Sonic Tension Meter

Model 507C

MANUAL

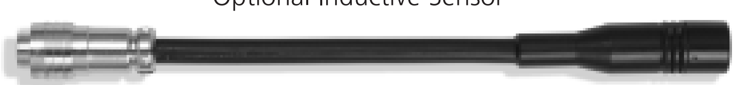
Gates®

Sonic Tension Meter Components

507C Meter

Cord Sensor

Optional Inductive Sensor



Optional Flexible Sensor

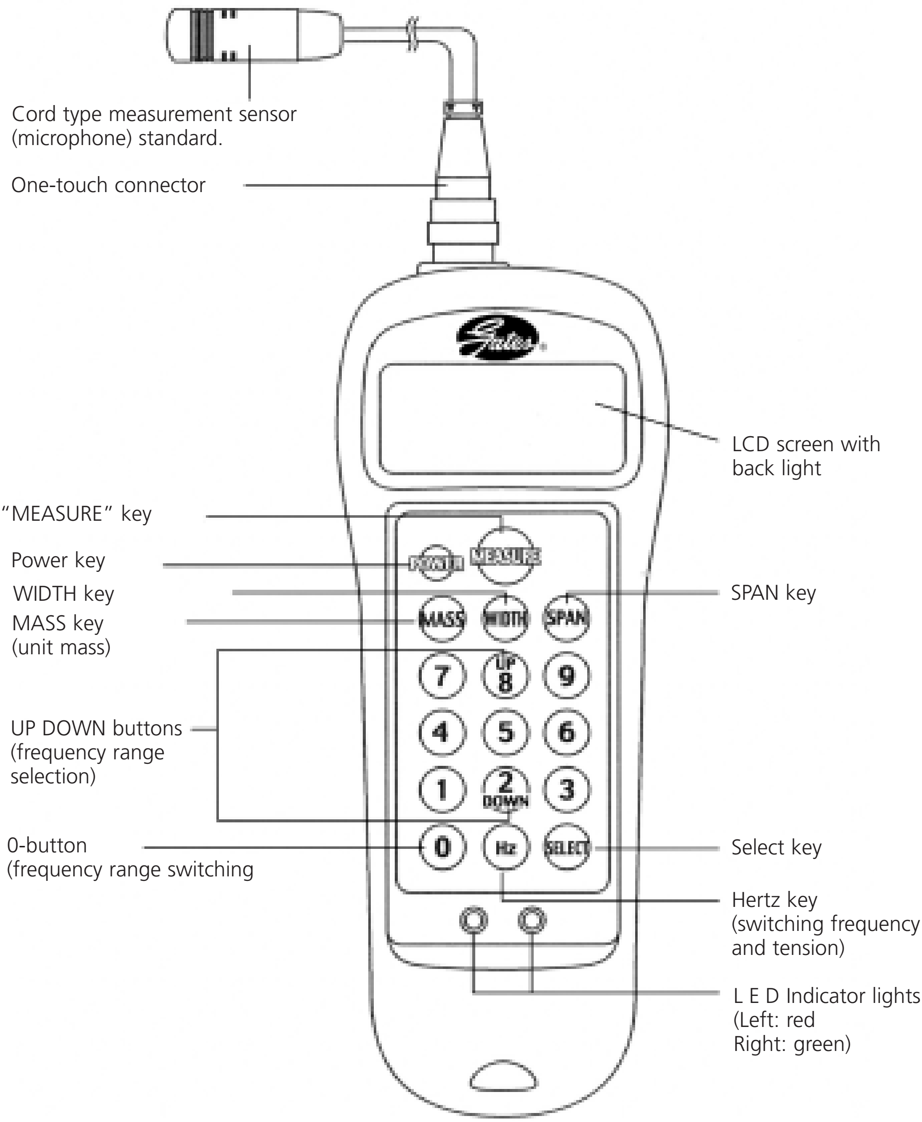
Contents

Thank you for purchasing the
Gates Sonic Tension Meter.

Please read this manual thoroughly to
fully utilize all the functions of this meter.

