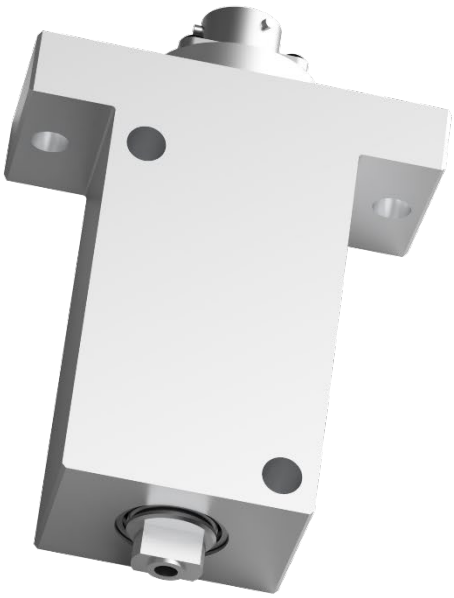
THE TENSION CONTROL SPECIALISTS

INSTRUCTION MANUAL



Model LT Low Tension Transducer

DOC 801-0655 R2

Dover Flexo Electronics
307 Pickering Road
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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E-mail: info@dfe.com Internet: www.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 "LT" Low Tension Transducer. If you have any questions concerning the operation of your device or the information in this manual, please contact us.

Email: techsupport@dfe.com
Telephone: (603) 332-6150

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

WARNING: During installation care should be taken not to drop the LT transducer, handle the LT 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.

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.

1 GENERAL DESCRIPTION

The Model "LT" Low 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 Low Tension Transducer is typically used in filament applications to ensure precise tension control in winding, unwinding and intermediate process zones.

1.1 CONSTRUCTION & MECHANICAL OPERATION

The standard Low Tension Transducer wheels are manufactured of aluminum to be lightweight and of low inertia and given a hard coat anodized surface finish to be durable. The bearings are standard deep-groove ball type with shields to discourage entry of contaminants. Custom wheel geometries and/or finishes are available, or the transducer may even be purchased without a wheel so that special hardware may be mounted at the drilled and tapped hole in the end of the transducer, subject to specific DFE engineering approval.

Inside the transducer is a single beam having two parallel cantilevered webs with strain gages mounted on each. When tension is applied, the beam deflects a small amount, causing an electrical output from the strain gages which is directly proportional to the filament tension.

The bore of the housing acts as a mechanical stop, preventing damage to the beam and gages 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.

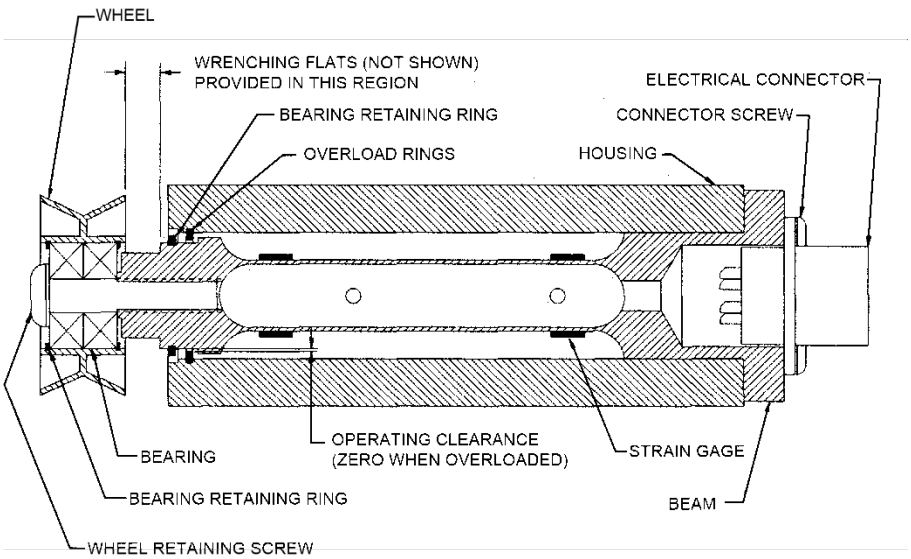


Figure 1 **– CUT AWAY VIEW OF MODEL LT TRANSDUCER**

CAUTION - NEVER USE THE WRENCHING FLATS ON THE BEAM FOR ANY PURPOSE OTHER THAN REMOVAL OF THE WHEEL FROM THE BEAM. USING THESE FLATS TO TURN THE THREADED HOUSING INTO A TAPPED HOLE WILL ALMOST CERTAINLY DAMAGE THE BEAM.

