DOVER FLEXO ELECTRONICS, INC.
ISO 9001 CERTIFIED

INSTRUCTION MANUAL

MODEL THN TENSION TRANSDUCERS

DOC 801-1752

5 YEAR WARRANTY

DOVER FLEXO ELECTRONICS, INC.

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1.1 GENERAL DESCRIPTION

The Model THN (thin) Tension Transducer is an electro-mechanical device that converts web tension into a dc voltage which is proportional to tension. The voltage is amplified in external electronic circuitry and displayed on an analog or digital meter which is calibrated to indicate 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 narrow width of the THN transducer allows it to be installed in locations where other transducers will not fit. It has also been designed so that it is not necessary to remove the transducers from the machine when removing the idler roll. Installation is very easy because the transducers are installed on the machine frames first, and the idler roll is then installed in the transducers. A single bolt in the center of the transducer mounts it to the machine frame. Because only one bolt is used, the transducer can be oriented at any angle without the need for multiple bolt patterns.

Versions of the THN are available for use with either dead shaft or live shaft idler rolls, and with a variety of shaft sizes.

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

1.2 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 required is known as the dead-shaft, or D version. Or the roll shaft may be rotating (live) and the transducer required 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 run-out of the coupling and idler shaft.

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.

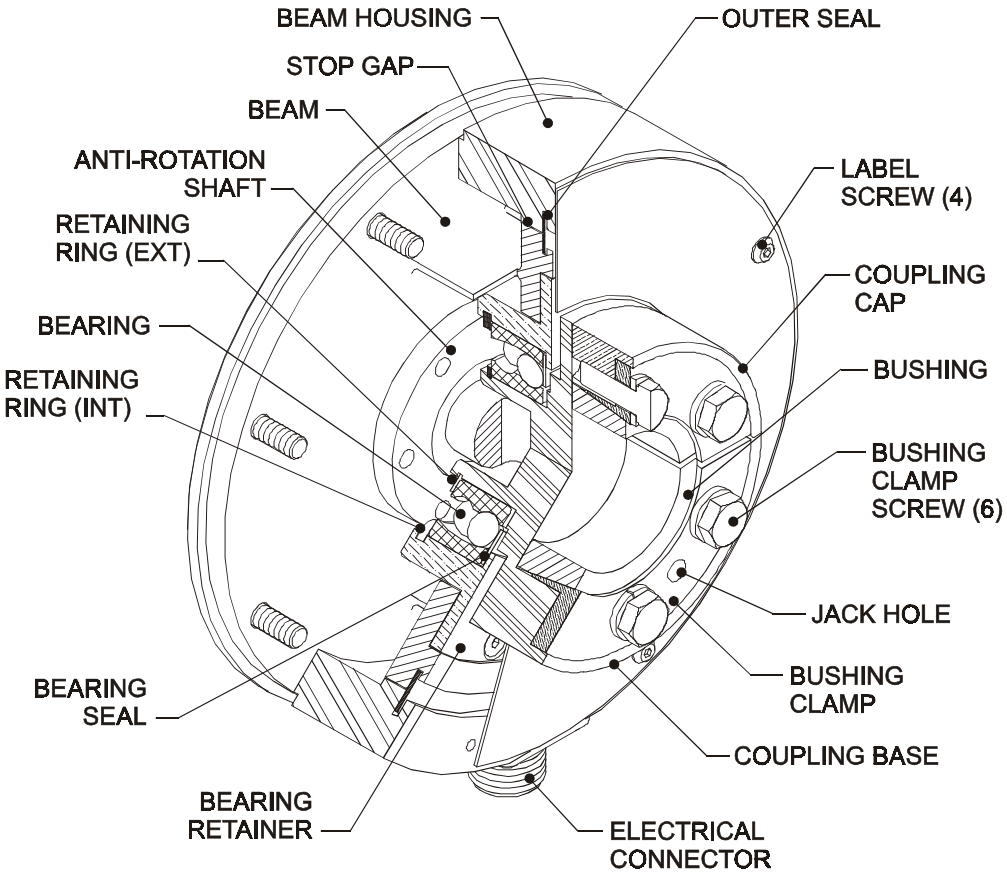


Figure 1 **- LIVE SHAFT VERSION CUT-AWAY VIEW**

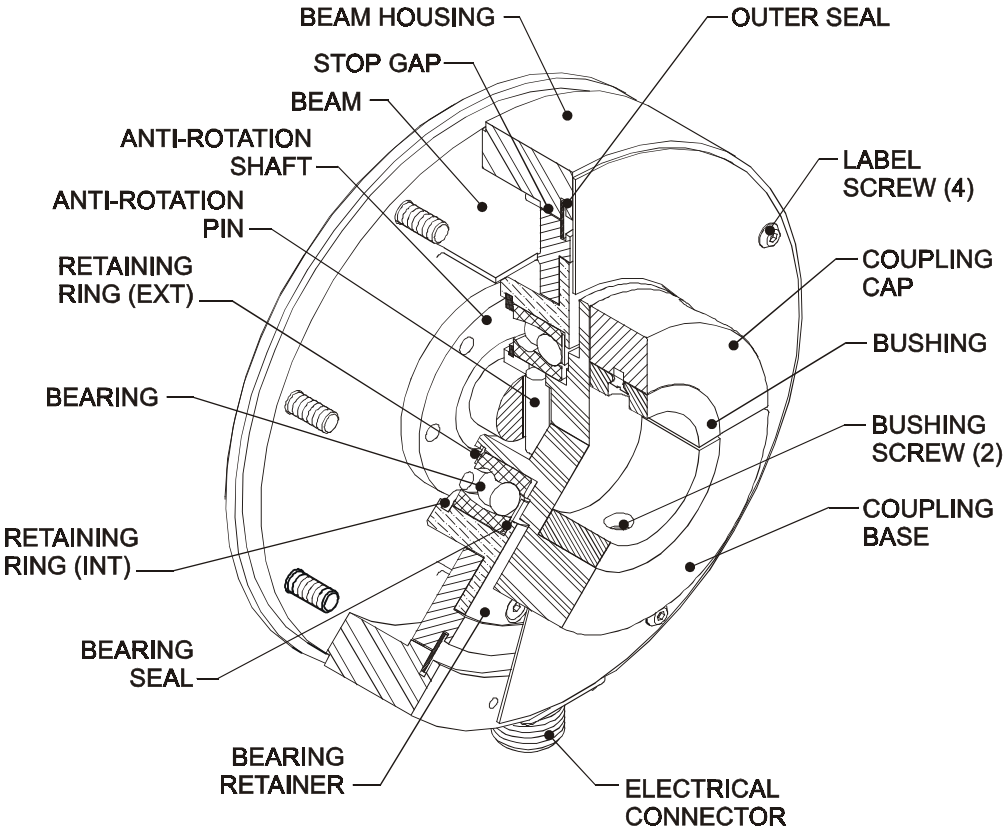


Figure 2 **- DEAD SHAFT VERSION CUT-AWAY VIEW**

1.3 SPECIFICATIONS

Excitation Voltage:	5 Volts dc
Output:	250 mV, nominal, at 5V excitation
Strain Gages:	semiconductor, 100 ohms +/- 15 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)
Material:	303 stainless steel and 7075-T6 aluminum
Minimum Overload Capacity:	2500 lbs. (11121 N)
Deflection at rated load:	0.005" typical (0.127 mm typical), 0.011 max. (0.28mm)
Mis-alignment Capacity (degrees)	2°
Mating Electrical Connector:	Amphenol MS3106A-10SL-3S
Standard Connector Position:	6:00 o'clock std., 12:00 for PB with reference to force direction at 6 o'clock
Electrical Connections:	pin A - white wire = output
(See Fig. 15)	pin B - black wire = +5V Excitation
	pin C - red wire = -5V Excitation
Maximum Shaft Sizes:	Dead (D) = 1.75" (44.5 mm), Live (L) = 1.57" (40 mm)
Shaft Size Tolerance:	nominal minus 0.002" (nominal minus 0.051 mm)
Load Ratings:	25, 50, 100, 200, 400, 800 lbs. (110, 225, 450, 900, 1800, 3550 N)
Mounting Bolt:	1/2-13 socket cap screw (M12 socket cap screw is optional)

1.4 STANDARD FEATURES

- **Only 2.57" (65.3mm) thick.** Fits where most transducers cannot. Accommodates idlers only 3.475" narrower than distance between side frames.
- **One-bolt installation.** Turn the transducer to the correct load orientation and tighten only one bolt.
- **Shaft clamp.** Allows quick removal of idler roll without removing transducers from machine.
- **Dual Cantilever Beam**. Provides high strength and accuracy at low tension.
- **Stainless Steel and Aluminum construction**. Excellent corrosion resistance.
- **Universal joint.** Corrects for misalignment and shaft bending.
- **Axial Compensation.** For changes of shaft length caused by temperature variations.
- **Both dead shaft and live shaft versions.** Accommodates either stationary or rotating idler roll shafts.

