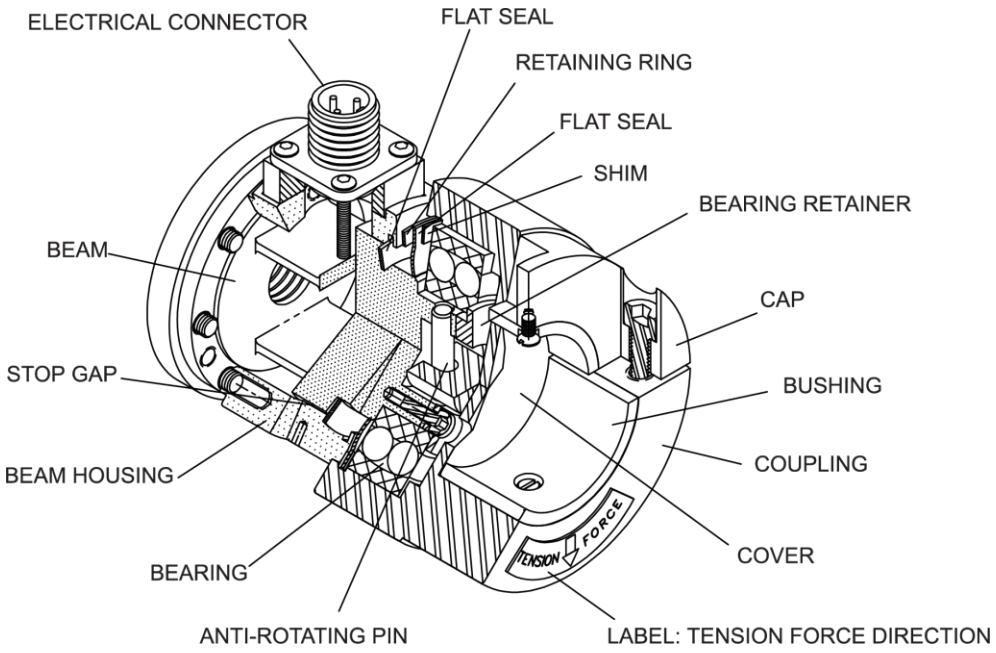


***Figure 2* - DEAD SHAFT VERSION CUT-AWAY VIEW**

1.2 SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

Excitation Voltage: 5 VDC Max (Std), 10 VDC Max (XR Option)
Output: 50 mV/V, Nominal
Strain Gages: Semiconductor, 120 Ohms (+/- 20 Ohms) Resistance
Repeatability: +/- 1/4% Full Span (FS)
Linearity and Hysteresis Combined: +/- 1/2% FS
Temperature Range: -10° F to +200° F (-23° C to +93° C)
Temperature Coefficient: 0.02% per Degree F, Typical (0.01% per Degree C, Typical)
Electrical Connections:
White Wire: Signal Output
Black Wire: Excitation (+)
Red Wire: Excitation (-)
Mating Electrical Connector:
MIL-Spec (Standard) - 3 Socket, Female. DFE P/N: 721-1445.
M12 (Option) - 4 Position, Female, A-Code Type.

MECHANICAL SPECIFICATIONS

Materials: 303 Stainless Steel, 6061-T6 & 7075-T6 Aluminum
Minimum Overload Capacity:
Size 0/1 - 1200 lbs (5338 N)
Size 2 - 2500 lbs (11121 N)
Deflection: 0.005" typical (0.127 mm typical)
Misalignment Capacity: 2°
Standard Connector Position:
S, FL and PFL styles - 6 O'clock
PB and TF - Rear
Maximum Coupling Bore / Shaft Sizes:
Size 0/1 - Live (L) = 1.00" (25 mm), Dead (D) = 1.50" (35 mm)
Size 2 - Live (L) = 1.50" (40 mm), Dead (D) = 1.75" (40 mm)
Shaft Size Tolerance: Nominal -0.002" (-0.051 mm)

Load Ratings:
Size 0/1 - 10, 25, 50, 100, 150 lbs (45, 110, 225, 450, 670 N)
Size 2 - 25, 50, 100, 200, 400, 800 lbs (110, 225, 450, 900, 1800, 3550 N)
Break-Away Torque (typical with greased bearing, live shaft version only):
Standard Seal
Size 0/1 - 4.5 oz-in / Unit (0.032 Nm / Unit)
Size 2 - 6.5 oz-in / Unit (0.046 Nm / Unit)
Labyrinth Seal
Size 0/1 - 0.3 oz-in / Unit (0.002 Nm / Unit)
Size 2 - *Option Not Available*

1.3 STANDARD FEATURES

Dual Cantilever Beam: Provides high strength and accuracy at low tension.
Grease Fitting: Allows quick lubrication without disassembly or removal from machine (live shaft version only).
Stainless Steel and Aluminum Construction: Excellent corrosion resistance.

1.4 CONFIGURATION CHOICES

These are explanations of standard choices of various configurations that were specified for your application.

Size: The cartridge size influence overall unit length, shaft coupling sizes and available load ratings.
Coupling Style: Live for rotating shafts, or Dead for stationary or non-rotating shafts.
Mounting Style: Screw or Bolt mount (S) uses a single bolt to mount to machine frame. Pillow Block bracket (PB) uses a right-angle bracket to mount onto the machine frame. Flange mount (FL) uses a four-bolt flange mounted onto the machine frame which can be rotated to any position for precise orientation. Through-Frame (TF, Size 2 only) style inserts a collar into the wall of the machine frame and is clamped with a flange outside the frame wall. Piloted Flange (PFL) fits directly in place of industry standard RFC1 style 3.0" piloted flange bearings.
Load Rating: The system should be sized to accommodate Net force resulting from material wrap angle, tension and force direction N)
Bore / Shaft Size: Determined by the cartridge and coupling size. See available sizes in section 1.2.
Force Direction: Selection applies only to Pillow Block bracket style. Choices are: 1:30, 3:00, 4:30, 6:00 (std), 7:30, 9:00, 10:30, 12:00.
NOTICE ***Note:*** Alignment of force direction can be more accurately accomplished at final installation.
Connector Position: Choices are as follows - **S, FL, PFL**: 1:30, 3:00, 4:30, 6:00 (std), 7:30, 9:00, 10:30, 12 o'clock. **PB**: 1:30, 3:00, 9:00, 10:30, 12 o'clock, and Rear (std). **TF**: Rear position only.

1.5 OPTIONS

Full Bridge (FB): Four strain gauges instead of two to form a Wheatstone Bridge connection. Applies only if one transducer is used.
Labyrinth Seal (LS): For very low break away torque. Used on Live shaft version only.
M12 Connector (M12): 4 position A-code male connector that fits industry standard cables.
Metric Mounting Screw (MMS): Metric mounting thread for S-mount style cartridge.
Vacuum Compensation (VAC): Transducer has special screws and features for fast and complete air evacuation. Used for transducers installed in vacuum metallizers. *Qualify application specs with Sales Dept prior to ordering.*