Important Warnings

- **Do not** drop this unit. Impact of any kind can result in damage.
- **Do not** put water, solvent or any other liquids on this unit.
- **Do not** leave this unit in a dusty environment.
- **Do not** leave this unit where it will get hot, such as in a car or in direct sunlight.
- **Do not** use volatile solvents to clean this unit.
- **Do not** use this in an area where a spark could cause an explosion.
- **Do not** pull hard on the cord of the sensor (microphone) from either end.
- **Do not** use this unit outside during a thunderstorm, turn off power and seek a safe place. Non-compliance could result in electric shock from thunderbolt.
- **Do not** bend the flexible arm sensor (microphone) within 20 mm (3/4 inch) of either end, because the construction is tubular, and the flexible arm sensor should not be bent at sharp angles.



Power supply: 2ea. AAA size batteries

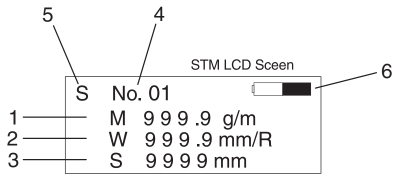
Operating Instructions

Attaching Sensor

Each of the male and female connectors has a notch on the surface. Fit the connectors together at the notch and push them together. To disconnect, hold the collar on the sensor and pull out.

Turn on the power

Press the "Power" key and the LCD screen display appears as follows:



1 – "MASS"
2 – "WIDTH"
3 – "SPAN"
4 – Storage Register Number
5 – Frequency Setting
6 – Battery Level Meter

The LCD screen is back lit for use in low light conditions. The screen and back light remain on for up to five minutes of inactivity, and then the unit automatically turns off.

The opening screen displays the contents of the data storage register that was last being used when the STM was turned off. Values for (1) "MASS" (Belt Mass Constant), (2) "WIDTH" (Belt Width), and (3) "SPAN" (Belt Span Length) are all displayed simultaneously.

Important Note: Reasonable non-zero belt constant values must be used in the storage registers in order to receive belt tension readings. The unit will display span frequency values regardless of the belt constants entered, but will display "Error" and the red light will remain on if the calculated belt tension value is beyond the display range of the screen.

Pointer (4) indicates the data storage register number where current belt data is saved. To change the data or storage register number, refer to "Input Data Storage and Retrieval" on page 7.

Pointer (5) represents the current frequency filter setting. To change, refer to "Frequency Filter Settings" on page 7.

Pointer (6) indicates the battery level meter. A dark battery symbol indicates a full charge. When the battery level becomes critically low, the meter indicator as well as a "Low Batt" message both blink.

Enter belt mass

M = □□□.□ g/m

Belt mass constants are provided on pages 11 and 12 of this manual. Capacity available for input is from 000.1 to 999.9 grams/meter. Press the "MASS" key and enter numbers on the keypad. Make sure the decimal is placed correctly in the display panel. If your entry is incorrect, press "MASS" again and the cursor returns to the original position.

Enter belt width or number of rib/strands

W = □□□.□ mm/#R

Capacity available for input is from 000.1 to 999.9 millimeters or number of ribs or strands.

For a Synchronous belt, enter the belt width in millimeters.
For an Industrial V-belt, enter the number of belts being measured.
For a PolyFlex® JB® belt, enter the number of belts being measured.
For a Micro-V® belt, enter the total number of ribs.

For a 21 mm wide Poly Chain® belt, enter "021.0";
For a 1" wide PowerGrip® timing belt, enter "025.4";
For a single strand Industrial V-belt, enter "001.0".

When using the Sonic Tension Meter on drives with multiple single or PowerBand® belts, be sure to use the appropriate mass constant and enter the correct number of belt strands being measured. There is no need to multiply the mass constant by the number of ribs/strands, as the Sonic Tension Meter will calculate the correct total belt mass.

Example:
For a V-belt drive using four individual 3V belts enter "1" for the belt width ("Width" key). The Sonic Tension Meter will display the static belt tension per individual belt. When measuring the belt tension in the V-belt drive, make sure the V-belts do not interfere with each other while vibrating.

If the same drive used a 4-strand 3V PowerBand® belt instead of single belts enter "4" for the belt width ("Width" key). The total belt tension for all four belts is measured as the entire belt vibrates. The Sonic Tension Meter will display the total static belt tension for the PowerBand® belt (for all strands within belt).

Enter the span length

S = □□□□ mm

Capacity available for input is from 000.1 to 999.9 millimeters. The span length represents the distance between the contact points on adjacent sprockets/pulleys/sheaves. This distance may be measured directly, or it may be calculated from the formula below. Calculating the span length provides the most accurate results.