1.5 CONFIGURATION CHOICES

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

- **Version Style.** L (Live) for rotating shafts, or D (Dead) for stationary or non-rotating shafts.
- **Mounting Style**. Stud or Bolt mount (S) uses a single bolt to mount flat against machine frame. Pillow Block bracket (PB) uses a right-angle bracket to mount onto the machine frame. The THN transducer can also be installed very precisely by using a shallow pilot bore in the machine frame. Flange Mount (FL) uses a four bolt mounting configuration.
- **Load Ratings.** 25, 50, 100, 200, 400, 800 lbs. (110, 225, 450, 900, 1800, 3550 N)
- **Bore/Shaft Size**. Choices are as follows:

  D Version: 3/4, 7/8, 1, 1 1/8, 1 3/16, 1 1/4, 1 1/2, 1 3/4 inches, 25mm, 30mm, 40mm

  L Version: 3/4, 7/8, 1, 1 1/8, 1 3/16, 1 1/4, 1 1/2 inches, 25mm, 30mm, 40mm

  Note: Cannot exceed maximum size listed in Specifications in section 1.3.
- **Connector Position**. 6:00 o'clock with tension force direction at 6 o'clock standard for S and FL styles. 1:30, 3:00, 4:30, 7:30, 9:00, 10:30, 12 o'clock optional. 12:00 is standard for PB style.

1.6 OPTIONS

- **Environmental Connector (EC)**. Seals with mating cable electrical connector to protect against contact oxidation; especially useful in corrosive environments.
- **Extended Range (XR)**. Produces twice the output signal for a given load rating. Used in applications requiring a full scale tension force that is as low as 6% of the transducer rating. 12% is standard. Must be used with electronics having the **XRE**, extended range option.
- **Full Bridge (FB)**. Four strain gauges instead of two to form a Wheatstone Bridge connection. Applies only if one transducer is used.
- **Metric Mounting Stud (MMS).** Metric screw for installation.
- **Vacuum Compensation (VAC).** Transducer has special screws and features for fast and complete air evacuation. Used for transducers installed in vacuum metallizers.

SECTION 2

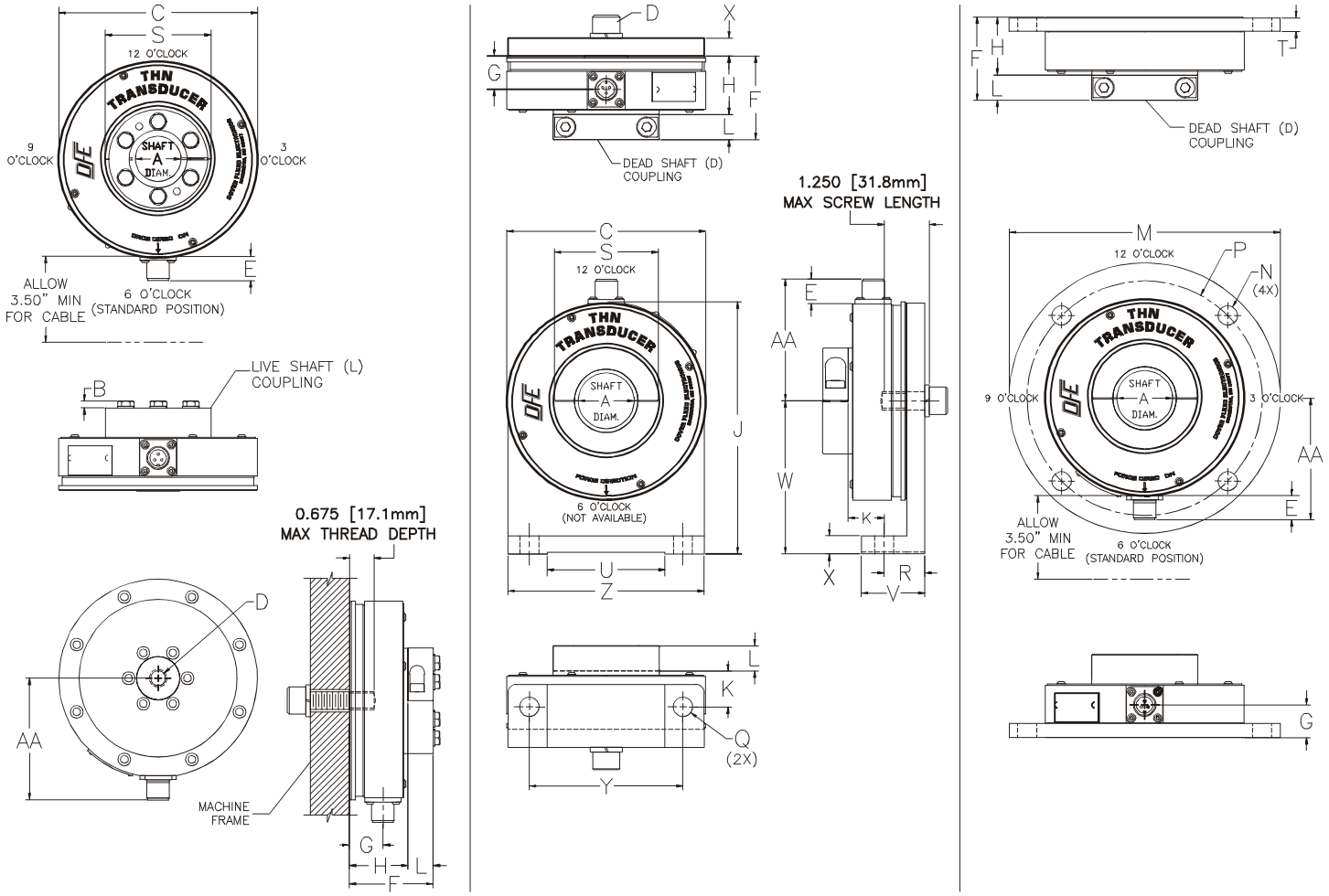
INSTALLATION

2.1 DIMENSIONS inches (mm)

SIZE		A (D)[1]	A (L)[1]	B	C	D [2]	E	F(max)[3]	F(max)[4]	G[3]	G[4]	H(max)[3]	H(max)[4]	J	K (max)
2	in.	ø1.75	ø1.57	ø0.18	ø5.50	1/2-13 UNC	0.69	2.39	2.36	0.93	0.91	1.69	1.66	7.00	1.05
	mm	ø44.5	ø40.0	ø4.5	ø139.7	M12 x 1.75	17.5	60.7	59.9	23.6	23.1	42.9	42.1	177.8	26.7

Notes: **1:** Bushings are available for smaller shaft diameters. (D) is for Dead shaft version, (L) is for Live shaft version. **2:** Thread size for Stud/Bolt mount only. **3:** Stud/Bolt and Pillow Block mounts only. **4:** Flange mount only.

SIZE		L	M	N	P	Q	R	S(max)	T	U	V	W	X	Y	Z	AA
2	in.	0.70	ø7.50	ø0.53	ø6.50	ø0.53	1.13	ø2.93	0.38	3.25	1.75	4.25	0.50	4.25	5.44	3.37
	mm	17.8	ø190.5	ø13.5	ø165.5	ø13.5	28.6	ø74.3	9.5	82.6	44.5	108.0	12.7	108.0	138.1	85.6



STUD (S) MOUNTING STYLE (STANDARD)

PILLOW BLOCK (PB) MOUNTING STYLE

FLANGE (FL) MOUNTING STYLE

Figure 3 **- THN DIMENSIONS**

2.2 PRE-INSTALLATION REQUIREMENTS

A. TRANSDUCER ROLL

The Model THN Transducers are used in pairs. One is mounted at each end of an idler roll shaft. The roll chosen is called the Transducer Roll.

1. **The Transducer Roll MUST be a true idler!** It can NOT 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 can not 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). If the shaft rotates, 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 2.4.2** for specifications. An unbalanced roll will reduce the accuracy of the tension signal and may **DAMAGE** the transducers.

B. WRAP ANGLE

The web must always contact the transducer roll in exactly 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. Minimum wrap angle of 20° is required in most cases.

C. 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 three methods; pillow block bracket ("PB"), a single stud/bolt ("S", style), or a four bolt flange ("FL"style), See below.