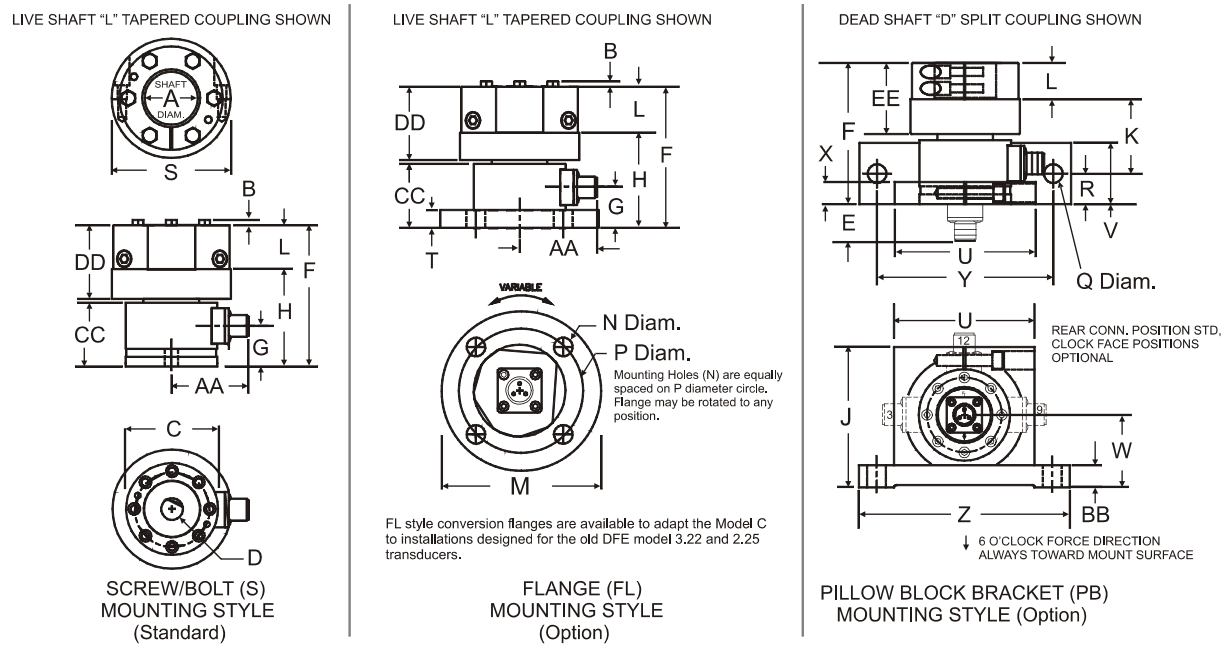
2 INSTALLATION

2.1 DIMENSIONS INCHES (MM)

SIZE		A (D) [1]	A (L) [1]	B	C	D	E	F (max)	G	H (max)	J	K (max)	L	M	N	P
0	**in.**	**1.50**	**1.00**	**0.13**	**1.80**	**3/8 - 16**	**1.20**	**3.02**	**0.95**	**2.45**	**2.75**	**1.62**	**0.56**	**3.12**	**0.34**	**2.50**
	mm	30	25	3.3	45.7	M10 x 1.5	30.5	76.7	24.1	62.2	69.9	41.4	14.2	79.2	8.6	63.5
1	**in.**	**1.50**	**1.00**	**0.13**	**1.80**	**1/2 - 13**	**1.20**	**3.18**	**0.95**	**2.61**	**3.01**	**1.71**	**0.56**	**4.00**	**0.43**	**3.25**
	mm	30	25	3.3	45.7	M12 x 1.75	30.5	80.8	24.1	66.3	76.5	43.4	14.2	101.6	10.9	82.6
2	**in.**	**1.75**	**1.50**	**0.16**	**2.60**	**5/8 - 11**	**1.04**	**4.00**	**1.15**	**3.00**	**3.99**	**2.16**	**0.98**	**4.49**	**0.53**	**3.50**
	mm	40	40	4	66	M16 x 2	26.4	101.6	29.2	76.2	101.3	54.9	24.9	114	13.5	88.9

Notes: 1. Bushings are available for smaller shaft diameters. **D** = Dead Shaft, **L** = Live Shaft.

SIZE		Q	R	S (L)	S (D)	T	U	V	W	X	Y	Z	AA	BB	CC	DD (L)	EE (D)
0	**in.**	**0.43**	**0.81**	**2.26**	**2.26**	**0.375**	**2.50**	**1.37**	**1.37**	**0.38**	**3.25**	**4.25**	**1.60**	**0.38**	**1.50**	**1.33**	**1.43**
	mm	10.9	20.6	57.4	57.4	9.5	63.5	34.8	34.8	9.7	82.6	108	40.6	9.7	38.1	33.8	36.3
1	**in.**	**0.53**	**0.72**	**2.26**	**2.26**	**0.535**	**2.50**	**1.41**	**1.63**	**0.38**	**4.00**	**5.38**	**1.60**	**0.38**	**1.66**	**1.33**	**1.43**
	mm	13.5	18.3	57.4	57.4	13.6	63.5	35.8	41.4	9.7	101.6	136.7	40.6	9.7	42.2	33.8	36.3
2	**in.**	**0.53**	**0.87**	**3.38**	**3.11**	**0.375**	**4.00**	**1.74**	**2.06**	**0.63**	**5.00**	**6.00**	**2.49**	**0.63**	**1.81**	**2.04**	**2.09**
	mm	13.5	22.1	85.9	79	9.5	101.6	44.2	52.3	16	127	152	63.2	16	46	51.8	53.1



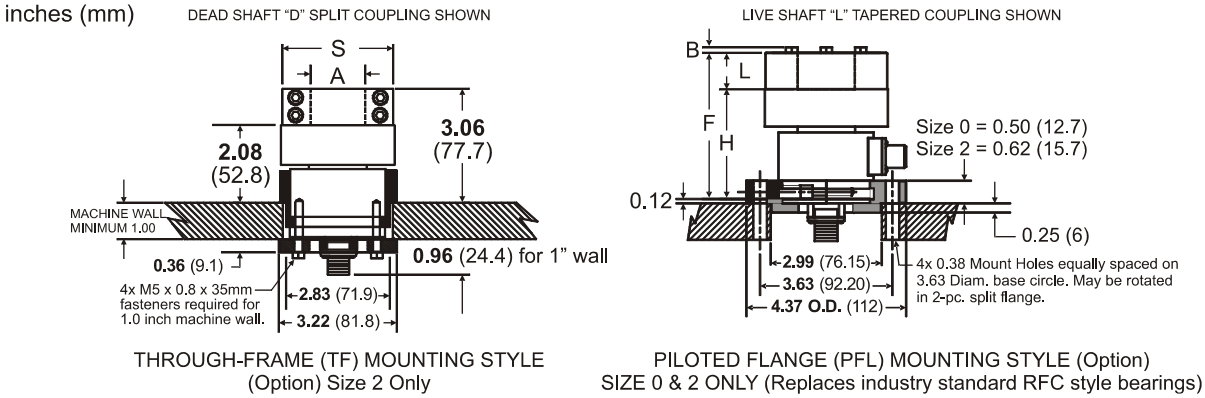


***Figure 3* - DIMENSIONS**

2.2 PRE-INSTALLATION REQUIREMENTS

1. TRANSDUCER ROLL

The Model C Transducers are used in pairs. One is mounted on each end of an idler roll shaft. The roll chosen is called the Transducer Roll or Load Cell Roll.

1. **The Transducer Roll must be a true idler,** it cannot be a driven roll. There can be no brakes, clutches, belts, chains, or gears attached to it or its shaft. It cannot be a nip roll or be in contact with a nip roll. It cannot be filled with water or have pipes or hoses attached to it. **Nothing must contact the roll or its shaft except the web.**
2. The Transducer Roll shaft may be non-rotating (use the D version transducer) or rotating (use the L version transducer). It must be designed and built for rotating service. Usually this means that it is straight, dynamically balanced, and strong enough to resist bending from web tension forces.
3. **The roll must be dynamically balanced if web speed is over 300 FPM.** Refer to Section 2.3.2 for specifications. **An unbalanced roll will reduce the accuracy of the tension signal and may damage the transducers.**

2. WRAP ANGLE

The web must always contact the transducer roll the same way. The wrap angle must not change as the unwind or rewind roll diameter changes. Therefore, there must be at least one idler roll between the transducer roll and the unwind or rewind shaft. If the machine has more than one webbing path, be sure to choose a roll that is wrapped the same for each. Otherwise, it will be necessary to install an additional pair of transducers, or dual calibration circuitry, or both. If the wrap angle is allowed to change, the transducer output will change with angle as well as tension, and accuracy will be reduced. A minimum wrap angle of 20° is recommended to ensure roll traction and prevent slippage.

3. MOUNTING SURFACE

The structure on which the transducers are mounted must be very stable and strong. Any movement of the structure may be sensed by the transducers and may cause inaccurate tension readings. The surfaces must also be smooth and flat, so the transducers won't be crooked when they are installed. The transducer is mounted on the machine frame by one of five methods: A single Screw (S), four-bolt Flange (FL), Pillow-Block bracket (PB), Through-Frame (TF) and Piloted-Flange (PFL) as illustrated below.

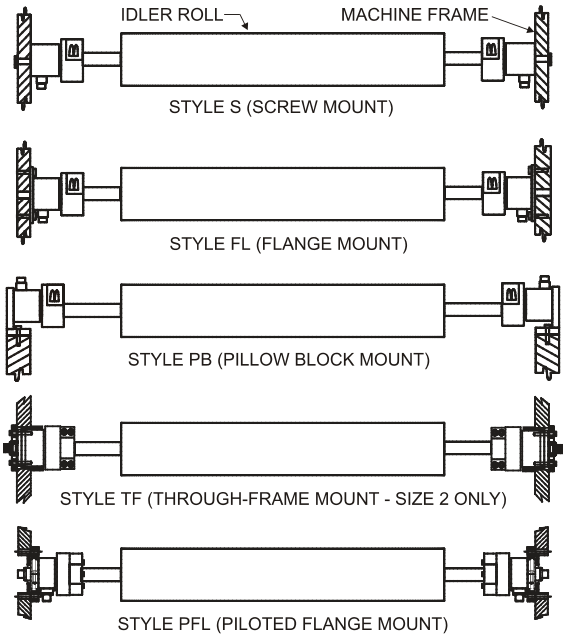


Figure 4 **- MODEL C MOUNTING STYLES**

4. TENSION ZONE

The roll must be located in the tension zone which is to be monitored or controlled. The beginning or end of any tension zone is always at a nip (driven or braked), unwind shaft, rewind shaft or drag bar. Any element in the web path that can change web tension is at one end of a tension zone.