1.2 SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

Excitation Voltage: 10 VDC (max)
Output: 100 mV/V, nominal
Strain Gages: Semiconductor type, 800 ohms nominal bonded resistance
Non-Repeatability: +/- 1/4% full span (FS)
Non-Linearity And Hysteresis Combined: ± 1 /2% FS
Temperature Range: -10° F to 200° F (-23° C to 93° C)
Temperature Coefficient: 0.02% per F degree typical (0,01 % per C degree typical)
Mating Electrical Connector: Bendix PT06E 10-6S
Electrical Connector Position: Rear Only
Connector Pin Assignments:

Pin A (White): Signal Output (-)
Pin B (Black): Excitation (+)
Pin C (Red): Excitation (-)
Pin D (Green): Signal Output (+)
Pin E (Blue): Excitation (-)
Pin F (Brown): Excitation (+)

MECHANICAL SPECIFICATIONS

Wheel: Material: 6061 Aluminum
Finish: 32 micro-inch hard coat anodized
Minimum Overload Capacity: 11 lbs (49 N)
Deflection Of Sensor Beam: 0.020 inch typical (0,50mm typical)
Load Ratings: 50, 100, 200, 500, 1000, 2000 grams (0.11, 0.22, 0.44, 1.10, 2.20, 4.40 lbs)
Break-Away Torque, Typical: 0.02 oz-in (1,5 gram-cm)
Basic Dynamic Load Rating Of Bearings: 299 lbs (1,340 N)

1.3 STANDARD FEATURES

Dual Cantilever Beam: Provides high strength and accuracy at low tension.
Stainless Steel and Aluminum Construction: Excellent corrosion resistance.