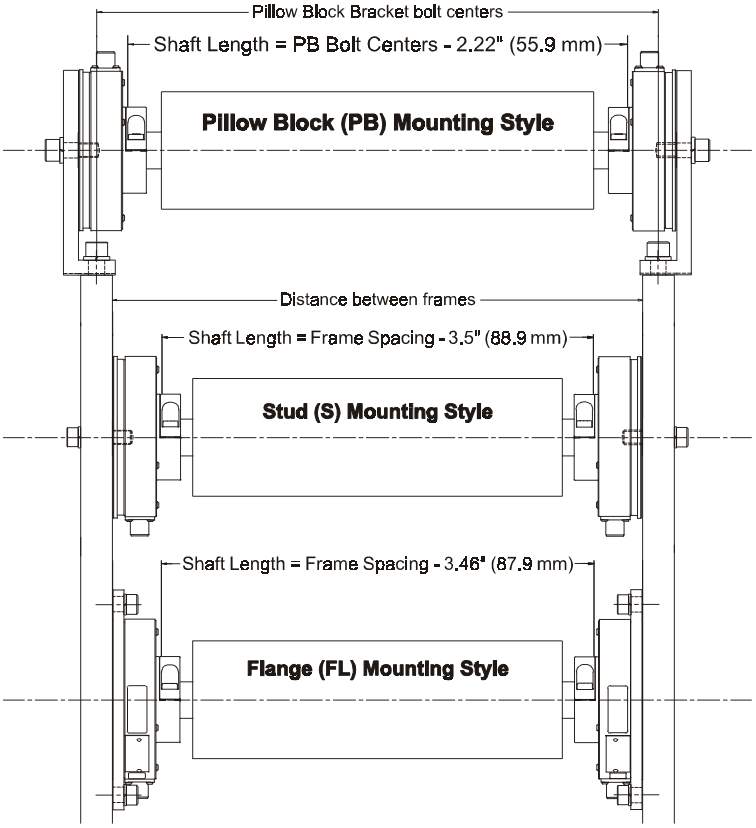


Figure 4 **- MODEL THN MOUNTING STYLES**

D. 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.

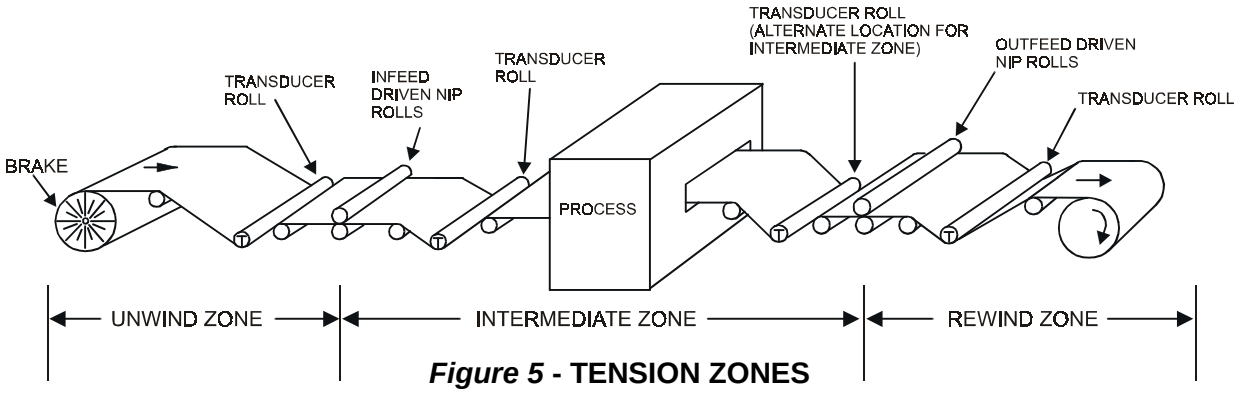


Figure 5 **- TENSION ZONES**

2.3 SELECTION OF LOAD RATING

A. LOAD RATINGS

The Model THN Transducer is available in several standard load ratings, ranging from 25 lbs. to 800 lbs. The correct rating for any 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.

B. SELECTION PROCEDURE

The correct load rating is found in four simple steps:

1. OBTAIN DATA TO PLUG INTO THE SELECTION FORMULA

a. Weigh the transducer roll.

b. Estimate the maximum web tension. Use the Typical Tensions table in Appendix B as a guide if necessary.

c. Determine the wrap angle.

d. Determine the angle of the tension force, F_T, relative to the vertical. (**NOTE:** F_T bisects the wrap angle B)

2. COMPUTE NET FORCE USING THE SELECTION FORMULA

Refer to Figure 6. 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.

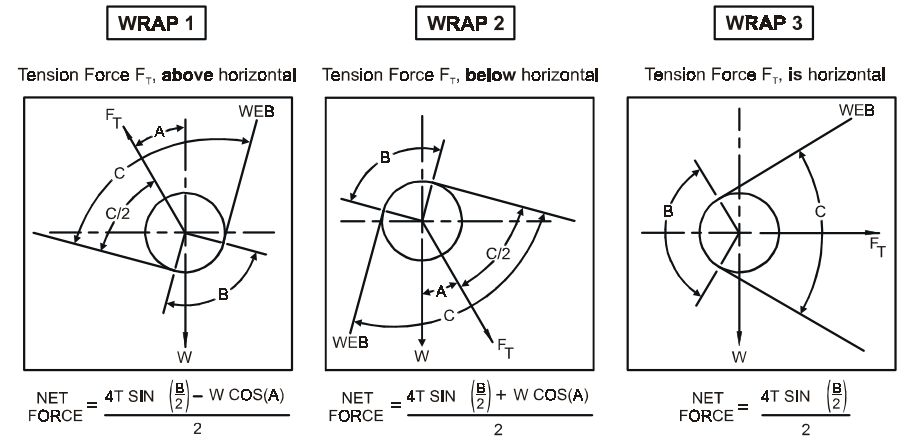


TABLE 1

Angle (Degrees)	SINE	COSINE
0	.000	1.000
5	.087	.996
10	.174	.985
15	.259	.966
20	.342	.940
25	.423	.906
30	.500	.866
35	.574	.819
40	.643	.766
45	.707	.707
50	.766	.643
55	.819	.574
60	.866	.500
65	.906	.423
70	.940	.342
75	.966	.259
80	.985	.174
85	.996	.087
90	1.000	.000

Figure 6 **- LOAD RATING SELECTION FORMULAS**

Use Figure 7 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 beam deflection stop.

3. SELECT THE LOAD RATING

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

***Figure 7* - LOAD RATING CHART**

4. 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. To find out if the roll is too heavy, compare the load rating with the effective weight of the roll as follows:

Refer back to the Net Force formula used in Section 2.3.B.2. The effective roll weight on the pair of transducers is the "W Cos(A)" term in the formula. If W Cos(A) is more than 95% of the load rating chosen, the tension meter will probably not be adjustable to zero. 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 6).
3. Use the next higher load rating. (This is the least desirable choice because it reduces the output signal).

2.4 INSTALLATION INSTRUCTIONS

Model THN Transducers are very easy to install, but the following instructions must be followed CAREFULLY:

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 (1.5mm) 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 BACK OF THE COUPLING.** (see Figure 8). ** for PB style, d is distance between PB bracket mounting hole centers*

SHAFT LENGTH CALCULATION			
SIZE	**STYLE S**	**STYLE FL**	**STYLE PB**
2	L = D - 3.48" [88.3]	L = D - 3.43" [87.2]	L = d - 2.22" [56.5]
L = Shaft length in inches D = Distance between mounting surfaces in inches d = 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 (feet per minute) 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. Refer to the illustrations appropriate for your version for illustration of the shaft end clearance.

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 THN transducer is designed with approximately 0.060 inches (1.5mm) of axial compensation per transducer with a maximum of 0.120" (3.0mm) per pair. To preserve this capability, follow the instructions below. A normal installation will have about 0.060" (1.5 mm) of axial movement. The D version coupling should also have a small amount of rotational free play (see Figure 12).

A. <u>Installation Procedure for the D (dead shaft) Version:</u>

1. Remove the cap from the shaft coupling by removing the coupling cap screws. Mount the transducers on the machine, with the cap side facing upward. If you are installing Mounting Style “S”,or “FL”, tighten the mounting bolts lightly enough to allow the transducer to be rotated on the machine frame with both hands. If you are installing Mounting Style “PB”, tighten the mounting bolts securely now.
2. Verify that the bushings supplied with the transducer will fit your idler shaft.
3. Lift and set the roll in place with the shaft ends resting in the bottom bushing halves of both transducer couplings.
4. Install the coupling caps (with the attached shaft bushings) but leave the screws loose.
5. Adjust the shaft depth to allow up to 1/16 inch (1.5mm) end clearance in ONE transducer ONLY (see figure 8). Tighten the cap screws to clamp the shaft into the transducer coupling.

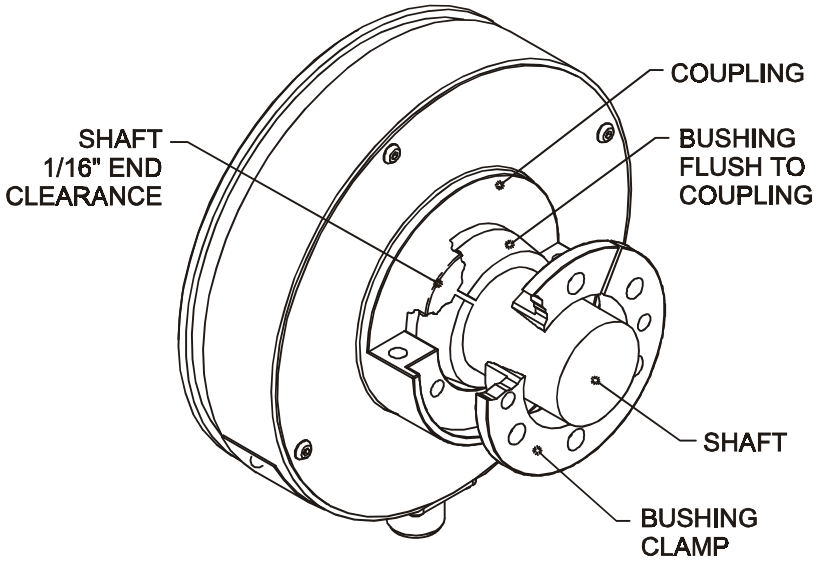


Figure 8 **- SHAFT END CLEARANCE**

6. Pull the roll toward the loose coupling on the other transducer while pushing this coupling away from the roll.
7. Rotate the shaft and the loose coupling a small amount by hand in the same direction until they both stop.
8. Tighten the coupling cap screws ALTERNATELY and PROGRESSIVELY 1/2 turn at time to clamp the shaft into the transducer coupling.