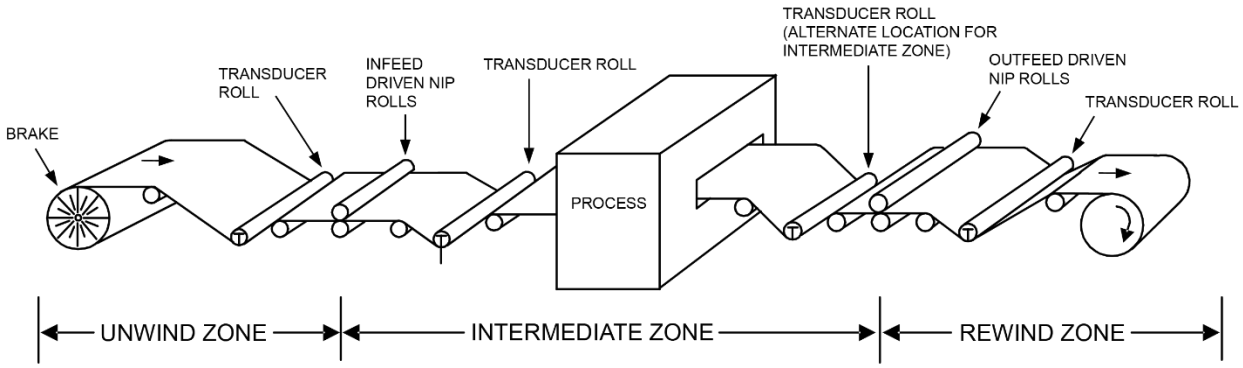


***Figure 5* - TENSION ZONES**

2.3 INSTALLATION INSTRUCTIONS

Model C Transducers are very easy to install. For the Dead Shaft (D) version, both transducers are mounted on the machine and the roll is then installed in them. For the Live Shaft (S) version, the second transducer must be installed with the roll. Follow the simple steps below.

1. DETERMINE SHAFT LENGTH

Measure the distance between the machine frames (D) where the transducers will be mounted. Use the appropriate formula below to determine the correct shaft length. The formulas allow approximately 1/16-inch (1.5 mm) clearance at both shaft ends. This clearance is necessary for proper operation and for ease of installation and removal. **Do not allow the shaft to contact the bottom of the bore** (see Figure 6).

NOTICE ***Note:*** For PB style, D_{pb} is distance between PB bracket mounting hole centers.

SHAFT LENGTH CALCULATION			
SIZE	**STYLE S, FL**	**STYLE PB**	**STYLE PFL**
0	L = D - 5 1/16 in (129 mm)	L = D_{pb} - 3 7/16 in (87 mm)	N/A
1	L = D - 5 3/8 in (137 mm)	L = D_{pb} - 3 9/16 in (90 mm)	N/A
2	L = D - 6 3/16 in (157 mm)	L = D_{pb} - 4 3/8 in (111 mm)	L = D - 3 9/16 in (90 mm)
L = Shaft length in inches		D = Distance between mounting surfaces in inches D_{pb} = Distance between PB bracket mounting hole centers in inches	

2. BALANCE THE ROLL

The roll must be dynamically balanced if web speed is 300 FPM or more. Balance the roll to Quality Grade G-2.5 as described in ISO 1940 and ANSI S2.19-75 standards. If these standards are not available, please contact Dover Flexo Electronics and we will provide the appropriate data.

3. INSTALL THE ROLL AND TRANSDUCERS ON THE MACHINE

This part of the installation is different for the (D) and (L) versions. Use the procedure under letter A for the (D) version. Use the procedure under letter B for the (L) version. However, refer to Figure 7 for both versions for illustration of the shaft end clearance.

Installation Procedure for the D (dead shaft) Version:

1. Remove the cap from the shaft coupling by removing the coupling cap screws. Mount the transducers on the machine. If you are installing Mounting Style “S”, “FL”, “PFL”, or “TF”, leave

the mounting bolts loose enough to allow the transducers to be turned easily by hand. If you are installing Mounting Style “PB”, tighten the mounting bolts securely now.

2. Turn the couplings so that the roll shaft will rest in the bottom half of the coupling when installed. Lift and set the roll in place with the shaft ends resting in the bottom bushing halves of both transducer couplings.
3. Install the coupling caps (with the attached shaft bushings) but leave the screws loose.
4. Adjust the shaft depth to allow approximately 1/16-inch (1.5 mm) end clearance in **one transducer only** (see Figure 6). Tighten the cap screws to clamp the shaft into the transducer coupling. **Do not tighten the cap screws on the other transducer yet.** This must be done later in Section 2.3.5 - *Tighten The Loose Transducer Coupling*.

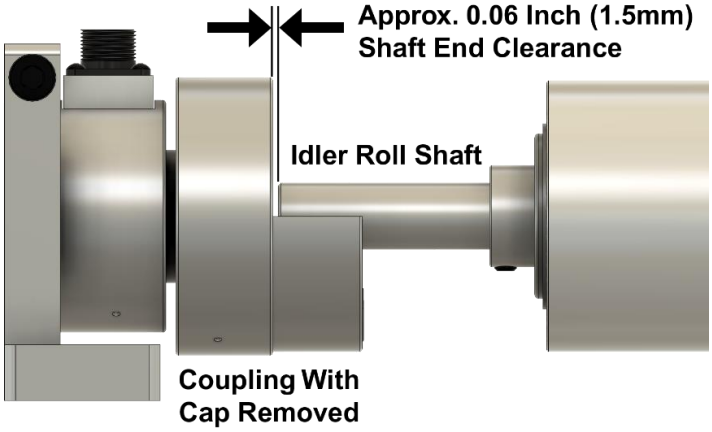


Figure 6 **- SHAFT END CLEARANCE**

Installation Procedure for the L (live shaft) version:

IMPORTANT: The coupling cap for the live shaft version has been made removable to allow the roll shaft to be taken out without loosening the transducers from the machine frame. **The cap must not be used to clamp the roll shaft. The cap must be tightened before the bushing clamp is tightened. If not, severe shaft run-out will occur. Follow the procedure below.**

1. Remove the coupling cap, bushing clamp, and shaft bushing from each transducer.
   NOTICE ***Note:*** Each cap should be kept paired with the coupling from which it was removed to ensure bushing clamp alignment.
2. Slide the bushing clamps and then the shaft bushings onto each end of the idler roll shaft.
3. Position the idler shaft in the transducers to allow approximately 1/16-inch (1.5 mm) end clearance in **one transducer only** (See Figure 6).
4. Slide the shaft bushing over the shaft and into the transducer coupling until the bushing touches the bottom of the bore. Mark the exposed shaft so the 1/16-inch end clearance is ensured.
5. Slide the bushing clamp over the bushing as far as it will go without forcing it. The bushing clamp helps position the shaft but **must not** interfere with the cap installation.
6. Start the three bushing clamp screws into the coupling. Do not tighten them yet. This will be done later.
7. Place the coupling cap for this coupling over the bushing clamp and install the two cap screws that fasten the cap to the body. Tighten them securely.
   PERFORM THE FOLLOWING STEPS ON ONE TRANSDUCER ONLY
8. Start the three bushing clamp screws that screw into the cap.
9. Tighten all six bushing clamp screws alternately and progressively, ½ turn at a time to lock the shaft into the transducer. For heavy transducer rolls it is helpful to rotate the shaft and coupling together while tightening the six clamp screws to assist in centering the weight in the tapered bushing and clamp. (Be sure the other end of the transducer roll is supported so that it will not fall as the coupling rotates.) **Do not tighten the bushing clamp screws on the second transducer yet.** This must be done later, in Section 2.3.5 - *Tighten The Loose Transducer Coupling*.

4. **ALIGN THE TRANSDUCERS (see Figure 7)**
The transducers must be turned so the *tension force arrow* (or the notch on the rear edge of the beam) points in the same direction as the force direction of the web or filament wrap.