1.4 OPTIONS

Non-standard wheels
Non-standard roll finishes

2 INSTALLATION

2.1 DIMENSIONS INCHES (MM)

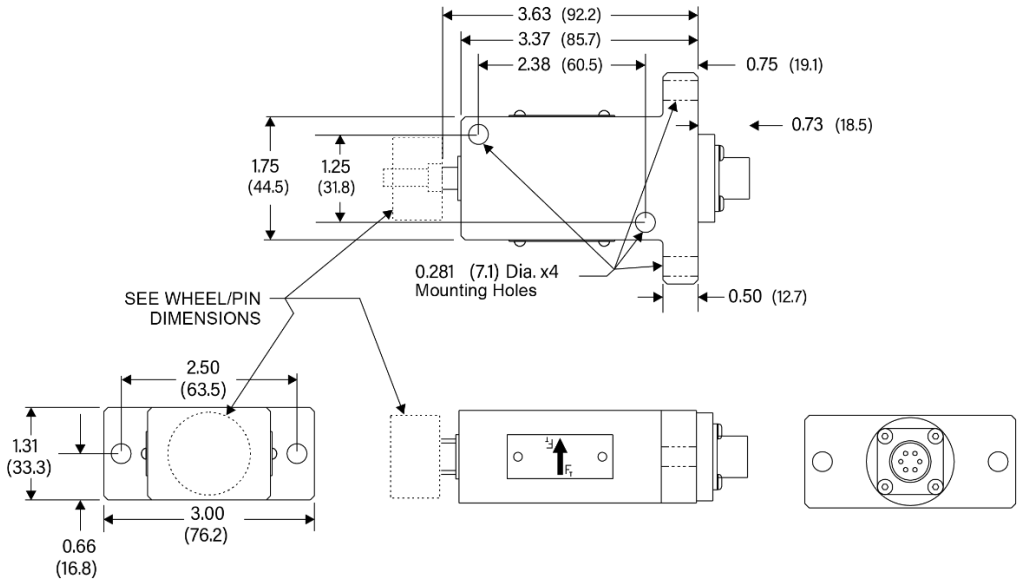


***Figure 2* – STACKABLE HOUSING DIMENSIONS**

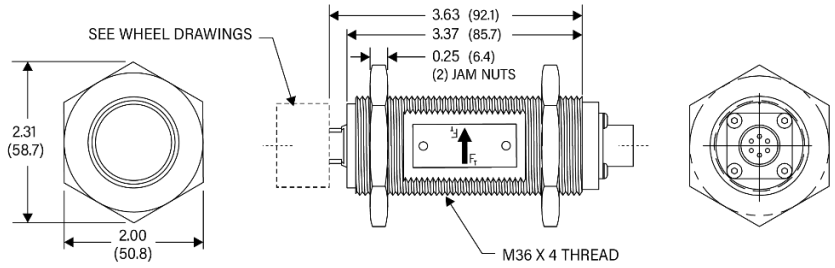


***Figure 3* – THREADED HOUSING DIMENSIONS**

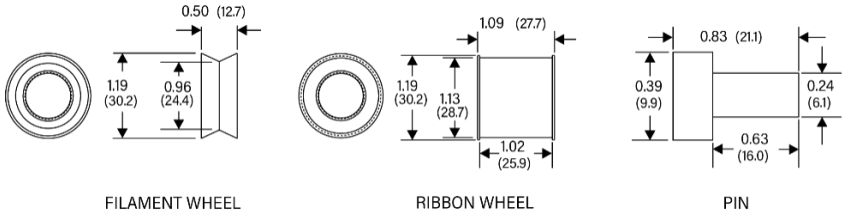


***Figure 4* – WHEEL/PIN DIMENSIONS**

2.2 PRE-INSTALLATION REQUIREMENTS

1. TRANSDUCER WHEEL

There can be no brakes, clutches, belts, chains or gears attached to the transducer wheel. It cannot be a nip wheel or be in contact with a nip wheel. **Nothing must contact the wheel except the web.**

2. WRAP ANGLE

The filament must always contact the transducer wheel in exactly the same way. The wrap angle must not change as the unwind or rewind reel diameter changes. Therefore, there must be at least one idler wheel between the transducer and the unwind or rewind shaft. If the machine has more than one filament path, be sure to choose a location that is wrapped the same for each. Otherwise, it will be necessary to install an additional transducer, or dual calibration circuitry, or both. If the wrap angle is allowed to change, the transducer output will change as well as tension in the web, and accuracy will be reduced.

3. MOUNTING SURFACE

The structure on which the transducer is mounted should be strong. Vibration of the machine frame could cause sympathetic vibration of the transducer, resulting in fluctuating output.

4. TENSION ZONE

The transducer 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 filament path that can change tension is at one end of a tension zone.

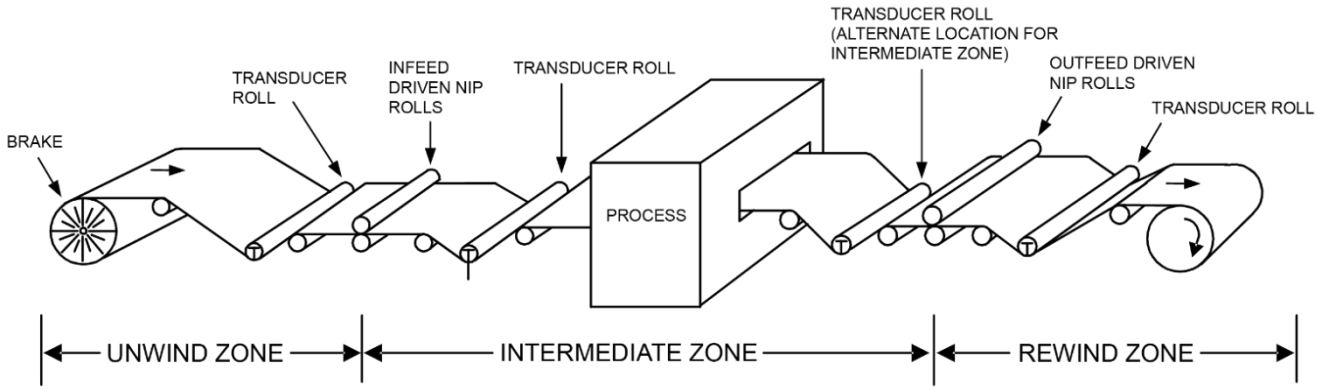


Figure 5 **– TENSION ZONES**

2.3 INSTALLATION

MOUNT THE TRANSDUCER

The transducer may be mounted by 1 of 3 methods; using either of 2 pair of mounting holes in the stackable housing as shown in Figures 6 & 7, or using jam nuts to position the threaded housing in a hole through the machine frame as shown in Figure 8.