B. Installation Procedure for the L (Live shaft) version:

IMPORTANT!! The coupling cap 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 it isn't, severe shaft run-out will occur. Follow the procedure below.

1. Remove the coupling cap, bushing clamp, and shaft bushing from each transducer.
2. Mount the transducers on the machine, with the cap side facing upward. If you are installing Mounting Style "S",or "FL", tighten the mounting bolts lightly enough to allow the transducer to be rotated on the machine frame with both hands. If you are installing Mounting Style "PB", tighten the mounting bolts securely now.

NOTE: The splits in the bushing, Bushing clamp, and coupling **MUST NOT** be aligned to ensure proper clamping. See Fig 8.

3. Slide a bushing clamp and then a shaft bushing onto each end of the idler roll shaft.
4. Lay the idler shaft in position between the transducers, and loosely assemble the bushing, bushing clamp, and coupling cap on **ONE** transducer to ensure capture of the idler shaft.

NOTE: Perform STEPS 5 through 11 for the transducer NOT ASSEMBLED in STEP 4 above!

5. Slide the idler to allow up to 1/16 inch (1.5mm) end clearance. Then slide the shaft bushing along the shaft toward the transducer until the bushing touches the back of transducer coupling. Mark the exposed shaft at this time so the 1/16 inch end clearance is ensured (see Fig. 9, Step1).

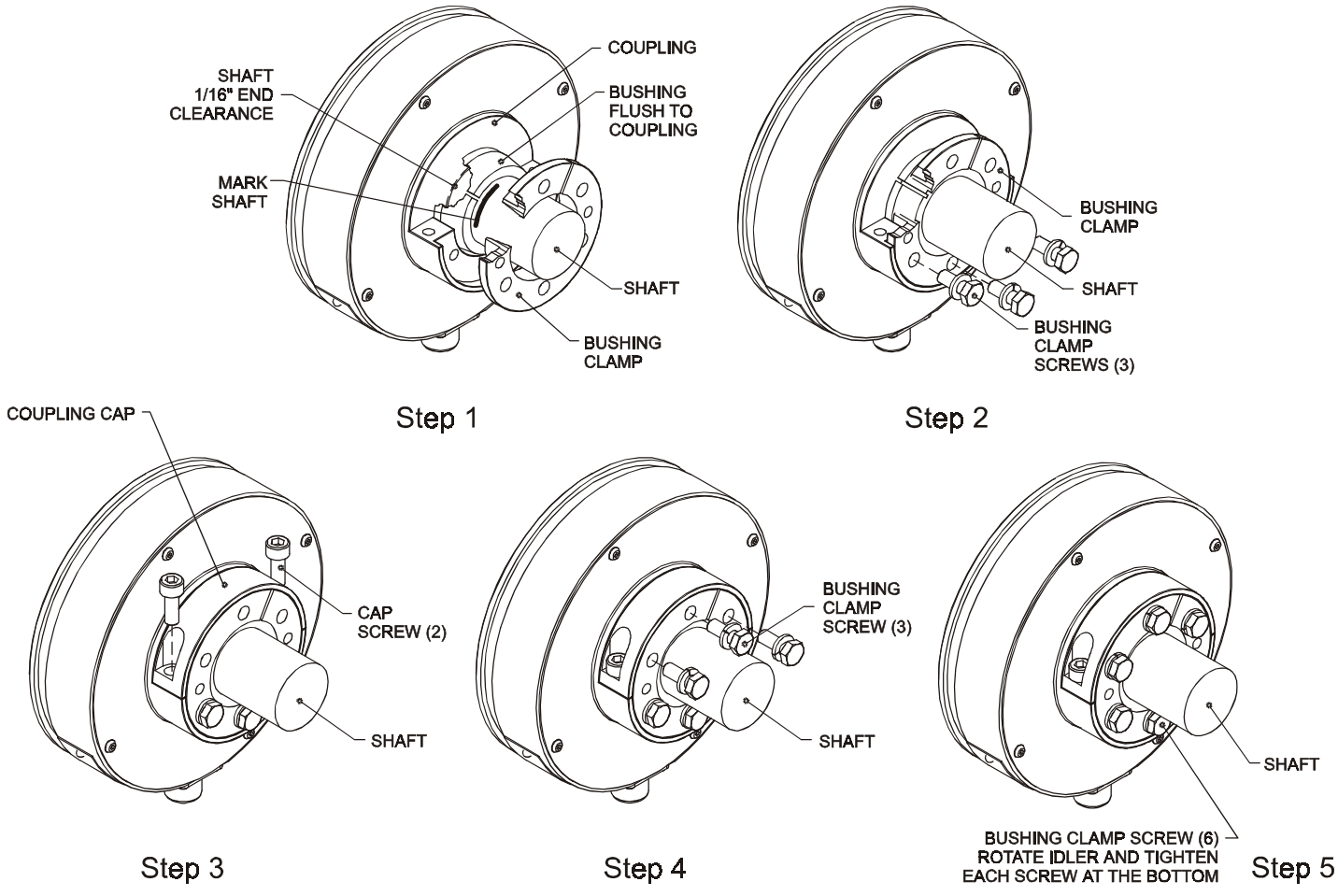


***Figure 9* - INSTALLATION OF FIRST LIVE SHAFT TRANSDUCER**

6. Slide the bushing clamp over the bushing as far as it will go without forcing it. The bushing clamp helps position, but MUST NOT interfere with the cap installation (see Fig. 9, Step 2)

7. Start three bushing clamp screws into the coupling finger-tight ONLY (see Fig. 9, Step 2). You will tighten them later.
8. Place the coupling cap for this transducer over the bushing clamp and install the two cap screws that fasten the cap to the body FINGER-TIGHT (see Fig. 9, Step 3).
9. Start the three bushing clamp screws that screw into the cap FINGER-TIGHT (see Fig. 9, Step 4).
10. Now, tighten the two cap screws SECURELY.
11. Tighten all six bushing clamp screws ALTERNATELY AND PROGRESSIVELY 1/2 turn at a time to lock the shaft into the transducer, by starting with the screw at the lowest position (see Fig. 9, Step 5). Then rotate the shaft and coupling together to position each screw to the lowest position, and tighten. This will center the weight in the tapered bushing and clamp. Tighten all six clamp screws in this manner.

NOTE: Remove the coupling cap from the transducer ASSEMBLED at the beginning of STEP 4.

12. Pull the roll toward the loose coupling while pushing this coupling toward the machine frame. Then slide the shaft bushing along the shaft toward the transducer until the bushing touches the back of the transducer coupling. (see Fig. 10, Step 1)
13. Slide the bushing clamp over the bushing as far as it will go without forcing it. (see Fig. 10, Step 2)