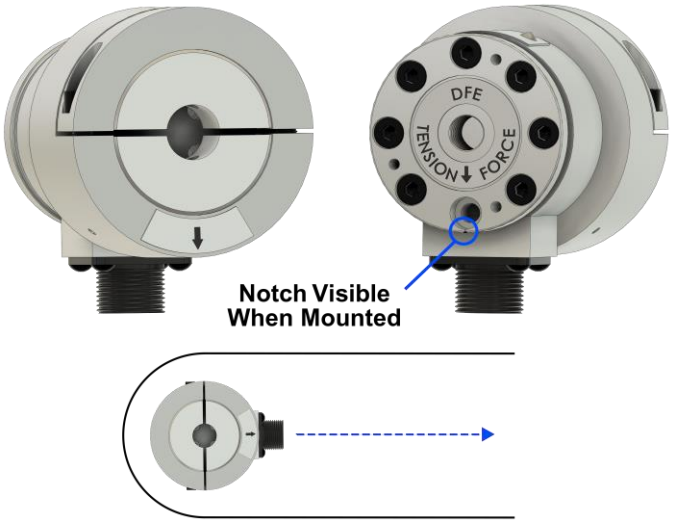


***Figure 7* - TENSION FORCE DIRECTION**

If you are installing "S", "FL", “PFL”, “TF” style transducers, **turn both transducers by hand** (do not use a wrench) so the arrow (or notch) bisects the wrap angle. Tighten all mounting bolts. If you are installing "PB" bracket style transducers, the transducer is already assembled with the force direction orientation specified when purchased. It can be aligned more accurately by loosening the clamp bolt on top of the bracket and turning the transducers by hand (pry the top of the bracket open with a screwdriver, if necessary), re-tighten the clamp bolt.

5. **TIGHTEN THE LOOSE TRANSDUCER COUPLING** (follow the instructions below very carefully)
For any tension transducer to operate properly, there must be some axial (along the idler shaft) movement capability to allow for shaft deflection and length variations caused by temperature fluctuations. The Model C transducer is designed with approximately 0.040 inch (1.0 mm) of axial compensation per transducer with a maximum of 0.080 inch (1.5 mm) per pair. To preserve this capability, follow the instructions below. A normal installation will have about 0.040 inch (1.0 mm) of axial movement. The D version coupling should also have a small amount of rotational free play (see Figure 9).

Procedure for the D (dead shaft) version:

Refer to Figure 8. Remember, the left end transducer is tightly clamped to the shaft and the right end coupling cap is loose.

1. Pull the roll toward the loose coupling on the right end while pushing this coupling away from the roll.
2. Rotate the shaft and the loose coupling a small amount by hand in the same direction until they both stop.
3. Tighten the coupling cap screws alternately and progressively ½ turn at time to clamp the shaft into the transducer coupling.

Procedure for the L (live shaft) version:

1. Install the coupling cap, securely tightened as in section 2.3.3 (live shaft procedure). Loosely start the six bushing clamp screws, then tighten as described in the same section (they are pictured in Figure 11). Refer to Figure 8 (normal installation). Remember, the left end transducer is tightly clamped to the shaft and the right clamp is loose.

2. Pull the roll toward the loose coupling on the right end while pushing this coupling away from the roll and tighten the six bushing clamp screws alternately and progressively, ½ turn at a time, to clamp the shaft into the transducer coupling.

Special procedure for hot installations: If the idler roll is exposed to high temperatures (from a hot web, for example), it may be advisable to maximize the axial play to allow the shaft length to expand more without danger of preloading the transducers. To increase axial play to the maximum; follow the procedures in Section 2.3.5, then push the loose coupling **toward the roll** instead of away from it. Refer to Figure 8 (hot installation). This will double the available axial expansion capability as compared to the normal installation procedures.

If shaft length is correct and installation has been done correctly, you will be able to move the idler roll shaft axially at least 0.040 inch (1.0 mm). **The axial movement is essential to the proper operation of the transducers, verify the axial movement now.** Use a feeler gage placed in the gap between the shaft coupling and beam housing to measure the movement (see Figure 9). On PB style mounting there is some adjustment to this movement with the clearance holes of the mounting bolts.

NOTICE ***Note:*** If you implement the special procedure for hot installations correctly, you will not be able to measure any axial movement until the roll/shaft temperature increases, resulting in thermal expansion.

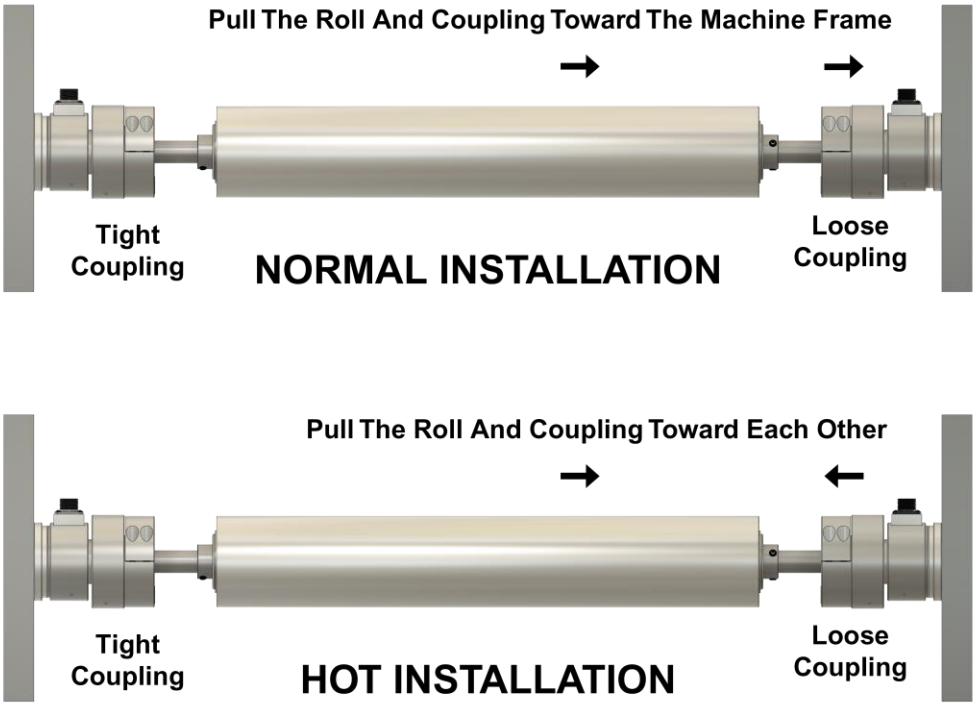


Figure 8 - **ADJUSTING FOR AXIAL PLAY**

Figure 9 - **AXIAL AND ROTATIONAL PLAY**

If no movement can be detected, loosen one shaft coupling and repeat the installation procedures, Section 2.3.3 (live or dead shaft). Also verify the rotational free play (D version, only) at this time (see Figure 9). Not much is needed, only enough to be able to feel. If none is detected, loosen one shaft clamp and turn both the idler shaft and the loose coupling in the SAME direction. Then re-tighten the clamp.

The rotational and axial movements eliminate the possibility of mechanically pre-loading the transducers. Pre-loading causes non-Linearity, zero-drift, and loss of calibration.

NOTICE ***Note:*** It is important for accuracy and safety that the cap screws on D version and bushing clamp screws on L version, be tightened firmly.

6. **CHECK THE GAP FOR BEARING AXIS ALIGNMENT (see Figure 9)**
   Up to 2° of bearing axis alignment is acceptable in dead shaft applications. Bearing misalignment will cause premature failure in live shaft applications. Measure the gap between the shaft coupling and the beam housing in at least four places equally spaced around the circumference of each transducer. A misalignment of 2° will measure 0.056 difference in clearance to the beam housing around the opposite side of circumference. Shim or reposition the transducers at the mount surface as necessary. If shims are installed, check the axial movement again. Refer to step 5 for the procedure. Be sure the correct axial movement is present.

2.4 REMOVAL OF ROLL AND/OR TRANSDUCERS

To remove the transducers, first support the idler roll so it won't fall. Then, follow the appropriate procedure below to remove the roll shaft from the transducers.

Procedure for the D (dead shaft) version:

1. Remove the four screws from the coupling cap on each transducer and lift off the cap.
2. Take the roll out of the transducers.

Procedure for the L (live shaft) version:

1. Remove the six bushing clamp screws from each transducer coupling.
2. Thread two of the screws into the jack holes in the bushing clamp (see Figure 10). Turn until finger-tight.

Figure 10 - **LOCATION OF COUPLING JACK HOLES**

3. Alternately tighten each screw a half turn at a time to back the bushing clamp out of the coupling until the cap, bushing and bushing clamp are loose.
4. Remove the two screws from the coupling cap on each transducer and lift off the cap.