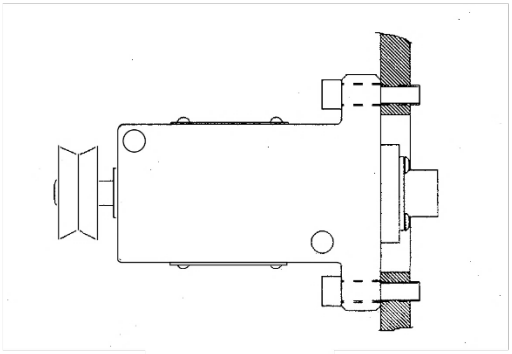


Figure 6 **– STACKABLE HOUSING MOUNT (end)**

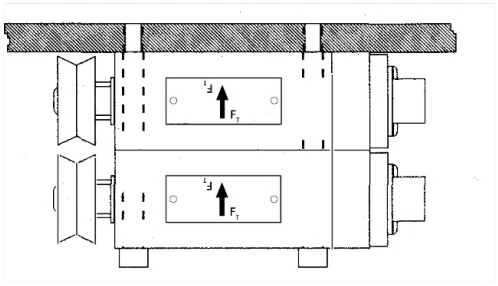


Figure 7 **– STACKABLE HOUSING MOUNT (side)**

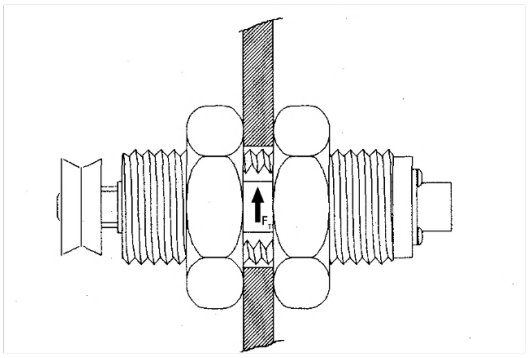


Figure 8 **– THREADED HOUSING, THROUGH-HOLE MOUNT**

ORIENT THE TRANSDUCER

The transducer must be oriented so the Tension Force arrow points in the same direction as the Tension Force. Tighten the mounting fasteners so it cannot move.

NOTICE During installation and handling, be careful not to drop the transducer. Damage could result.

2.4 ELECTRICAL OPERATION

The Low Tension Transducer has two strain gages on each web of the dual cantilevered beam; two in compressive regions and the other two in tensile regions. The four total strain gages are electrically connected in a Wheatstone bridge configuration to provide automatic temperature compensation and 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 this transducer may be of a very stable low-gain design. An added benefit of the high output from the strain gages is inherent immunity to electrical noise.

3 CALIBRATION AND SETUP

3.1 INTRODUCTION

No physical calibration adjustments are required with the Low Tension 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 9. Pass the rope over the filament wheel and through the same path as the web follows. Tie the end to the machine at least one idler beyond the Low Tension Transducer. Pass the other end by at least one idler before the Low Tension Transducer. 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.

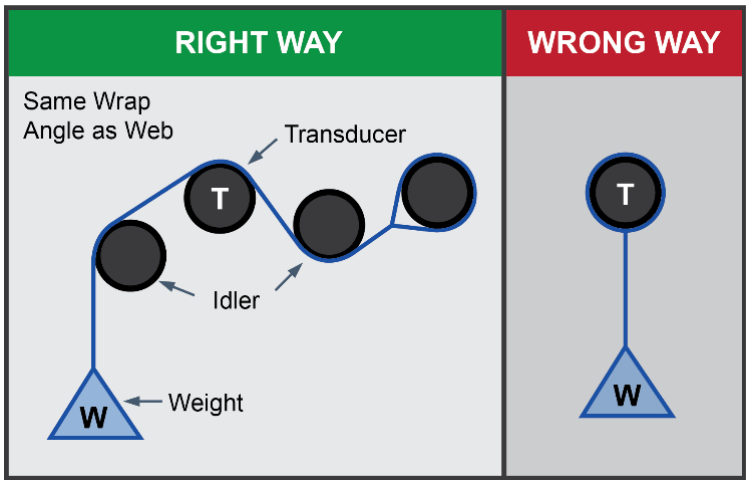


Figure 9 **– FILAMENT PATH**

4 CARE AND MAINTENANCE

The Dover Flexo Model "LT" Low Tension Transducer is 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 the filament wheel. Contact the DFE Sales Dept to review significant application changes and obtain engineering approval.