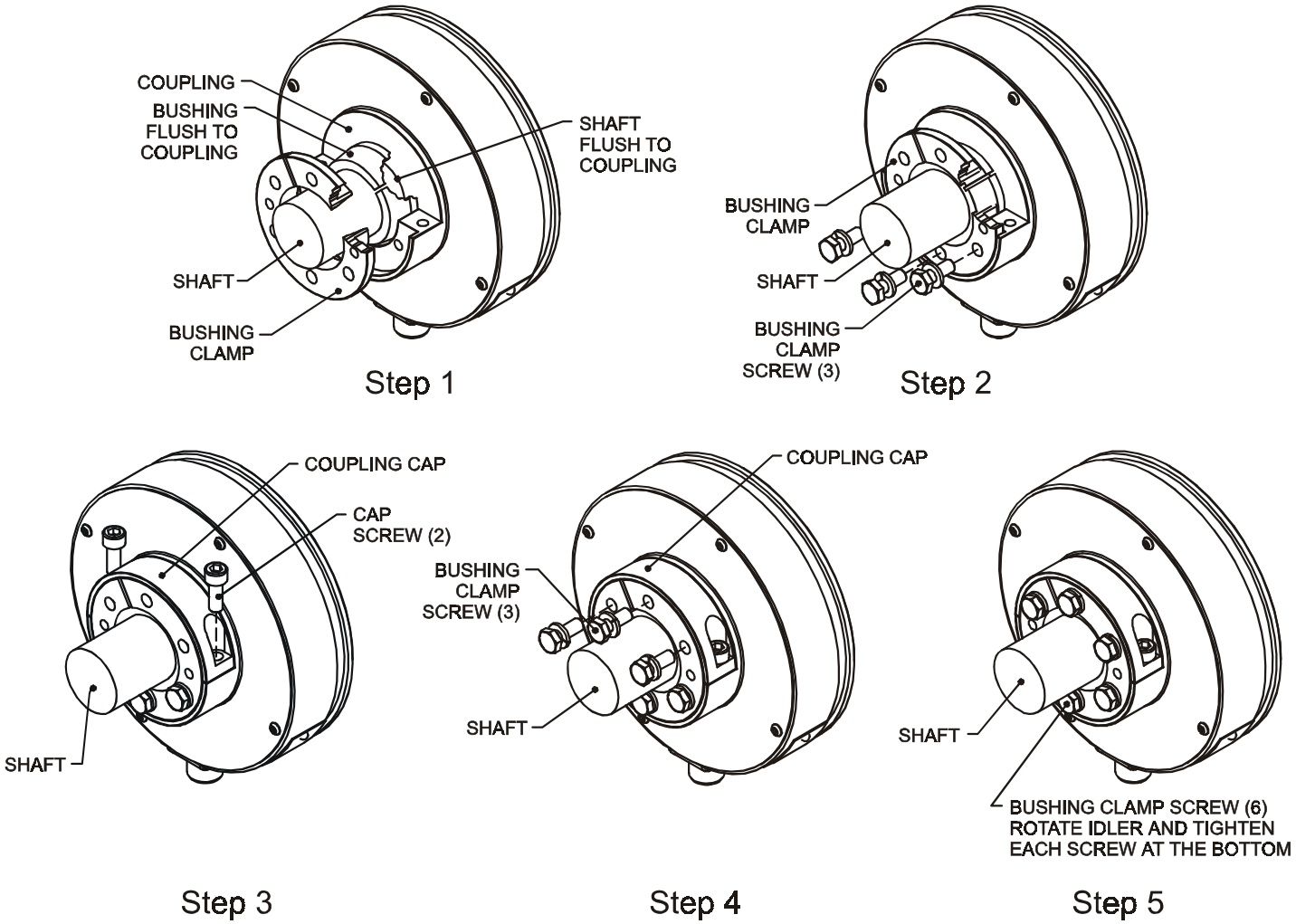


Figure 10 **- INSTALLATION OF SECOND LIVE SHAFT TRANSDUCER**

14. Start three bushing clamp screws into the coupling finger-tight ONLY (see Fig. 10, Step 2).
15. Place the coupling cap for this transducer over the bushing clamp and install the two cap screws that fasten the cap to the body FINGER-TIGHT (see Fig. 10, Step 3).

16. Install the three bushing clamp screws that screw into the cap FINGER-TIGHT (see Fig. 10, Step 4). Rotate the coupling so that it faces the same direction as the coupling on the other end of the shaft.
17. Now, tighten the two cap screws SECURELY
18. Tighten all six bushing clamp screws ALTERNATELY AND PROGRESSIVELY 1/2 turn at a time to lock the shaft into the transducer, by starting with the screw at the lowest position (see Fig. 10, Step 5). Then rotate the shaft and coupling together to position each screw to the lowest position, and tighten. This will center the weight in the tapered bushing and clamp. Tighten all six clamp screws in this manner.

C. <u>Special procedure for Hot Installations</u>: 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 3.A.6-8 or 3.B.12-18, BUT push the loose coupling <u>away from</u> the roll instead of toward the machine frame. Refer to Fig. 11. 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 0.060 inch (1.5mm). **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 12). On PB style mounting there is some adjustment to this movement with the clearance holes of the mounting bolts. **NOTE:** If you used the special procedure for hot installations, you will not be able to measure any axial movement until the idler roll gets hot.

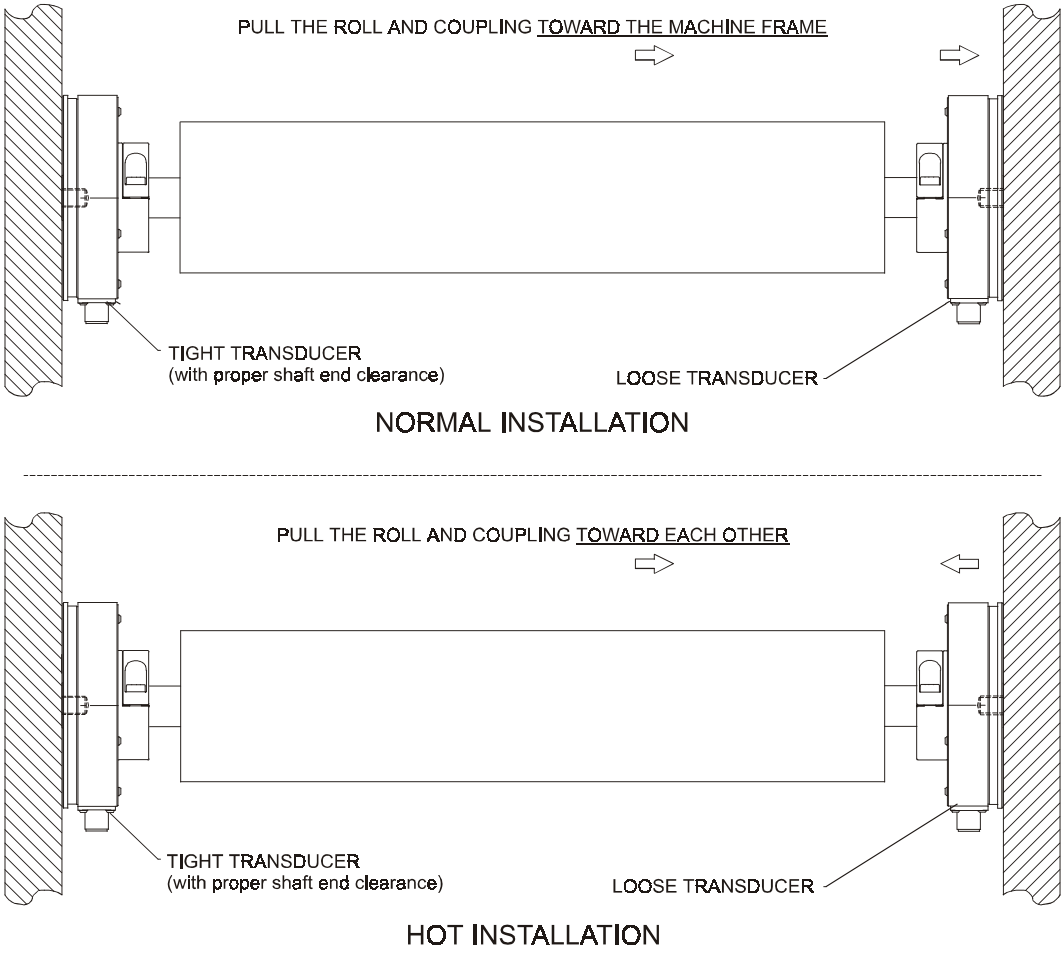


Figure 11 - **ADJUSTING FOR AXIAL PLAY**

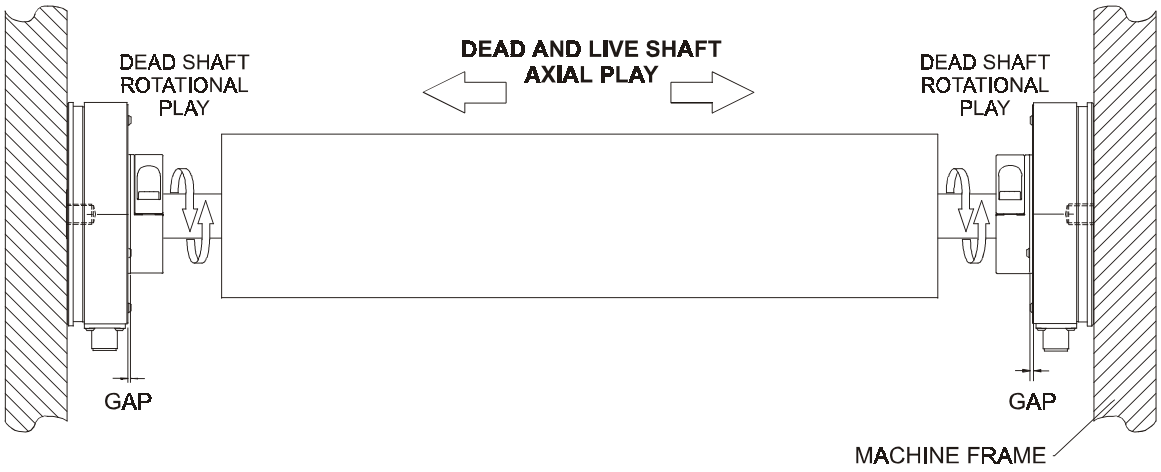


Figure 12 - **AXIAL AND ROTATIONAL PLAY**

If no movement can be detected, loosen one shaft coupling and repeat the installation procedures, Section 2.4.3, A or B.

Also verify the rotational free play (D version, only) at this time, see Figure 10. 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.

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

5. ORIENT THE TRANSDUCERS (see Figure 13)

The transducers must now be turned so the Tension Force arrow (or the notch on the rear edge of the beam) points in the same direction as the Tension Force.

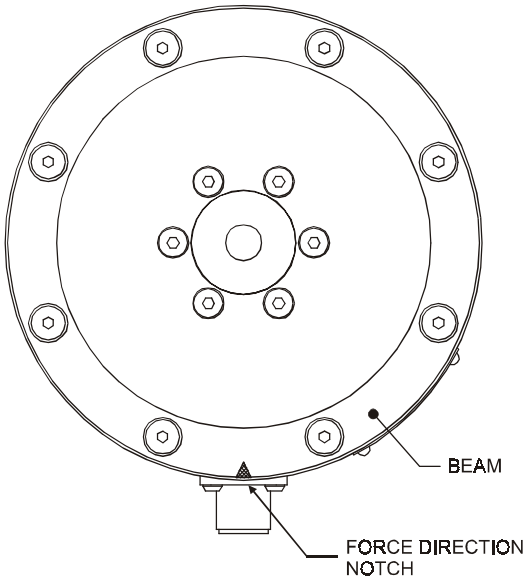


Figure 13 **- TENSION FORCE DIRECTION**

If you are installing "S", or "FL" 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 attachment bolt on the side of the bracket and turning the transducers by hand. When done, tighten the attachment bolt.