NOTICE ***Note:*** The cap and coupling body are fit together as one assembly at the factory and should remain paired together in service.

2.5 ELECTRICAL OPERATION

The Model C Transducer is used in pairs, one on each end of an idler roll shaft. Web tension exerts a force on the roll which is transmitted to the cantilever beam by the shaft coupling. Two semiconductor strain gages are mounted on the beam, one on the top and one on the bottom. As force is applied and the beam deflects, the top gage is stretched, and the bottom gage is compressed. This increases the electrical resistance of the top gage and decreases the resistance of the bottom gage. The gages in both transducers are electrically connected in a Wheatstone bridge configuration. The output from the bridge is the sum of the output from the two transducers. Therefore, web position, width and loose or tight edges do not affect the accuracy of the tension signal.

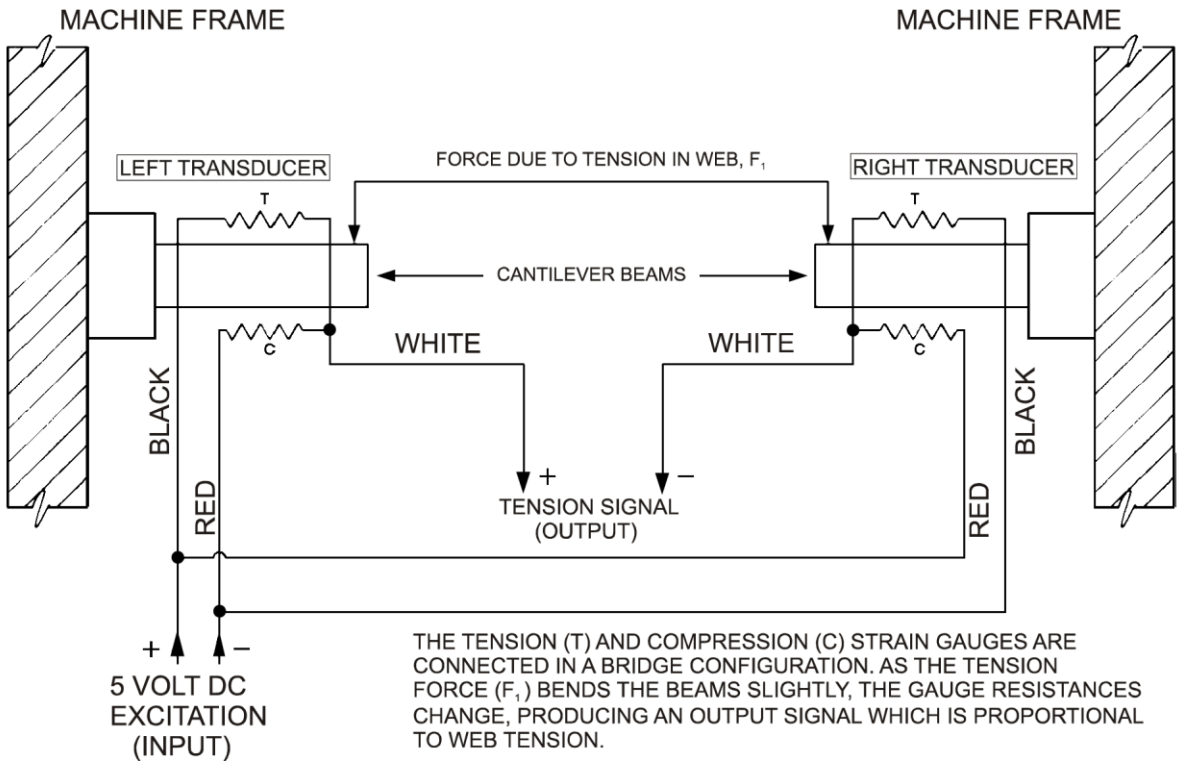


Figure 11 **- STRAIN GAGE CONNECTIONS**

The physical location of the strain gages, on opposite sides of the beam, ensures that each gage experiences the same temperature variations. This, and the Wheatstone bridge configuration, provides automatic temperature compensation and a stable output.

The strain gages are high output semiconductor devices which typically have an output sixteen times greater than the inexpensive foil gages used in some transducers. Therefore, the signal amplifier used with these Model C transducers is a very stable low-gain design. An added benefit of the high output is inherent immunity to electrical noise.

3 CALIBRATION AND SETUP

3.1 INTRODUCTION

No physical calibration adjustments are required with the Model C Transducer. Follow the electronic calibration steps listed in the manual of the Tension Controller, Indicator or Amplifier being used with the device. Some general calibration instructions are listed below for reference.

3.2 ZERO THE AMPLIFIER, INDICATOR OR CONTROLLER

1. With no weight on the idler roll and power connected to the devices, press the *Quik-Cal*™ **Zero** button on the supported amplifier or indicator. If using a touchscreen indicator or controller, press the **Zero** command at the touchscreen menu prompt.

3.3 CALIBRATE THE TENSION METER

1. See Figure 12. Pass the rope over the Transducer Roll and through the same path as the web follows. Tie the end to the machine at least one idler roll beyond the Transducer Roll. Pass the other end by at least one idler roll before the Transducer Roll. Be sure the rope does not pass over any driven rolls, braked rolls, or dead bars (this will cause inaccurate calibration). Attach the weight to the free end of the rope and let it hang without touching anything.
2. **Wait for the weight to stop swinging**.
3. Press the **Calibrate** button on supported *Quik-Cal*™ amplifiers and indicators or press the **Calibrate** command at the touchscreen menu prompt.
4. This concludes the calibration procedure.

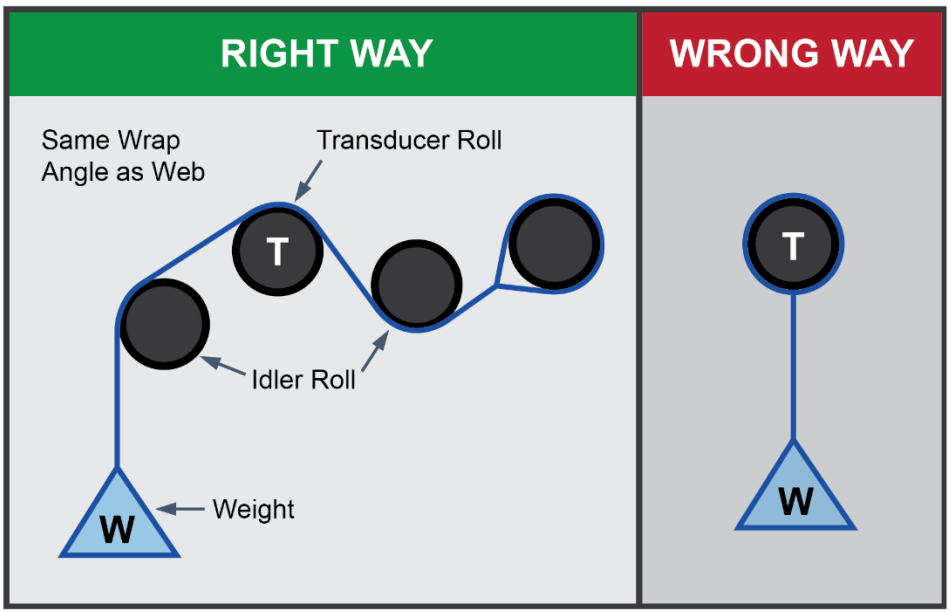


Figure 12 **- WEB PATH**

4 CARE AND MAINTENANCE

Dover Flexo Model C Tension Transducers are manufactured of quality materials. Transducers that operate within established load, speed and environmental guidelines will be relatively maintenance-free and long-lasting. Any changes in your application which affect the dynamics of your equipment such as web speed, net force, material, etc. may require an increase or decrease in load rating or the replacement of an idler roll. Contact the DFE sales dept to review significant application changes and obtain engineering approval.

4.1 BEARING LIFE

The coupling bearing in the L (live or rotating shaft) version of the Model C transducer will turn continuously in normal operation. It has been selected to give a long service life under typical operating conditions if properly maintained with lubrication. Use the formulas below to find the L10 life, in hours, for your application.

To find the radial load (P) for your application, use the appropriate sizing formula in Appendix B, substituting 2 for the 4 in the numerator to eliminate the oversizing factor.

RPM = 3.82 x web speed in feet per minute/diameter of transducer roll in inches.
RPM = 318.3 x web speed in meters per minute/diameter of transducer roll in millimeters).