4.1 BEARING LIFE

The bearings in the Low Tension Transducer will turn continuously in normal operation. They have been selected to give a long service life under typical operating conditions. Use the formula 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 to eliminate the oversizing factor.

RPM = 318.3 x line speed in meters per minute/diameter of transducer wheel in millimeters
(RPM = 3.82 x line speed in feet per minute/diameter of transducer wheel in inches).

BEARING SPECIFICATIONS		
Bearing Type	**Rated Load (C)**	**Maximum Speed (RPM)**
Ball	299 lbs (1340 N)	36000

LIFE CALCULATION FORMULAS (where P is a radial load as described above)

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

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

5 TROUBLESHOOTING GUIDE

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 WHEEL SHAKES, VIBRATES or BOUNCES

1. Wheel is not balanced.
2. Transducer is not securely mounted.
3. Wheel is turning at its natural frequency. Call our **Technical Service Department** for analysis of operating conditions and solution to problem.
4. Transducer beam is vibrating sympathetically with a vibrating machine frame.

2. CANNOT ADJUST TENSION OUTPUT DEVICE[1] / DISPLAY TO READ ZERO WHEN RIBBON / FILAMENT IS SLACK

1. Failure in the tension indicator circuit. Refer to tension indicator/controller manual.
2. 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. Also measure between pins D, E and D, F. In each case the resistance should be about 800 ohms. Measure the resistance between any pin and the housing of the transducer. The meter should read infinite resistance. Apply an appropriate force to the wheel by hand or by using a line and a weight, in the direction of the tension force and maintain it while again measuring between pins A, B and A, C. Repeat while measuring between pins D, E and D, F. The resistance should be only a few ohms different from before.
3. Wheel greater than 95% load rating W COS(A).

3. TENSION OUTPUT DEVICE[1] / DISPLAY READS BACKWARDS

1. Transducer connected to Legacy Electronics[2]. Signal wires are reversed, or transducer is installed backwards with force arrow pointing in opposite direction.

4. TENSION OUTPUT DEVICE[1] / DISPLAY PEGS HIGH OR LOW

1. Meter is not electrically adjusted to zero. Refer to tension indicator/controller manual.
2. Transducer cable has broken wire, poor connection, or short circuit.
3. Strain gage failure. Perform test in 2.2 above.
4. Failure in the tension amplifier circuit of the indicator/controller.

5. TENSION OUTPUT DEVICE[1] / DISPLAY DOES NOT READ ZERO WHEN WEB IS SLACK AND READING DRIFTS WITH TIME

1. Meter is not calibrated. See SECTION 3.
2. Transducer cable has a broken wire, poor connection, ground, or short circuit.
3. A strain gage is cracked. Perform the test in 2.2 above.

6. TENSION OUTPUT DEVICE[1] / DISPLAY DOES NOT READ THE SAME EACH TIME THE SAME FORCE IS APPLIED (poor repeatability)

1. Extreme build-up of dirt, ink, adhesive, grease or other foreign material inside end of transducer causing interference with beam movement.
2. Transducer cable has a broken wire, poor connection, ground, or short circuit.
3. Strain gage failure. See 2.2 above.

7. TENSION OUTPUT DEVICE[1] / DISPLAY READING DOES NOT CHANGE WHEN FORCE IS APPLIED TO WHEEL, METER READS ZERO

1. Meter is not calibrated. See SECTION 3.
2. Extreme build-up of dirt, ink, adhesive, grease, or other foreign material inside end of transducer causing interference with beam movement.
3. Transducer cable has broken wire, poor connection, ground, or short circuit.
4. Transducer cables connected incorrectly, or to wrong transducer.
5. Failure of tension amplifier circuit in controller/indicator.
6. Unit not turned on.