6. CHECK THE GAP FOR BEARING AXIS ALIGNMENT (see Figure 12)

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 0.056 difference in clearance to the beam housing around the opposite side of circumference represents the maximum 2° mis-alignment. 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.

2.5 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.

A. <u>Procedure for the D (dead shaft) version:</u>

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

B. <u>Procedure for the L (live shaft) version:</u>

1. Rotate your idler so that both transducer coupling caps are facing upward. 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 14). Turn until finger-tight.

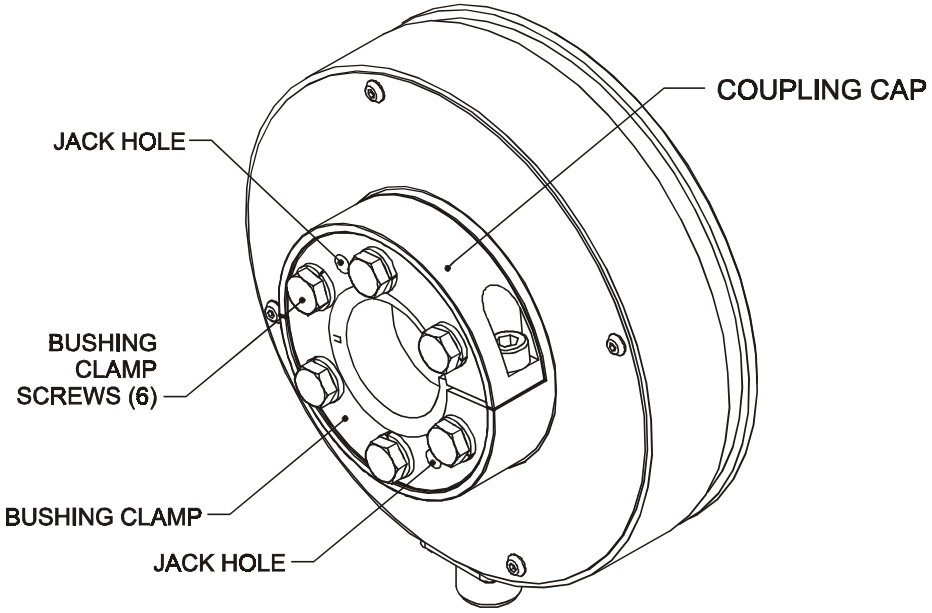


Figure 14 **- LOCATION OF COUPLING JACK HOLES**

5. 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.
6. Remove the two screws from the coupling cap on each transducer and lift off the cap.
7. Remove your idler roll.

2.6 ELECTRICAL CONNECTIONS

Make your connections as shown below. The tension (T) and compression (C) strain gages Are connected in a bridge configuration. As the beams bend slightly under web tension, the gage resistances change producing an output signal which is directly proportional to the web tension.

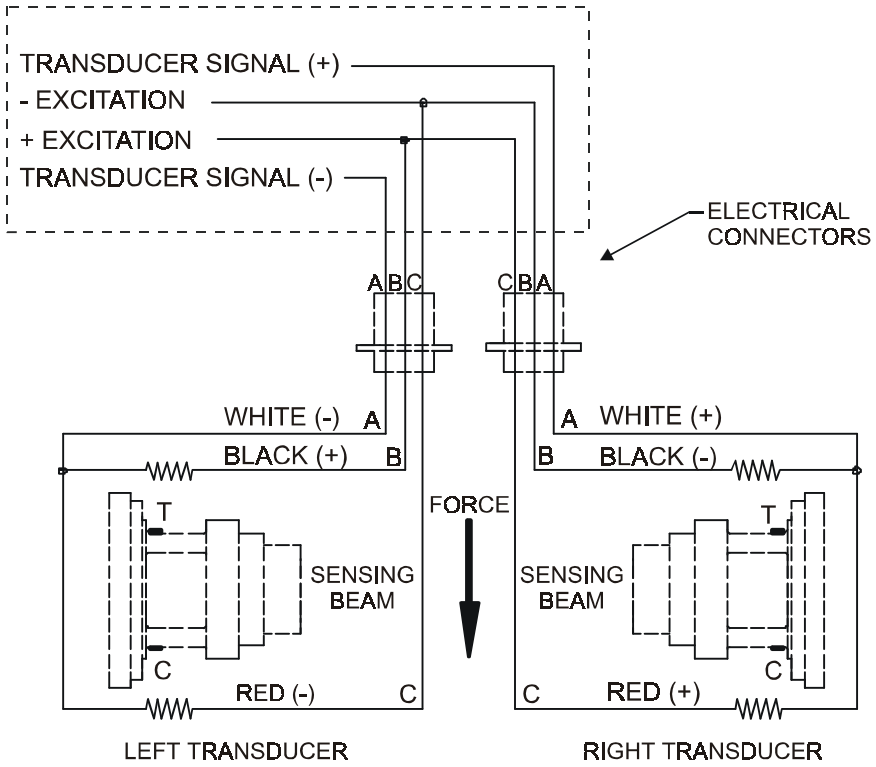


Figure 15 **- ELECTRICAL CONNECTORS**

SECTION 3

CALIBRATION AND SETUP

3.1 INTRODUCTION

There are no calibration adjustments on the Model THN transducer itself. The instructions below are for the electronic device to which the transducers are connected. All of the terminology and procedures, following, assume that the transducers are connected to a **DOVER FLEXO ELECTRONICS** tension controller or tension indicator. If some other device is being used, you should follow the instructions furnished with it.

These are general instructions which are correct for most **DFE** controllers and indicators, and are placed here for your convenience. If you have any difficulty calibrating or if there is any discrepancy between these instructions and those in the Instruction Manual for the indicator or controller, you should disregard these instructions and follow the instructions in the Manual for the indicator or controller.

*The transducers must be properly installed and oriented as directed in **SECTION 2.4**, pages 8-14.*

3.2 ZERO THE TENSION METER

1. Turn the "POWER" switch off. If the meter does not read zero, turn the mechanical adjustment screw on the meter face so the needle indicates zero tension.
2. Find an object of some kind that weighs at least 25% of the maximum value on the tension meter scale. (Be sure you know the exact weight). Calculate the exact ratio of this calibration weight and the expected web tension.
3. Find a rope, tape, or wire that will support the weight in 2. above.
4. Verify that there is no web contacting the Transducer Roll. Turn the "POWER" switch on. Wait for about five minutes for the tension meter to settle. Turn the "CALIBRATE" pot. to approximately 75%. Then, turn the "ZERO" pot. so the tension meter reads zero tension.

3.3 CALIBRATE THE TENSION METER

See Figure 16. Pass the rope over the Transducer Roll in exactly the same path as the web follows. Tie the end in 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 in-accurate calibration). Attach the weight to the free end of the rope and let it hang without touching anything. Turn the "CALIBRATE" pot. so the tension meter reads the same ratio of scale as the ratio of the calibration weight and maximum tension calculated in Section 3.2. Remove the weight and rope. This concludes the calibration procedure.

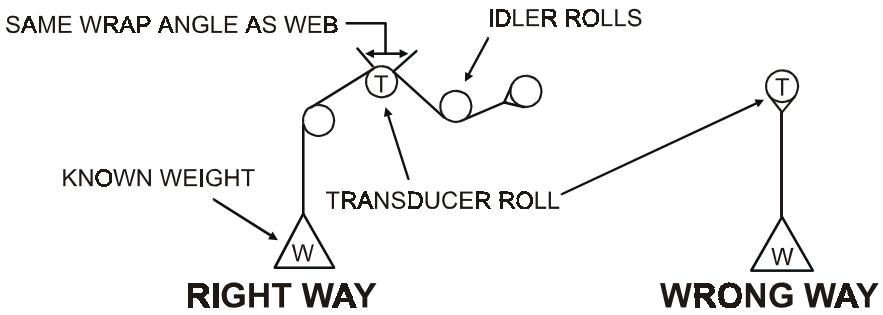


***Figure 16* - WEB PATH**

SECTION 4

CARE AND MAINTENANCE

Your Dover Flexo Model THN Tension Transducers have been manufactured of quality materials. With proper application and installation your transducers 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. could possibly require upgrading of load rating or roll change. Contact Dover for specific information and engineering approval.

Certain routine maintenance and adjustments can be performed by the user. These include bearing replacement and/or lubrication. seal replacement, changing connector position, or adjustment of the coupling position (for dead shaft transducers only).

It may be desirable to adjust connector position slightly (relative to the force direction) to make cable routing easier. If you wish to do this you should mark the transducer housing at the position you want the connector to be located BEFORE removing the transducer from the machine. Mark BOTH transducers, keeping in mind that connector position can only be adjusted in a plus or minus 45 degree increment from the way it was shipped.

For Dead Shaft transducers, you may want to adjust the position of the coupling, to facilitate idler roll removal and reinstallation. Usually it is desirable to have the coupling oriented so that the idler is removed in the upward direction. If you wish to do this you should mark the transducer housing at the position you want the coupling to be located BEFORE removing the transducer from the machine. Mark BOTH transducers, keeping in mind that coupling position can only be adjusted in 60 degree increments.