BEARING SPECIFICATIONS			
Size	**Bearing Type**	**Rated Load (C)**	**Maximum Speed (RPM)**
0	Ball	1,990 lbs (8,840 N)	18,700
1	Ball	1,990 lbs (8,840 N)	18,700
2	Ball	3,510 lbs (15,600 N)	11,050

LIFE CALCULATION FORMULAS *(where P is radial load as described above)*
$L10 = (16667 / RPM) \times (C / P)^3$, for ball bearings

An L10 life of 20,000 to 30,000 hours is usually considered satisfactory for web process machinery such as printing presses, coaters, etc.

4.2 LUBRICATION

The coupling bearing is lubricated at the factory with a high-quality light grease. For the D version (dead shaft), this should be adequate for the life of the transducer. Follow the procedure below for L version (live shaft) transducers.

1. PROCEDURE

The grease fitting is a flush-to-the surface type. (See Figure 13 for location). Use a hand operated push-type grease gun and fill the housing only 1/3 to ½ full (see chart below for housing capacity). Too much grease will increase friction, causing the transducer to turn hard. It also causes churning, resulting in separation of the grease components, breakdown in lubricating value and excessive temperature. Grease life is halved with every 25°F (14°C) increase in temperature and is doubled with every 25°F (14°C) reduction in temperature. Please read the CAUTION in Section 4.2.4 on next page.

GREASE CAPACITY CHART	
Size 0,1	0.21 oz. (6.2 cc)
Size 2	1.0 oz. (29.6 cc)

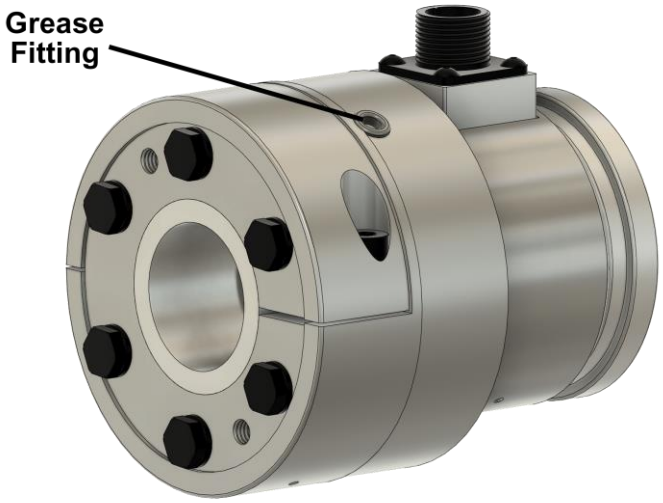


Figure 13 **- GREASE FITTING LOCATION**

2. RECOMMENDED GREASE

The grease should be a non-fibrous NLGI No.2 grade. The thickener should be a lithium or lithium complex soap for resistance to water and high temperature. Greases with a polyurea thickener are also suitable. In any case, the maximum rated operating temperature of the grease should be at least 250°F (104°C). The following are some that meet these requirements:

MOBIL	Mobilith AW2 (Used by DFE)
SHELL	Darina 2
KEYSTONE	81EP-2 and Zeniplex 2
TEXACO	Premium RB
LUBRIPLATE	630-2 and 1200-2
CHEVRON	SRI-2

3. LUBRICATION SCHEDULE

The bearing should be re-lubricated periodically. How often depends on the speed and operating temperature of the bearing. These are different for every application, so it is not possible to offer a single recommendation for every case. We recommend re-greasing every six months of single shift per day operation. More often if speeds and temperatures are higher than usual (recall the effects of high temperature mentioned in Section 4.2.1, and the bearing life section 4.1 requires proper lubrication). If there is an established lubrication schedule for the other bearings on the machine it should be satisfactory for the transducer bearings as well.

4. SEALS

The bearing cavity is closed except for the back which is covered by a seal. The standard seal is a rubber lip type which will allow pressure or excess grease to escape around its edge during re-lubrication. The optional seal is a metal labyrinth type.

CAUTION - IT MAY CLOSE TIGHTLY DURING RE-LUBRICATION AND PREVENT PRESSURE OR EXCESS GREASE FROM ESCAPING.

Care should be taken to avoid over-pressurizing the bearing cavity! This could cause the seal to rupture or deform, causing friction. Use a hand operated push-type grease gun to prevent damage. If you feel resistance to the grease flow, reduce the force you are using and push more slowly. If this doesn't work, push the shaft coupling axially in one direction and try again. If it still doesn't work, try the other direction. Moving the coupling axially will open the seal and allow pressure or excess grease to escape. Remember, the housing should only be 1/3 to ½ full of grease. See previous page.

5 TROUBLESHOOTING

This is a list of problems which could occur during initial start-up or afterwards. The probable causes are listed with the *most likely one first* and the *least likely one last*.

1. **TRANSDUCER ROLL SHAKES, VIBRATES, or BOUNCES**
   1. Roll is not balanced. See Section 2.2.1.3 (page 10) and 2.3.2 (page 11).
   2. Shaft is not clamped tightly in transducers. Coupling screws are loose or shaft diameter is undersized.
   3. Transducer mounting bolts are not tight.
   4. Shaft is too weak or there is too much shaft extension between the ends of the roll and the transducers.
   5. Shaft is bent or too weak.
   6. Roll is turning at its natural frequency. Call our **Technical Service Department** for analysis of operating conditions and solution to problem.

2. **CAN NOT ADJUST TENSION METER TO READ ZERO WHEN WEB IS SLACK**.
   1. Transducer roll is too heavy. See Appendix B, Section 5 (page 24).
   2. Transducers are pre-loaded. See Section 2.3.1 (page 11) and 2.3.5 (pages 13-15).

3. **TENSION METER READS BACKWARDS**
   1. Transducers are installed backwards with force arrow pointing in opposite direction. See Section 2.3.4 (page 13).
   2. Transducer cables are connected wrong at controller/indicator terminal strip. Signal wires are reversed.

4. **TENSION METER NEEDLE PEGS HIGH OR LOW**
   1. Meter is not electrically adjusted to zero. Follow the manual of the amplifier, indicator or controller for adjustment procedure.
   2. Transducers are pre-loaded. See Section 2.3.1 (page 11) and 2.3.5 (pages 13-15).
   3. Transducer cable has broken wire, poor connection, or short circuit.
   4. A strain gage has failed. To verify, unplug the transducer cable and use an ohmmeter to measure the resistance of the gages at the connector on the transducer. Measure between pins A, B, and A, C. In each case, the resistance should be about 100 ohms. Measure the resistance between any pin and the outside of the transducer. The meter should read infinite resistance. Apply a force to the roll by hand or by using a rope and a weight, in the direction of the tension force and maintain it while again measuring between pins A, B and A, C. The resistance should be only a few ohms different from before.
   5. Failure in the tension amplifier circuit in the controller or indicator. Follow the troubleshooting steps in the relevant manual.

5. **TENSION METER DOES NOT READ ZERO WHEN WEB IS SLACK AND READING DRIFTS WITH TIME.**
   1. Indicator or meter is not properly Zeroed and/or Calibrated. Consult the appropriate amplifier, indicator or controller manual for Zero and Calibration procedure.
   2. Transducers are pre-loaded. See Section 2.3.1 (page 11) and 2.3.5 (pages 13-15).
   3. The structure that the transducers are mounted on is weak. See Section 2.2.3 (page 10).
   4. Transducer cable has a broken wire, poor connection, or short circuit.
   5. A strain gage is cracked. Perform the test in 4.4 above.

6. **TENSION METER DOES NOT READ THE SAME EACH TIME THE SAME FORCE IS APPLIED (poor repeatability)**
   1. Transducers are pre-loaded. See Section 2.3.1 (page 11) and 2.3.5 (pages 13-15).

2. The structure the transducers are mounted on is weak. See Section 2.2.3 (page 10).
3. The shaft coupling cap screws are loose.