Span Length Formula

$$S = \sqrt{CD^2 - \frac{(D-d)^2}{4}}$$

Where: S = Span Length (mm)
CD = Center Distance (mm)
D = Large Pulley Diameter (mm)
d = Small Pulley Diameter (mm)

Input Data Storage and Retrieval

Mass, width and span values can be stored for up to 20 different drive systems. Press the “SELECT” key to toggle through the 20 storage registers. Storage registers can also be recalled by simply pressing the “Select” key and the number that corresponds to the storage register. The storage register number is displayed in the upper left hand corner of the LCD screen; Pointer (4) on page 5.

The contents of all three data registers is displayed simultaneously. The contents of a register can be changed by simply pressing the mass, width, or span key and entering a new value. The new value is automatically saved if the storage register is changed, or the meter is turned off.

Frequency Filter Settings and Ranges

A frequency filtering feature is available to focus the meter frequency measurement response to a narrower range. This can be useful in improving the response of the meter, and in filtering out potentially interfering background noise.

Holding down the “0” button for 1-2 seconds will display a menu that allows the frequency measurement range to be changed. The available ranges are as follows:

High	500 – 5000 Hz
Standard	10 – 600 Hz
Low	10 – 50 Hz

The default setting is the “Standard” range, and can be changed by pressing the “UP” and “DOWN” keys. To accept the highlighted range, press the “MEASURE” key. Note the letter in the upper left hand corner of the LCD display indicates the frequency range setting Pointer (5) on page 5; H - High, S - Standard, L - Low.

Microphone Gain Setting

The microphone gain level is set automatically when the unit is turned on, based upon environmental background noise. If maximum microphone sensitivity is desired, turn the meter on without the microphone attached and wait for the meter to power up. Then connect the microphone so tension measurements can be taken.

Measurement

Press the “MEASURE” key and the green LED light will begin flashing. Tap the belt span to make the belt span vibrate. Hold the sensor approximately 1 cm (0.4 inch) from the belt or closer without touching the belt. The green LED light will continue to flash until a signal is received by the sensor, then the green LED light will turn off and a wave-form graphic will appear on the LCD screen. After the signal is processed, the measured belt tension is displayed, the meter beeps three times, and the green LED light turns on indicating a successful tension measurement.

After a tension reading has been obtained, pressing the “Hz” key toggles the LCD display output between tension, frequency, or both.

If the belt signal cannot be measured, or the measured frequency or the calculated belt tension is out of the range of the meter, the red LED light will turn on. When this occurs, either the tension or frequency fields may also display ERROR.

To make another tension reading, simply tap the belt again. The auto-trigger feature will automatically re-activate the meter without pressing the “MEASURE” key.

Tension Display

T = □□□□ Kg_f or lb_f or N

The displayed output of measured force can be switched between units of Kilograms force, Pounds force, and Newtons. This can be accomplished as follows:

With the unit powered off, press the “0” and “9” and “Power” keys at the same time. The meter will then turn on with the current unit of measure displayed. Units can then be changed by pressing the "SELECT" key until the desired unit appears. Press and hold down the “POWER” key again until the meter turns off. Now turn the meter on for normal operation. Data entered into the unit must still be in SI units of millimeters and grams.

The capacity available for output is 99,900 Pounds force, Kilograms force, or Newtons.

Frequency Display

F = □□□□Hz

Pressing the “Hz” key toggles the LCD display output between tension, frequency, or both.

Measurement Errors

If either the calculated belt tension or measured frequency cannot be displayed the red LED light will turn on and the LCD screen may display “ERROR”. If an error has been made in the measurement, “ERROR” will be displayed. Check the accuracy of the mass constants, width and span values and retry the measurement until a tension or frequency value is displayed. With the auto-trigger feature it is not necessary to press the “Measure” key again.

When a tension or frequency reading is obtained, take at least two additional readings for comparison. Three readings in relative close proximity indicate reasonably accurate belt tension readings.

Tension measurements made on belts at very low tensions may yield greater variability and a greater probability for errors. If a tension reading cannot be obtained, the belt may be too loose to generate a clear harmonic frequency signal. If this is the case, the belt may need to be tightened in order to obtain a tension reading. The optional Inductive Sensor is more effective at very low frequencies than the conventional microphone sensors, and may provide better results.