8. TENSION OUTPUT DEVICE[1] / DISPLAY READING BOUNCES

1. Filament tension is fluctuating because of machine speed fluctuations, worn bearings, chattering unwind brake, flat spot in unwind or rewind roll, machine vibration, etc.
2. Transducer is not securely mounted.
3. Tension controller damping requires adjustment. See controller Instruction Manual for procedure.
4. Failure in the tension amplifier circuit of the controller/indicator.

Note[1]: Tension output devices such as amplifiers, display indicators and closed-loop controllers

Note[2]: Legacy electronics that precede *Quik-Cal*™ digital calibration technology

APPENDIX A: TRANSDUCER ELECTRICAL CONNECTIONS

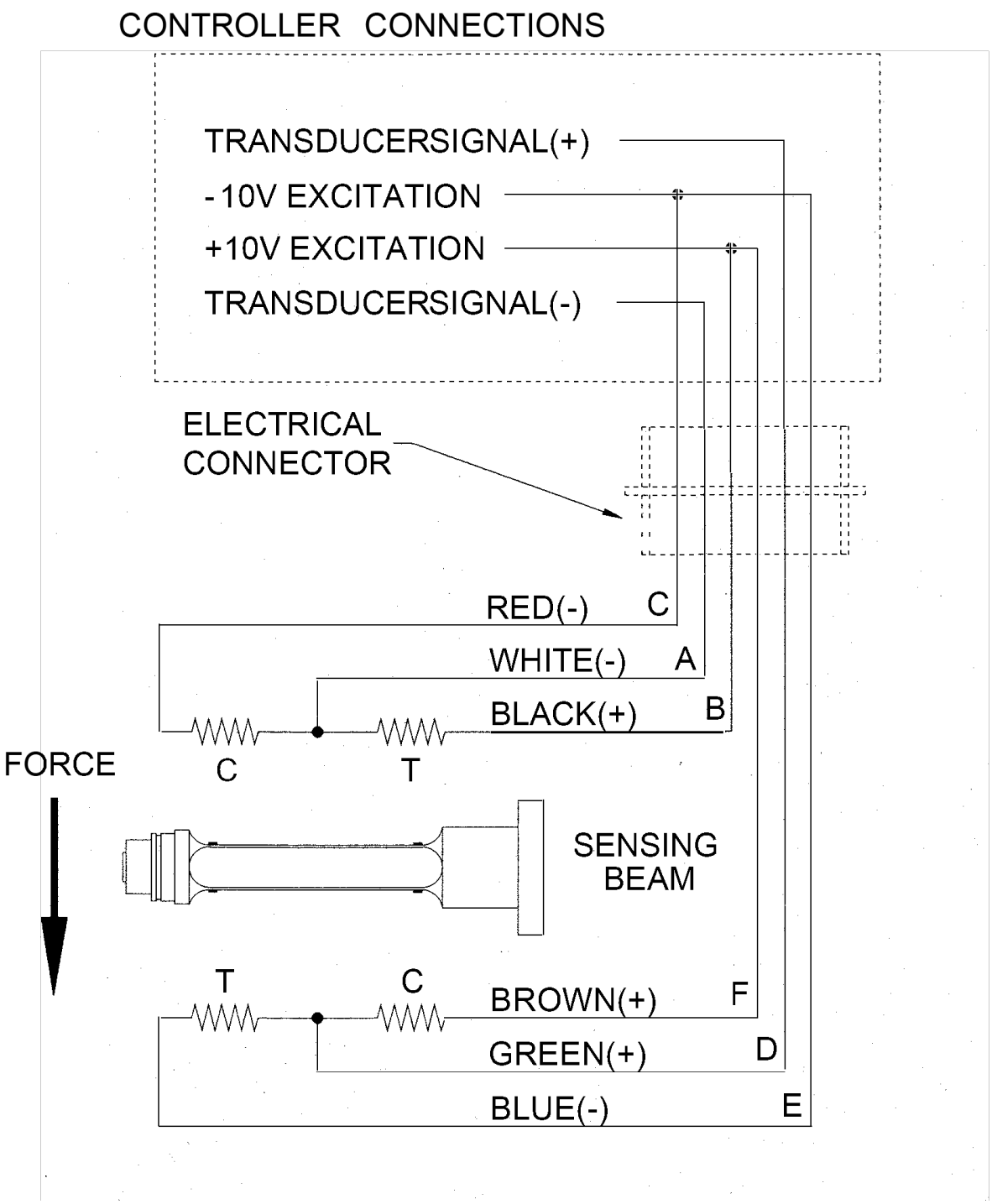


Figure 10 **– STRAIN GAUGE CONNECTIONS**

APPENDIX B: SELECTION OF LOAD RATING

1. LOAD RATINGS

The Low Tension Transducer is available with six standard load ratings ranging from 50 grams to 2000 grams (0.11 lbs TO 4.40 lbs). The correct transducer load rating for your application is determined by maximum filament tension, wrap angle, direction of force, and wheel weight. Choose the appropriate wrap configuration from the diagrams below. Then compute the Net Force using the formula below the diagram.

2. SELECTION PRODECURE

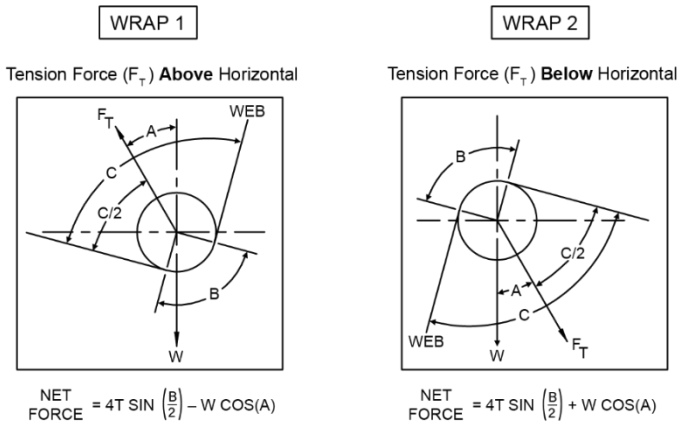
The correct load rating is found in four simple steps:

Step 1: OBTAIN DATA TO PLUG INTO THE SELECTION FORMULA

1. Estimate the maximum filament tension. Use the Typical Tensions table in Appendix C as a guide if necessary.
2. Determine the wrap angle and tension force direction.

Step 2: COMPUTE NET FORCE USING THE SELECTION FORMULA

Refer to Figure 11. 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.



W = Wheel Weight (See Note Below)
