Sonic Tension Meter

Model 505C

MANUAL

Gates®

Sonic Tension Meter Components

505C Meter

Cord Sensor

Optional Inductive Sensor

Optional Flexible Sensor

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We're glad that you've purchased 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** pull hard on the cord of the sensor (microphone) from either end.
- **Do not** bend the flexible arm sensor (microphone) within 20 mm (3/4 inch) of either end. Its construction is tubular, and it should not be bent at sharp angles.

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 displays the current input data storage register number. To change, refer to "Input Data Storage and Retrieval."

Important Note: Reasonable non-zero values must be entered, or available in storage register, if unit is being used to measure frequency only. Unit will display "Err" and red light will remain on if no values are available."

Enter belt unit weight.

M = □□□.□ g/m

Unit weight data is provided on pages 8 and 9 of this manual. Capacity available for input is from 000.1 to 999.9 g/m. Push the "Weight" key and enter numbers on the keypad. Make sure the decimal is placed correctly in the display panel. If your entry is incorrect push "Weight" again, and the cursor returns to the original position.

Enter width or number of rib/strands.

W = □□□.□ mm/#R

For a 21 mm wide Poly Chain belt, enter "0210";
For a 1" wide PowerGrip timing belt, enter "0254";
For a single strand industrial V-belt, enter "0010".

Capacity available for input is from 000.1 to 300.0 mm or number of ribs or strands. For a synchronous belt, enter the width in millimeters. For a Micro-V® belt, enter the number of ribs. For a PolyFlex® JB® belt, enter the number of strands. Enter the number of ribs/ strands only for the belt being tested.

If the belt width is greater than 300 mm, use the following example as a guide. For a belt 500 mm wide, enter W = 250.0, which is one-half of 500 mm. Double the displayed tension to yield the actual belt span tension.

Enter the span length.

S = □□□□mm

Capacity available for input is from 0001 to 3000 mm. 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 gives the best 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)

For span lengths greater than 3000 mm, use the following example. For a belt span length of 4000 mm, enter S = 2000, which is one-half of 4000 mm. Multiply the displayed tension by four to yield the actual belt span tension.

Input Data Storage and Retrieval

Weight, width and span constants can be stored for up to 10 different drive systems. Push the "Select" key to toggle through the 10 storage registers, or push a number between 0 and 9, then enter values for the belt constants. After this is completed, the belt constants can be recalled for a drive by simply pushing the "Select" key and the number that corresponds to the storage register.

Measurement

Push the "Measure" key and the green LED will begin flashing. It will flash until a signal is received by the sensor. 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 light will turn off after a signal is received and remain off for about 1.5 seconds during processing. The measured belt tension is then displayed; the meter beeps three times; and the green LED turns back on and remains on until another signal is received. If the belt tension or frequency cannot be measured, the red LED will turn on.

Tension Display

T = □□□□ Kg_f or lb_f or N

The units of measured force can be switched between $kilograms_f$, $pounds_f$, and newtons. This can be accomplished as follows:

With the unit powered off, push the "0" and "9" and "Power" key down at the same time. Units can then be changed by pushing the "Select" key until the desired unit appears. Push the "Power" key again to return the meter to its normal operating mode.

Frequency Display

F = □□□□Hz

Push the Hz key to view the frequency measurement.

When the Hz key is pressed again, the measured tension is re-displayed.

Measurement Errors

If the belt tension or frequency cannot be measured the red LED will turn on. If an error has been made in the measurement, "Err" will be displayed. Continue to retry the measurement until tension is displayed. It is not necessary to push the "Measure" key again.

***Hz only readings** must have data values stored or unit may display "Err" and red light will stay on.

Frequency Range

Frequency range is selected automatically when the "Measure" key is pressed. The meter is capable of reading frequencies from 10 to 1000 Hz.

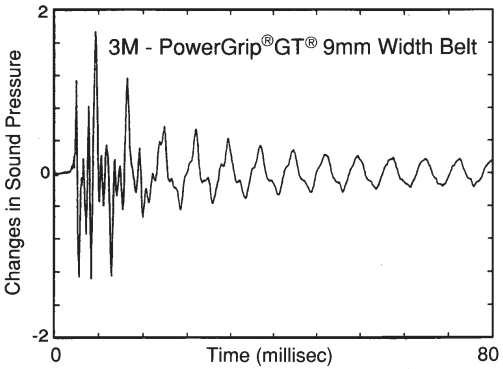
Background Noise

It is not necessary to set "Gain" with this meter. Gain is set automatically when the "Power" key is pushed. Turning on the meter without the sensor attached will result in the meter having maximum sensitivity.

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. See diagram below.

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.



Oscillation Damping in a Synchronous Belt

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 unit weight, span length and width of the belt must be entered.

Formula:

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

Where:

T = Belt span tension (newtons)
S = Length of the span to be measured (mm)
M = Belt weight unit (g_f/m/mm)
f = Natural frequency of the belt (Hz)
W = Belt width (mm)

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.

Adjusted Belt Weights

Adjusted weight constants are for standard stock belts only. Non-standard belt constructions may yield inaccurate results and may require special adjusted weight 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 8M	6.93
Twin Power 14M	11.44

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	55
E	79

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 contact Gates Application Engineering at (303) 744-5800.

The following catalogs 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

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 you have entered the correct numbers into the meter, take at least three readings to confirm that results are consistent and that 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 twice 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 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. Measuring tensions below these minimum recommended values should be avoided, as the meter may display "Err"/ "Error-Remeasure" or provide inaccurate results.

New Belt Installation

- When 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 spans before making any measurements. Factors such as sprocket/shaft eccentricity, belt/sheave groove variation, 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, shield the sensor from the wind or use a microphone windscreen.

Inductive Sensor

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

  A simple way to use this sensor is with a magnetic material attached to the backside of the belt.

Using Frequency Mode

- If a specific process is used to set belt tension in a particular application, and the meter is used only to monitor the resulting belt tensions, the frequency mode can be used rather than displaying an absolute 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 unit weights 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 a new belt unit weight to measure in terms of absolute tension. A process of this type can be used to measure the tension in industrial V-belt drives.

Features:

- 10 Memory Registers for Belt Constants
- Max Frequency of 1000 Hz
- Auto Gain Control
- Auto Set Frequency Range Filters
- Auto Shut Off - The meter will automatically shut off after 10 minutes of inactivity. Power can be shut off manually by pressing and holding the power button for 1-2 seconds.
- Includes cord sensor - Product No. 7420-0206.
- 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.

Warranty and Service

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 repairs contact your local Gates sales representative.

For meter calibration/certification needs contact:
Reatta Engineering
7822 S. Wheeling Ct., Ste. A
Englewood, Colorado 80112
Phone: (303) 936-1350
Fax: (303) 935-5956

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)

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To locate a distributor for pricing or purchases,
visit **www.gates.com/industrial** and click on "U.S. Distributors"

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