NOTE: Frequency only readings must have data values in the storage registers or the meter’s red LED light will stay on.

Battery Gauge

A battery graphic is located in the upper-right hand corner of the LCD screen. This gauge provides an estimate of the remaining battery power. A dark filled graphic indicates a full charge. When the battery level becomes critically low, the meter indicator as well as a “Low Batt” message both blink.

Optional Sensors

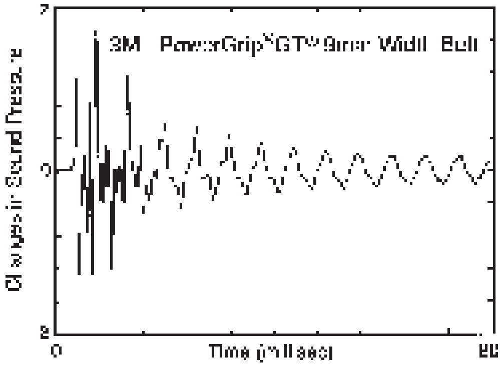
The 507C Sonic Tension Meter comes equipped with a cord type sensor. The cord type sensor provides the most effective results.

An optional flexible stick-type sensor allows one hand operation, but it is sometimes difficult to hold the meter and sensor still enough to maintain close and consistent clearance between the vibrating belt span and the sensor.

An optional Inductive Sensor relies on a magnetic field rather than on sound waves. This allows tension measurements to be taken in both noisy and windy environments. In order for the Inductive Sensor to function, a magnetic field must be present on the belt. This can be easily accomplished by taping a small magnet to the back of the belt.

Sonic Tension Meter Operating Theory

When an impulse is applied to a belt span, it first oscillates in all modes of vibration, but the higher frequency modes decay faster than the fundamental mode. This leaves a continuous sinusoidal wave that is related to a specific belt tension; note diagram.



Oscillation Damping in a Synchronous Belt

Using a microcomputer, a data processing method to capture a belt's natural oscillation frequency was developed. Using this method, the wave form frequency can be determined easily.

The new system uses special sensors to detect belt oscillation wave forms. Data from these sensors is sent to the microcomputer inside the Sonic Tension Meter for processing and conversion into the natural frequency. To calculate belt tension, the Sonic Tension Meter system uses the “transverse vibration of strings theory.” To operate the meter, the belt mass, span length and width of the belt must be entered.

Formula:

$$T = 4 \times M \times W \times S^2 \times f^2 \times 10^{-9}$$

Where:

T = Belt span tension (Newtons)
M = Belt mass constant (gf/m/mm)
W = Belt width (mm) or number of belt strands
S = Length of the span to be measured (mm)
f = Natural frequency of the belt (Hz)

Unlike a string, belts have cross-sectional rigidity. Therefore, tension values measured by the meter may be higher than the actual belt tension, depending on the operating conditions under which the effects of rigidity arise. When the actual belt tension must be more precisely measured, a simple calibration test may be necessary.

Belt Mass Constants

Adjusted mass constants are for standard stock belts only. Non-standard belt constructions may yield inaccurate results and may require special adjusted mass constants or special calibration procedures. Units are grams/meter per mm of width.

Poly Chain® GT® and GT®2 Belts	g/m
5M (5mm)	3.0
8M (8mm)	4.7
14M (14mm)	7.9

PowerGrip® GT®2 Belts	g/m
2M (2mm)	1.4
3M (3mm)	2.8
5M (5mm)	4.1
8M (8mm)	5.5
14M (14mm)	9.6
20M (20mm)	12.8
Twin Power 3M	2.7
Twin Power 5M	4.6
Twin Power 8M	6.9
Twin Power 14M	11.4

PowerGrip® GT® Belts	g/m
8M (8mm)	5.8
14M (14mm)	9.7

PowerGrip® HTD® Belts	g/m
3M (3mm)	2.4
5M (5mm)	3.9
8M (8mm)	6.2
14M (14mm)	9.9
20M (20mm)	12.8
Twin Power 3M	2.7
Twin Power 5M	4.6
Twin Power 8M	7.2
Twin Power 14M	12.3

PowerGrip® Timing Belts	g/m
MXL (0.080")	1.3
XL (0.200")	2.4
L (0.375")	3.2
H (0.500")	3.9
XH (0.875")	11.3
XXH (1.25")	14.9
Twin Power XL	1.9
Twin Power L	3.2
Twin Power H	4.6

For a single V-belt, enter 1 rib/strand. When measuring a PowerBand® (multiple) rib/strand belt, enter the number of ribs/strands per belt. Units are grams/meter per rib or strand.