B = Wrap angle = 180° - C°
T = Maximum Web Tension
A = Angle Between Tension Force (F_T) and Vertical

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 11 **– LOAD RATING SELECTION FORMULA**

Step 3: SELECT THE LOAD RATING

Use the 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. Therefore, the actual force exerted on the transducer will not exceed its rating if the transducer is chosen according to the chart below.

LOAD RATING CHART			
Net Force		**Load Rating**	
grams	**lbs**	**grams**	**lbs**
up to 60	(0.13)	50	(0.11)
60 - 120	(0.13 – 0.26)	100	(0.22)
120 - 240	(0.26 – 0.52)	200	(0.44)
240 - 600	(0.52 – 1.32)	500	(1.10)
600 - 1200	(1.32 – 2.64)	1000	(2.20)
1200 - 2400	(2.64 – 5.29)	2000	(4.40)

Step 4: COMPARE LOAD RATING WITH EFFECTIVE TRANSDUCER WHEEL WEIGHT

The following applies only to non-standard wheels or other hardware used in place of the standard wheels:

Sometimes a wheel is so heavy that its weight uses up most of the operating range of the transducer. 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 wheel is too heavy, compare the load rating with the effective weight of the wheel as follows: The effective wheel weight 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 wheel weight,
2. Increase angle (A),
3. Use the next higher load rating (this is the least desirable choice because it reduces transducer signal output).

APPENDIX C: TYPICAL TENSION OF 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

See www.dfe.com/terms-and-conditions/ for current Terms and Conditions.

307 PICKERING ROAD
ROCHESTER, NEW HAMPSHIRE 03867-4630
U.S.A

TEL: (603) 332-6150
FAX: (603) 332-3758

E-mail: info@dfe.com Internet: www.dfe.com

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