7. TENSION METER READING DOES NOT CHANGE WHEN FORCE IS APPLIED TO ROLL. METER READS ZERO.

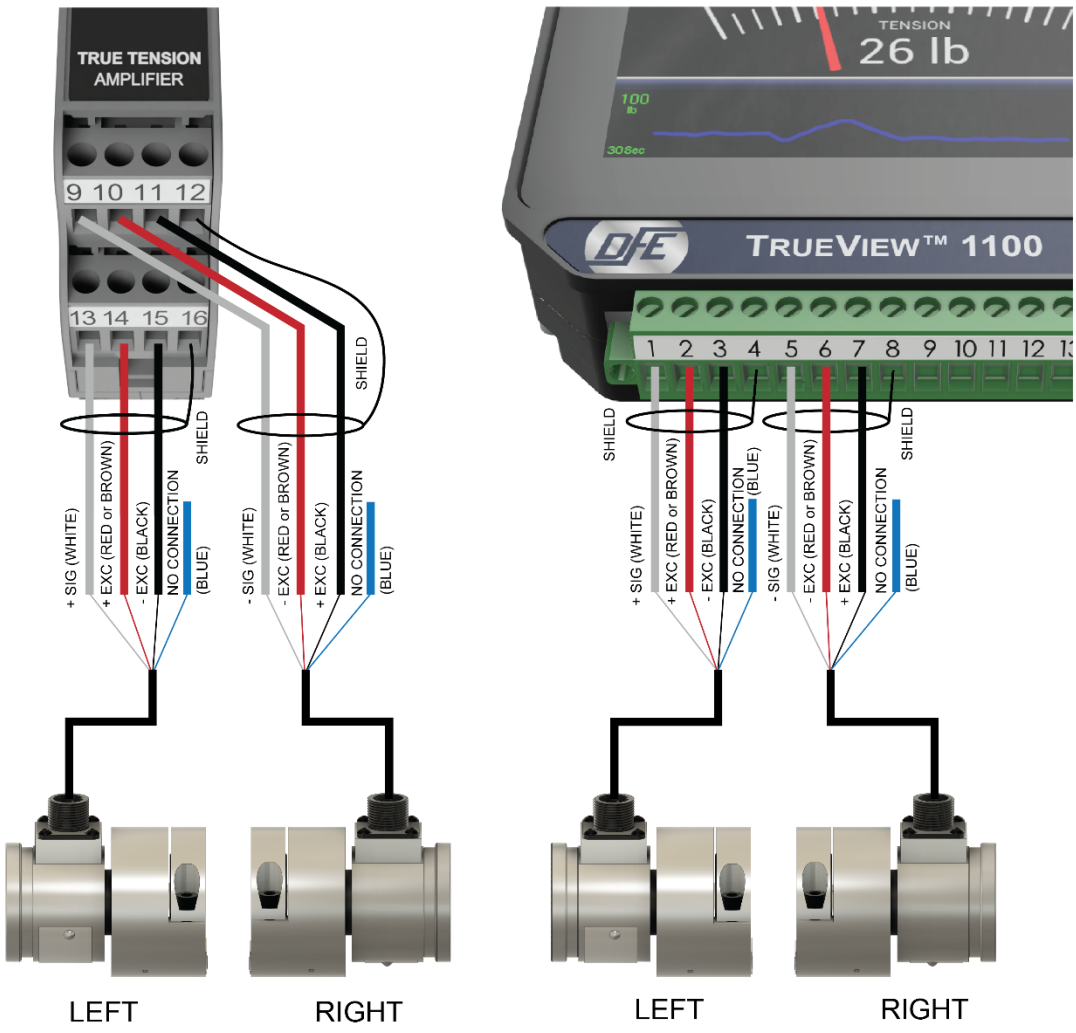
1. Indicator or meter is not properly Zeroed and/or Calibrated. Consult the appropriate amplifier, indicator, or controller manual for Zero and Calibration procedure.
2. Gap between shaft coupling and beam housing is not even. See Section 2.3.6 (page 15).
3. Transducer roll is too heavy. See Appendix B, Section 5 (page 24).
4. Transducer cable has broken wire, poor connection, or short circuit.
5. Transducer cables connected incorrectly, or to wrong transducers.
6. Failure of tension amplifier circuit in controller/indicator.
7. Unit is not turned on.

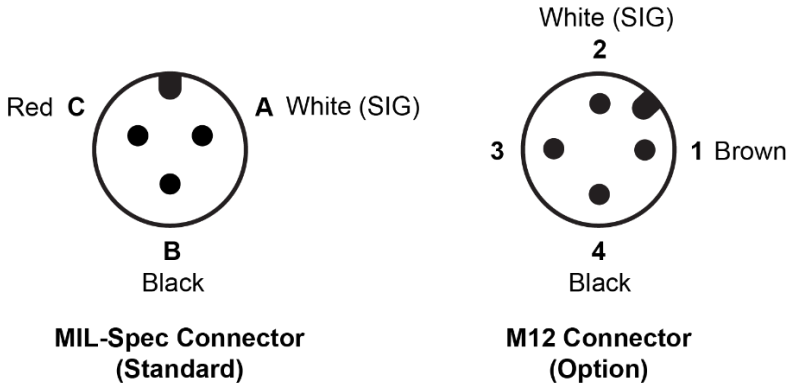
8. TENSION METER NEEDLE BOUNCES

1. Web tension is fluctuating because of machine speed fluctuations, bent roll shafts, worn idler roll bearings, chattering unwind brake, flat spot in unwind or rewind roll, etc.
2. Shaft is loose in the transducers. Shaft coupling cap screws are loose or shaft diameter is under-sized.
3. Transducer mounting bolts are loose.
4. Tension controller damping is not adjusted properly. See controller instruction manual for procedure.

APPENDIX A: TRANSDUCER ELECTRICAL CONNECTIONS

TA1 Amplifier **TrueView™ 1100 Indicator**





Note: Cables for the M12 connector do not use the blue wire.

***Figure 14* - MODEL C TRANSDUCER WIRING**

APPENDIX B: SELECTION OF LOAD RATING

1. LOAD RATINGS

The Model C Transducer is available in several standard load ratings, ranging from 10 to 800 lbs. The correct rating for a particular application depends on web tension, transducer roll weight, wrap angle, and the direction of the tension force on the transducer roll. Figure 6 below contains mathematical formulas which use these factors to determine the correct load rating.

2. SELECTION PROCEDURE

The correct load rating is found in four simple steps:

1. Weigh the transducer roll.
2. Estimate the maximum web tension. Use the Typical Tensions table in Appendix A as a guide if necessary.
3. Determine the wrap angle.
4. Determine the angle of the tension force, F_T, relative to the vertical.

NOTICE ***Note:*** F_T bisects the wrap angle B.

3. COMPUTE NET FORCE USING THE SELECTION FORMULA

Refer to Figure 15. Select the appropriate wrap configuration as determined by the direction of the tension force (above, below or on horizontal). Compute the Net Force, using the formula below the wrap diagram.

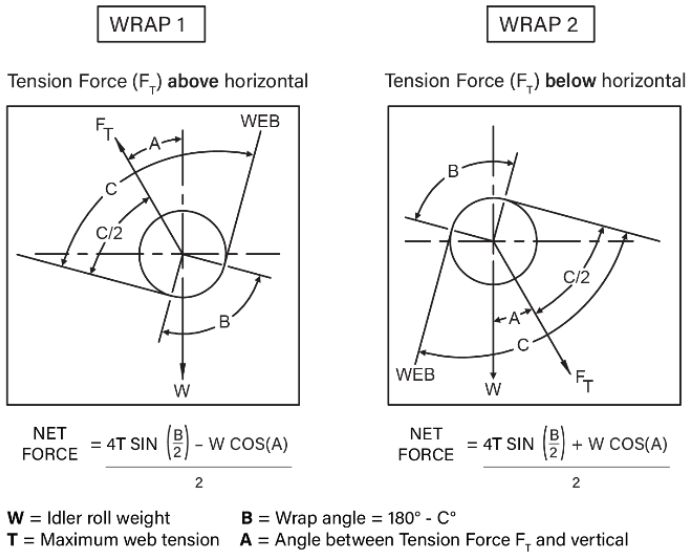


TABLE 1

ANGLE	SINE	COSINE
0°	0.000	1.000
5°	0.087	0.996
10°	0.174	0.985
15°	0.259	0.966
20°	0.342	0.940
25°	0.423	0.906
30°	0.500	0.866
35°	0.574	0.819
40°	0.643	0.766
45°	0.707	0.707
50°	0.766	0.643
55°	0.819	0.574
60°	0.866	0.500
65°	0.906	0.423
70°	0.940	0.342
75°	0.966	0.259
80°	0.985	0.174
85°	0.996	0.087
90°	1.000	0.000

Figure 15 **- LOAD RATING SELECTION FORMULAS**

4. SELECT THE LOAD RATING

Use chart below to select the correct load rating. In some cases, the load rating may be ***less than*** the computed Net Force. This is acceptable because the Net Force formula contains an oversizing factor of 2 for tension surges, which means that the actual force exerted on the transducer will not exceed its rating if the transducer is chosen according to the chart below. The actual force on the transducer will reach 125% of the load rating before hitting the safety stop gap.