4.1 TRANSDUCER DISASSEMBLY AND REASSEMBLY

1. DISASSEMBLY PROCEDURE

1. Remove the four screws holding the Force Direction plate onto the housing, and then remove the Force Direction plate itself.
2. Remove the eight screws holding the bearing housing onto the beam, and then remove the coupling assembly.

   At this time you can change the position of the coupling (see section B), replace the seal (see section C), or change the position of the connector (see section D). If you need to need to replace and/or lubricate the bearing, continue as follows:
3. On the inside of the bearing housing, remove the retaining ring holding the coupling base into the bearing, and then remove the coupling base assembly.
4. Remove the retaining ring holding the bearing in the bearing housing. Remove the bearing.

   At this time you can replace and/or lubricate the bearing (see section A).

2. REASSEMBLY PROCEDURE

Perform the steps described in Section 1 in reverse order, paying attention to the position of the force direction plate, which must be reassembled with its arrow lined up with the notch in the beam (see Fig. 8).

A. BEARING LUBRICATION AND REPLACEMENT

1. <u>Lubrication</u>

The coupling bearing is lubricated at the factory with a high quality light grease (see Replacement Parts Listing for acceptable types). For the dead shaft version only, this should be adequate for the life of the transducer.

For live shaft transducers, 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. 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. If there is an established lubrication schedule for the other bearings on the machine it should be satisfactory for the transducer bearings as well

If the bearing needs to be lubricated, the transducer will need to be partially disassembled. Refer to the disassembly procedure in above.

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:

EXXON	Unirex N2
SHELL	Darina 2
KEYSTONE	81EP-2 and Zeniplex 2
TEXACO	Premium RB
LUBRIPLATE	630-2 and 1200-2
CHEVRON	SRI-2

Note: **DOVER FLEXO ELECTRONICS** uses EXXON Unirex N2.

Once the bearing has been removed, you can pack the bearing manually, or use a standard bearing packer. Keep in mind that 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.

2. <u>Bearing Replacement</u>

Choose a suitable bearing according to the Replacement Parts Listing. After it has been packed with grease as described above, it may be reinstalled into the bearing housing. It is a light press fit. Choose a mandrel or sleeve slightly smaller than the inside diameter of the bearing housing to press the bearing in. Note: DO NOT press on the inner race. Doing so will deform the bearing and greatly reduce bearing life.

B. CHANGING POSITION OF COUPLING (Dead shaft only)

You should have already placed a mark on the housing to identify the desired coupling position. Place an additional mark on the housing to mark the original position. Remove the six screws in the rear of the transducer. Once they have been removed, you can rotate the antirotation shaft until its vertical groove agrees with the mark you previously put on the housing. Then rotate the shaft until you find the nearest set of holes that line up with the set of holes in the beam. Then reinstall the six antirotation shaft screws and tighten. Reassemble in reverse order of assembly.

C. SEAL REMOVAL AND REPLACEMENT

The flat seal may be replaced if it becomes damaged. Refer to the Replacement Parts Listing to order a replacement seal from DFE. To remove the seal, use a sharp object such as a pick to pry it out from between the transducer housing and the beam. It should come out easily. To reinstall the replacement seal, push the seal into the groove in the housing, from the inside,. Then using a dull object such as a small screwdriver, simply work your way around the opening, tucking it into the groove in the beam.

D. CHANGING CONNECTOR POSITION

Remove the eight screws in the rear of the transducer which hold the beam to the housing. Once they have been removed, you may rotate the beam relative to the housing by ONLY 1:30 (45 degrees) in either direction, until the next set of holes is found. NOTE: ROTATING ANY FURTHER WILL BREAK THE LEAD WIRES AND DAMAGE THE TRANSDUCER, requiring service by DFE. Once the next set of holes is found, reinsert the eight screws, and retighten

When all maintenance procedures have been performed, refer to section 2 for reassembly.

SECTION 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

a. Roll is not balanced. See Section 2.4.2 page 8 and Section 2.2 page 6.

b. Shaft is not clamped tightly in transducers. Coupling screws are loose or shaft diameter is undersize.

c. Transducer mounting bolts are not tight.

d. Shaft is too weak or there is too much shaft extension between the ends of the roll and the transducers.

e. Shaft is bent or too weak.

f. 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

a. Transducer roll is too heavy. See Section 2.3.B.4 on page 8.

b. Transducers are pre-loaded. See Section 2.4.1 page 8 and 2.4.4 page 11.

3. TENSION METER READS BACKWARDS

a. Transducers are installed backwards with force arrow pointing in opposite direction. See Section 2.4.3 page 8.

b. Transducer cables are connected wrong at controller/indicator terminal strip. Signal wires are reversed.

4. TENSION METER NEEDLE PEGS HIGH OR LOW

a. Meter is not electrically adjusted to zero. See Section 3.2 page 15.

b. Transducers are pre-loaded. See Section 2.4.1 page 8 and 2.4.4 page 11.

c. Transducer cable has broken wire, poor connection or short circuit.

d. A strain gage has failed. To verify: Unplug the transducer cable and use an ohm-meter 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 (200 ohms for XR). 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.

e. Failure in the tension amplifier circuit of the controller/indicator.

5. TENSION METER DOES NOT READ ZERO WHEN WEB IS SLACK AND READING DRIFTS WITH TIME.

a. Meter is not calibrated. See Section 3.3 page 15

b. Transducers are pre-loaded. See Section 2.4.1 page 8 and 2.4.4 page11.

c. The structure the transducers are mounted on is weak. See Section 2.2.C page 6.

d. Transducer cable has a broken wire, poor connection or short circuit.

e. A strain gage is cracked. Perform the test in 4d above.

6. **TENSION METER DOES NOT READ THE SAME EACH TIME THE SAME FORCE IS APPLIED** (poor repeatability)
   a. Transducers are pre-loaded. See Section 2.4.1 page 8 and 2.4.4 page 11.
   b. The structure the transducers are mounted on is weak. See Section 2.2.C page 6.
   c. The shaft coupling cap screws are loose.

7. **TENSION METER READING DOES NOT CHANGE WHEN FORCE IS APPLIED TO ROLL. METER READS ZERO.**
   a. Meter is not calibrated. See Section 3.3 page 15.
   b. Gap between shaft coupling and beam housing is not even. See Section 2.4.6 page 14.
   c. Transducer roll is too heavy. See Section 2.3.B.4, page 8.
   d. Transducer cable has broken wire, poor connection or short circuit.
   e. Transducer cables connected incorrectly, or to wrong transducers.
   f. Failure of tension amplifier circuit in controller/indicator. Unit not turned on.

8. **TENSION METER NEEDLE BOUNCES**
   a. 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.
   b. Shaft is loose in the transducers. Shaft coupling cap screws are loose or shaft diameter is under-size.
   c. Transducer mounting bolts are loose.
   d. Tension controller is not adjusted properly. See controller Instruction Manual for procedure.

9. **TRANSDUCER ROLL WON'T TURN FREELY** (Live shaft version, L, only)
   a. Clamp screws too tight. Loosen and re-tighten to no more than 5 lb-ft torque. The bearing on the idler roll shaft is squeezed too tightly.

SECTION 6

REPLACEMENT PARTS

PART	DESCRIPTION (DFE PART NUMBER)
Electrical Connector	MS3102A - 10SL - 3P (106-0070)
Connector Screws	M3 x 6 Socket Button Head (123-0032)
Bearing Retainer Screws	M3 x 8 Flat Head (123-0481)
Coupling Bearing Seal	(501-0473)
Stop Gap Seal	(501-0472)
Shaft Bushing: D & L Type	Specify Bore
D-type Coupling Cap Screws	M8 x 20 (123-0487)
L-type Coupling Cap Screws	M6 x 16 (123-0050)
Force Direction Plate Screws	M3 x 6 (123-0032)
Anti-Rotation Shaft Screws	M5 x 10 (123-0483)
Beam Screws	M5 x 20 Flat Head (123-0490)
Mounting Screws	1/2 - 13UNC, M12 x 1.75 (optional)
Bushing Clamp Screws (L type)	M6 x 16 Hex Head (123-0491)
Bearing	1205E (133-0069)

NOTE: All screws are steel socket head, metric, grade 12.8 or higher, coarse thread unless otherwise noted.

Call **Customer Service** for prices and for part numbers of items not listed. For help with service or repairs, call **Technical Service.**

DOVER FLEXO ELECTRONICS

Telephone: 603-332-6150

Fax: 603-332-3758

TOOLS NEEDED FOR DISASSEMBLY

The following metric socket screw keys are the only tools normally needed for assembly or disassembly of the Model THN transducer.