Super HC® V-Belts	g/m
3V	72
5V	200
8V	510
3VX	61
5VX	158

Super HC® PowerBand® Belts	g/m
3V	96/strand
5V	241/strand
8V	579/strand
3VX	70/strand
5VX	185/strand

Predator® Belts	g/m
3VP	89/strand
5VP	217/strand
8VP	528/strand
BP	212/strand
CP	332/strand

Hi Power® II Belts	g/m
A	96
B	168
C	276
D	554
E	799

Hi Power® II PowerBand® Belts	g/m
A	151/strand
B	200/strand
C	342/strand
D	663/strand

Tri-Power® Belts	g/m
AX	85
BX	144
CX	232

Hi Power® II Dubl-V Belts	g/m
AA	125
BB	194
CC	354
DD	750

Power Cable® Belts	g/m
A	108
B	172
C	302

Metric Power™ V-Belts - Lengths ≤ 3000mm	g/m
XPZ	51
XPA	87
XPB	156
XPC	249
10X	44
13X	86
17X	139

Metric Power™ V-Belts - Lengths > 3000mm	g/m
SPZ	72
SPA	115
SPB	186
SPC	337
13X	100
17X	171

Micro-V® Belts	g/m
H	5/rib
J	7/rib
K	18/rib
L	29/rib
M	109/rib

Truflex® Belts	g/m
2L	22
3L	44
4L	77
5L	125

PoweRated® Belts	g/m
67 (3L)	52
68 (4L)	83
69 (5L)	138

Polyflex® Belts	g/m
3M	4
5M	10
7M	24
11M	49

Polyflex® JB® Belts	g/m
3M	5/strand
5M	11/strand
7M	30/strand
11M	64/strand

Belt Installation Tension

Proper belt installation tension is essential in V-belt and synchronous drives for optimum performance and reliability. The correct installation tension for a belt, or set of belts, depends upon the drive geometry and load conditions and must be calculated. Procedures for calculating belt tension are included in the appropriate drive design manual. To determine the belt tension recommended for specific drive applications, either refer to the appropriate belt drive design manual or to the DesignFlex II belt drive selection program located at: http://www.gates.com/designflex

The following belt drive design manuals listed below may be helpful:

Poly Chain® GT®2 Belt Drive Design Manual No. 17595
Light Power and Precision Drives No. 17183
Heavy-Duty V-Belt Drive Design Manual No. 14995-A
PowerGrip® GT®2 Belt Systems No. 17195

These catalogs can be downloaded from the www.gates.com website by following the links for catalogs under the Industrial Power Transmission headings, or contact Gates Application Engineering at (303) 744-5800.

Tips on Using the Sonic Tension Meter

The Gates Sonic Tension Meter is capable of measuring belt tension with greater accuracy and consistency than traditional methods. It should not, however, be expected to produce exacting results in every case. While numerous factors can be found to influence the accuracy of the meter's output, one must remember that traditional methods of belt tensioning such as force/deflection or belt elongation are approximate.

The following suggestions are provided to help you achieve a high level of accuracy with the Gates Sonic Tension Meter:

Consistent Readings

- After the correct constants have been entered into the meter, take at least three readings to confirm that results are consistent and the meter is not erroneously reading background noise.

Minimum Belt Span Length

- When measuring the tension in synchronous belts, use spans that are more than 20 times the length of the tooth pitch. Using spans shorter than this may result in readings that are higher than the actual tension due to belt cross-sectional stiffness.

- When measuring the tension in V-belts, use spans that are more than 30 times the belt top width. Using spans shorter than this may result in readings that are higher than the actual tension due to belt cross-sectional stiffness.

Minimum Belt Tension

- There are limits as to how low a span tension value the meter can measure depending upon the belt type and cross section. Minimum recommended installation tension values are available for all belt sections from either drive design manuals or Gates Application Engineering. Attempting to measure belt tensions below these minimum recommended values should be avoided, as the meter may display "Error" or provide inaccurate results. If the belt span tension is low, and a tension reading cannot be obtained, try increasing the belt tension and then take another reading.