LOAD RATING CHART	
NET FORCE (lbs)	LOAD RATING (lbs)
up to 13	10
14 - 32	25
33 - 63	50
64 - 125	100
126 - 187	150
126 - 250	200
251 - 500	400
501 - 1000	800

5. COMPARE LOAD RATING WITH EFFECTIVE TRANSDUCER ROLL WEIGHT

Sometimes, a transducer roll is so heavy that its weight uses up most of the operating range of the transducers. When this happens, it may not be possible to adjust the tension indicating meter to read zero when tension is zero because the adjustment range of the electronic circuit has been exceeded. If this is the case, one or more of the following changes must be made to reduce W COS(A) to less than 95% of the load rating:

1. Reduce the transducer roll weight.
2. Increase angle (A), see Figure 15.
3. Use the next higher load rating (this is the least desirable choice because it reduces the transducer output signal).

APPENDIX C: TYPICAL TENSION FOR VARIOUS MATERIALS

TYPICAL TENSIONS FOR WEB MATERIALS

ACETATE		0.5 lb. per mil per inch of width
FOIL	**Aluminum**	0.5 lb. per mil per inch of width
	Copper	0.5 lb. "
CELLOPHANE		0.75 lb. "
NYLON		0.25 lb. "
PAPER	15 lb *	0.4 lb. per inch of width
	20 lb	0.5 lb. "
	30 lb	0.75 lb. "
	40 lb	1.25 lb. "
	60 lb	2.0 lb. "
	80 lb	3.0 lb. "
	100 lb	4.0 lb. "
	* based on 3000 sq. ft. ream	
PAPERBOARD	8pt	3.0 lb. per inch of width
	12pt	4.0 lb. "
	15pt	4.5 lb. "
	20pt	5.5 lb. "
	25pt	6.5 lb. "
	30pt	8.0 lb. "
POLYETHYLENE		0.12 lb. per mil per inch of width
POLYESTER (Mylar)		0.75 lb "
POLYPROPYLENE		0.25 lb. "
POLYSTYRENE		1.0 lb. "

RUBBER	**GAUGE**	**AT 25% STRETCH**	**AT 50% STRETCH**
	10 mil	1.75	3.68
	12 mil	1.10	2.03
	16.5 mil	4.09	8.17
	26 mil	2.47	4.97

SARAN	.15 lb. per mil per inch of width

STEEL	**GAUGE - INS**	**UNWIND-PSI**	**REWIND-PSI**
	.001 -.005	1000	4000
	.006 -.025	850	3500
	.026 -.040	750	3000
	.041 -.055	650	2600
	.058 -.070	550	2200
	.071 -.090	450	1800
	.091 -.120	450	1400
	.121 -.140	400	1200
	.141 -.165	400	1000
	.166 -.200	400	900
	.201 -.275	400	800
	.276 -.380	300	700

VINYL	0.05 lb. per mil per inch of width

*** For laminated webs, sum the tension for the individual webs and add 0.1 lb per inch width.

TERMS AND CONDITIONS OF SALE AND SHIPMENT

1. THE COMPANY
Dover Flexo Electronics, Inc. is here in after referred to as the Company.

2. CONFLICTING OR MODIFYING TERMS
No modification of, additions to or conflicting provisions to these terms and conditions of sale and shipment, whether oral or written, incorporated into Buyer's order or other communications are binding upon the Company unless specifically agreed to by the Company in writing and signed by an officer of the Company. Failure of the Company to object to such additions, conflicts or modifications shall not be construed as a waiver of these terms and conditions nor an acceptance of any such provisions.

3. GOVERNING LAW
This contract shall be governed by and construed according to the laws of the state of New Hampshire, U.S.A. The parties agree that any and all legal proceedings pursuant to this contract shall take place under the jurisdiction of the courts of the State of New Hampshire in the judicial district of Strafford County.

4. PENALTY CLAUSES
Penalty clauses of any kind contained in orders, agreements or any other type of communication are not binding on the Company unless agreed to by an officer of the Company in writing.

5. WARRANTY
Dover Flexo Electronics, Inc. warrants, to the original Buyer, its' products to be free of defects in material and workmanship for five years from date of original shipment. Repairs on products are warranted for 90 days from date of shipment. During the warranty period the Company will repair or replace defective products free of charge if such products are returned with all shipping charges prepaid and if, upon examination, the product is shown to be defective. This warranty shall not apply to products damaged by abuse, neglect, accident, modification, alteration or mis-use. Normal wear is not warrantied. All repairs and replacements under the provisions of this warranty shall be made at Dover Flexo Electronics or at an authorized repair facility. The Company shall not be liable for expenses incurred to repair or replace defective products at any other location or by unauthorized persons or agents. This warranty contains all of the obligations and warranties of the Company. There are no other warranties, either expressed or implied. No warranty is given regarding merchantability or suitability for any particular purpose. The Company shall not be liable in either equity or law for consequential damages, losses or expenses incurred by use of or inability to use its' products or for claims arising from same. No warranty is given for products of other manufacturers even though the Company may provide these products with its' own or by themselves. The provisions of this warranty cannot be changed in any way by any agent or employee of the Company. Notice of defects must be received within the warranty period or the warranty is void. The warranty is void if the serial number tag is missing or not readable.

6. PAYMENTS
Standard terms of credit are net 30 days from date of shipment, providing satisfactory credit is established with the Company. Amounts past due are subject to a service charge of 1.5% per month or portion thereof or 18% per annum. The Company reserves the right to submit any unpaid late invoices to a third party for collection and Buyer shall pay all reasonable costs of such collection in addition to the invoice amount. All quoted prices and payments shall be in U.S. Dollars. If the Company judges that the financial condition or payment practices of the Buyer does not justify shipment under the standard terms or the terms originally specified, the Company may require full or partial payment in advance or upon delivery. The Company reserves the right to make collection on any terms approved in writing by the Company's Finance Department. Each shipment shall be considered a separate and independent transaction and payment therefore shall be made accordingly. If the work covered by the purchase order is delayed by the Buyer, upon demand by Company payments shall be made on the purchase price based upon percentage of completion.

7. TAXES
Any tax, duty, custom, fee or any other charge of any nature whatsoever imposed by any governmental authority on or measured by any transaction between the Company and the Buyer shall be paid by the Buyer in addition to the prices quoted or invoiced.

8. RETURNS
Written authorization (MRA) must be obtained from the Company's factory before returning any material for which the original Buyer expects credit, exchange, or repairs. Material returned for credit must be unused, received back within 30 days of original ship date and shall be subject to a re-stocking charge of 15%. Special Product Requests (SPRs), product manufactured specially to customer specifications, and non-DFE product purchased on customer behalf shall not be returnable for any reason. All material returned, for whatever reason, shall be sent with all freight charges prepaid by the Buyer.

9. SHIPPING METHOD AND CHARGES
All prices quoted are EXW the Company's factory. The Company shall select the freight carrier, method and routing. Shipping charges are prepaid and added to the invoice of Buyers with approved credit, however the Company reserves the right to ship freight-collect if it prefers. Shipping charges will include a charge for packaging. Company will pay standard ground freight charges for items being returned to Buyer which are repaired or replaced under the Warranty. Claims of items missing from a shipment must be received, in writing, within 30 days of original shipment

10. CANCELLATION, CHANGES, RESCHEDULING
Special Product Requests (SPRs), product manufactured specially to customer specifications, and non-DFE product purchased on customer behalf shall not be returnable for any reason. Buyer will be subject to a 15% fee for any standard item on order with the Company which is cancelled by the Buyer. A one-time hold on any item ordered from the Company shall be allowed for a maximum of 30 days. After 30 days, or upon notice of a second hold, Company shall have the right to cancel the order and issue the appropriate cancellation charges which shall be paid by Buyer. Items held for the Buyer shall be at the risk and expense of the Buyer unless otherwise agreed upon in writing. Company reserves the right to dispose of cancelled material as it sees fit without any obligation to Buyer. If Buyer makes, or causes to make, any change to an order the Company reserves the right to change the price accordingly.

11. PRICES
Prices published in price lists, catalogs or elsewhere are subject to change without notice and without obligation. Written quoted prices are valid for thirty days only.

12. EXPORT SHIPMENTS
Payment for shipments to countries other than the U.S.A. and Canada or to authorized distributors shall be secured by cash in advance or an irrevocable credit instrument approved by an officer of the Company. An additional charge will apply to any letter of credit. There will also be an extra charge for packaging and documentation.

13. CONDITION OF EQUIPMENT
Buyer shall keep products in good repair and shall be responsible for same until the full purchase price has been paid.

14. OWNERSHIP
Products sold are to remain the property of the Company until full payment of the purchase price is made.

Rev.10 10/15/19

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