SCREW SIZE	KEY SIZE (MM)
M1.6 / M2	1.5
M3 Button Head	2.0
M3	2.5
M4	3.0
M5	4.0
M6	5.0
M8	5.0

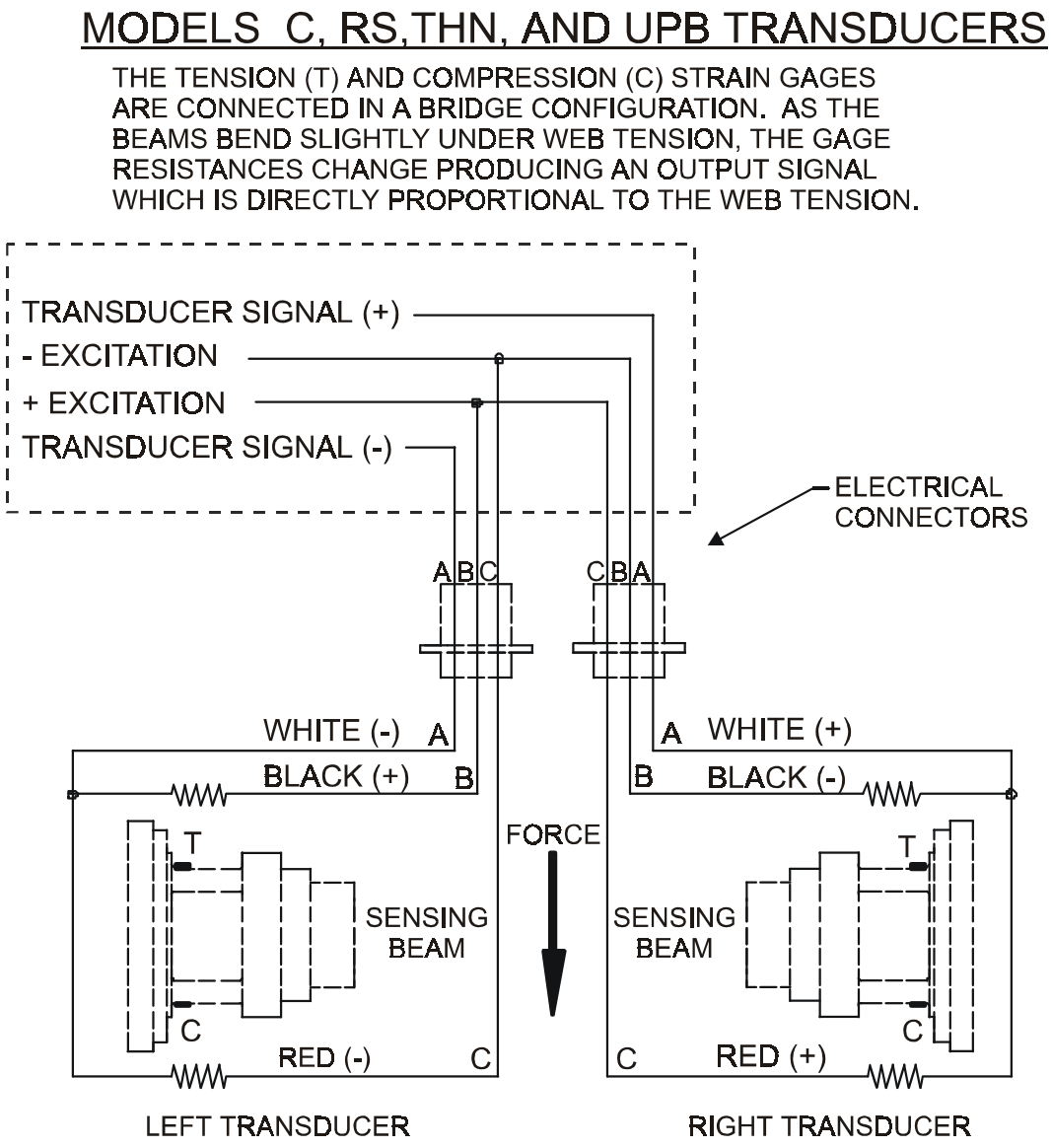


Figure 17 **- MODEL THN TRANSDUCER WIRING**

Appendix B: Typical Tensions 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. per mil per inch of width
NYLON		0.25 lb. per mil per inch of width
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. per mil per inch of width
POLYPROPYLENE		0.25 lb. per mil per inch of width
POLYSTYRENE		1.0 lb. per mil per inch of width

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		0.15 lb per mil per inch of width	
STEEL	GAUGE - INS	UNWIND-PSI	REWIND-PSI
	0.001 - 0.005	1000	4000
	0.006 - 0.025	850	3500
	0.026 - 0.040	750	3000
	0.041 - 0.055	650	2600
	0.058 - 0.070	550	2200
	0.071 - 0.090	450	1800
	0.091 - 0.120	450	1400
	0.121 - 0.140	400	1200
	0.141 - 0.165	400	1000
	0.166 - 0.200	400	900
	0.201 - 0.275	400	800
	0.276 - 0.380	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 of width.

Appendix C: 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, or the nomogram on the next page, to find the L_{10} life, in hours, for your application.

To find the radial load (P) for your application, use the appropriate sizing formula in Figure 6 on page 7, 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: 2

Bearing Type ball

Rated Load (C) 3510 lbs (15600 N)

Maximum Speed (RPM) 11,050

LIFE CALCULATION FORMULAS

(where P is radial load as described above)

$L_{10} = (16667 / RPM) \times (C) / P)^3$, for ball bearings

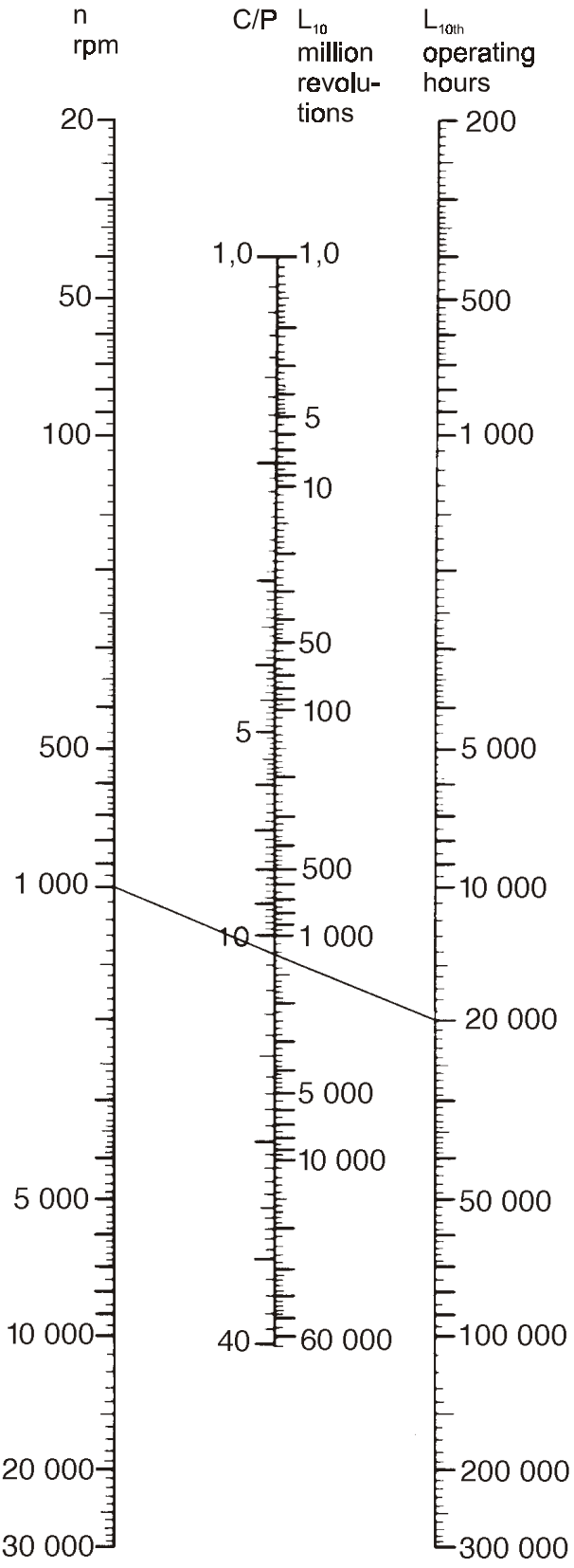
An L_{10} life of 20,000 to 30,000 hours is usually considered satisfactory for web process machinery such as printing presses, coaters, etc.

If preferred, the bearing life nomogram (Figure 17) on the next page can be used instead of the formulas. The result will be the same.

TO USE THE NOMOGRAM:

1. Use the set of three scales for ball bearings
2. Compute the speed of the bearing, in RPM.
3. Compute the ratio C/P.
4. Find the speed on the left scale. Mark it.
5. Find the value of C/P on the middle scale. Mark it on the left side of the middle scale.
6. Connect the two marks with a straight line extending to the right scale. Read the L_{10} life on the right scale where the line intersects it.

BEARING LIFE NOMOGRAM



This life is expected to be exceeded by 90% of the bearings. The median life is approximately five times as long.

TERMS AND CONDITIONS OF SALE AND SHIPMENT

1. THE COMPANY **5/1/00**

Dover Flexo Electronics, Inc. is hereinafter 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 its' products to be free of defects in material and workmanship for five years from date of original shipment. Warranty is valid on products purchased on or after April 2, 1999. 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 can not 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.

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 must be obtained from the Company's factory before returning any material for which the Buyer expects credit, exchange, or repairs under the Warranty. Returned material (except exchanges or repairs under the Warranty) shall be subject to a minimum re-stocking charge of 15%. Non-standard material or other material provided specially to the Buyer's specification 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 F.O.B. 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.

10. CANCELLATION, CHANGES, RESCHEDULING

Buyer shall reimburse Company for costs incurred for any item on order with the Company which is cancelled by the Buyer. Costs shall be determined by common and accepted accounting practices.

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 of 10% will apply to any letter of credit. There will 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.

NOTES

INDEX

DOVER FLEXO ELECTRONICS, INC.

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