New Belt Installation

- Before measuring belt installation tension, turn the drive over by hand for several revolutions to fully seat the belt and equalize tension in all of the belt spans. Factors such as sprocket/shaft eccentricity, belt/sheave groove irregularity, etc., can influence belt tension as the sprockets or sheaves rotate. If the measured belt tension changes significantly as the drive is rotated, and accurate measurements are needed, determine the low and high values and average them together.

Windy Environment

- Wind can adversely affect the ability of the meter to make a reading by creating excessive background noise. If measuring in a windy location, the Inductive Sensor should be used instead of a microphone sensor.

Inductive Sensor

- An optional Inductive Sensor should be utilized in noisy or windy environments for optimal results. The Inductive Sensor uses a magnetic field rather than sound waves.

  A simple way to use this sensor is with a magnet taped to the backside of the belt. Small "rare earth" magnets provide excellent results with minimal influence on the belt span frequency due to the added weight.

Using Frequency Mode

- If an assembly process is used to set belt tension in a particular application, and the meter is used only to monitor belt installation tensions, the frequency mode can be used rather than displaying an absolute measured tension value. Belt span frequencies for minimum and maximum tension conditions can be measured so assemblers/technicians can use the meter to verify that belt installation tension is within an acceptable range.

Re-calibration for Non-Standard Belts

Measuring the tension of special belts with extra thick backings, alternate materials, etc., may yield less than accurate results using belt mass constants for standard belts. In these cases, a simple calibration process may be used. The belting can be placed on a fixture with a known span length under various known tensions (hanging weights can be used). By taking frequency measurements at various tensions, span frequency vs. tension data can be collected.

This data can then be used in a graphical format or in equation form to convert measured span vibration frequencies to accurate belt tensions. Data of this type is specific to each application and cannot be applied to drives with different span lengths. Because the resulting data may not be linear, it is best to measure the tension of non-standard belts in terms of frequency rather than deriving new belt mass constants to measure in terms of absolute tension.

Summary of Features

- Model 507C - Product No. 7420-0507
- Includes cord type sensor - Product No. 7420-0206.
- 20 Memory Registers for Belt Constants
- Max Frequency of 5000 Hz
- Auto Microphone Gain Control
- Variable Frequency Range Filters
- Auto Shut Off - The meter will automatically shut off after 5 minutes of inactivity. Power can be shut off manually by pressing and holding the power button for 1-2 seconds.
- Batteries - 2 each; AAA. The battery compartment can be found on the backside of the meter.

Optional Accessories

- Flexible Sensor -
  Product No. 7420-0204
  Makes single-handed operation possible.
- Inductive Sensor -
  Product No. 7420-0212
  Recommended for noisy or windy environments.
  Magnets included.

Warranty, Service and Certification

Thank you for using the Gates Sonic Tension Meter. Gates warrants the meter to successfully operate for a period of one year (or six months for the sensors) from the date of purchase and will repair any defects for which Gates is responsible without charge within this period.

For meter calibration/certification and warranty needs contact:

Reata Engineering
7822 S. Wheeling Court. Suite. A
Englewood, Colorado 80112
Phone: (303) 936-1350
Fax: (303) 935-5956

NOTE: Reata Engineering charges for re-calibration/certification.

Unit Conversion Formulas

lb_f x 4.4482 = N x 0.2248 = lb_f
lb_f x 0.4536 = kg_f x 2.2046 = lb_f
N x 0.1020 = kg_f x 9.8067 = N

lb_f = Pounds force
N = Newtons force
Kg_f = Kilograms force

Inches x 25.4000 = mm
mm x 0.0394 = inches
mm = Millimeters

Span Length Formula

$$S = \sqrt{CD^2 - \frac{(D-d)^2}{4}}$$

Where:
S = Span Length (mm)
CD = Center Distance (mm)
D = Large Pulley Diameter (mm)
d = Small Pulley Diameter (mm)

A Tomkins Company

www.gates.com/stm

For technical information on Model 507C:
Phone: 303.744.5800 • **Fax:** 303.744.4600 • **E-mail:** ptpasupport@gates.com

To locate a distributor:
visit **www.gates.com/industrial** and click on "U.S. Distributors"

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