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## 1.0 OVERVIEW

The CHECK-LINE® BTM-400PLUS Belt Tension Meter is an electronic measuring instrument that precisely measures the static tension or natural frequency of flat, V-, cog or toothed belts of rubber, leather, fabric, plastic and composite materials—at standstill.

The BTM-400PLUS consists of a gauge body and two (2) separate sensor probes that emit and receive a pulsed, ruby-red beam of light. One probe is a detachable type, best for one-handed operation, and the other is a hand-held, cable-connected type, for easier access to hard-to-reach and “small-window” measuring locations. After certain belt characteristics have been entered into the gauge’s microprocessor, and a section of the belt has been caused to vibrate, the probe is brought close to the vibrating belt. The reflected light signal is then fed into the gauge’s microprocessor which converts it into a pre-selected reading of either **Belt Vibration Frequency (Hz)** or **Belt Tension (Newtons (N) or Pounds Force (lbf))**.

**Note:** Where only Belt Vibration Frequency (Hz) is of interest, belt characteristics need not be entered into the microprocessor.



Figure 1. Complete BTM-400PLUS Outfit

## 11.0 SPECIFICATIONS

|                               |                                                                                           |
|-------------------------------|-------------------------------------------------------------------------------------------|
| <b>Measuring range</b>        | 10 – 400 Hz                                                                               |
| <b>Digital sampling error</b> | < 1%                                                                                      |
| <b>Indication error</b>       | ± 1 Hz                                                                                    |
| <b>Total error</b>            | < 5%                                                                                      |
| <b>Nominal temp.</b>          | 68 °F (20 °C)                                                                             |
| <b>Operating temp.</b>        | 50 to 122 °F (10 to 50 °C)                                                                |
| <b>Max. storage temp.</b>     | 23 to 158 °F (–5 to 70 °C)                                                                |
| <b>Gauge body material</b>    | Plastic (ABS)                                                                             |
| <b>Dimensions, body*</b>      | 3.15 in. x 6.5 in. x 1.47 in (80 x 165 x 37mm)                                            |
| <b>Probe cable length</b>     | 3.9 ft. (1.2 m) overall                                                                   |
| <b>Dimensions, case</b>       | 8.9 in x 7.0 in x 2.0 in.(226 x 178 x 50mm)                                               |
| <b>Display</b>                | 2-line LCD, 16 char./line                                                                 |
| <b>Languages</b>              | German, English, French, Italian, Spanish, Portugese, Danish, Swedish, Norwegian, Finnish |
| <b>Free span length, max.</b> | 30 ft. (10 m)                                                                             |
| <b>Belt density, max.</b>     | 10 kg/m                                                                                   |
| <b>Power supply</b>           | 9 volt alkaline battery                                                                   |

\* Includes detachable type probe.

*Note: All specifications subject to change without notice.*

Figure 2. Keypad

Keys on the membrane keypad

Belt Density

Free Span Length

ENTER

ARROW UP

ARROW DOWN

ON/OFF



## 10.0 TYPICAL BELT DENSITIES

|                                   |                                                                                    |                                                                                    |                                                      |
|-----------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------|
| <b>Ribbed V-belts</b>             | PJ = 0.082<br>PM = 1.100                                                           | PL = 0.320                                                                         | kg/m per 10 ribs                                     |
| <b>V-belts</b>                    | SPZ = 0.074<br>SPB = 0.195<br>10 = 0.064<br>17 = 0.196<br>22 = 0.324<br>32 = 0.668 | SPA = 0.123<br>SPC = 0.377<br>13 = 0.109<br>20 = 0.266<br>25 = 0.420<br>40 = 0.958 | kg/m per belt<br><br><br><br><br><br>kg/m per belt   |
| <b>Power belts</b>                | SPZ = 0.120<br>SPB = 0.261<br>3V/9J = 0.120<br>8V/25J = 0.693                      | SPA = 0.166<br>SPC = 0.555<br>5V/15J = 0.252                                       | kg/m per rib<br><br><br>kg/m per rib                 |
| <b>Polyurethane toothed belts</b> | T 2,5 = 0.015<br>T 10 = 0.048<br>AT 3 = 0.023<br>AT 10 = 0.063                     | T 5 = 0.024<br>T 20 = 0.084<br>AT 5 = 0.034<br>AT 20 = 0.106                       | kg/m per 10 mm width<br><br><br>kg/m per 10 mm width |

## 2.0 INTRODUCTION

A belt drive achieves its maximum lifetime and efficiency when:

1. It is properly configured and rated for the application.
2. The belt is tensioned to the manufacturer's recommended tension.
3. The pulleys are perfectly aligned.

The CHECK•LINE® BTM-400PLUS Belt Tension Meter affords the user an easy, reliable method for accurately measuring the tension in a belt system at *standstill*.

## 3.0 OPERATING PRINCIPLE

When the Free Span\* of a belt is plucked, tapped or struck, it will vibrate at a frequency known as its “natural” frequency, the value of which depends on the existing tension in and the total mass of the Free Belt Span, according to the following relationship:

$$f = \sqrt{T/4dL^2} \quad \text{or} \quad T = 4dL^2f^2$$

where:

**f** = Natural frequency of the Free Belt Span (Hz)

**T** = Tension in belt (N or lbf)

**d** = Belt density (kg/m or lb/ft)

**L\*** = Length of the Free Belt Span (m or ft), which vibrates when struck.

\* For definition of Free Span, refer to 4.2 and Figure 2.

The d and L parameters are fixed in the design of the belt, while the “natural” frequency (f) varies with the applied Belt Tension (T). The BTM-400PLUS picks up the vibration frequency of the Free Belt Span and displays it, or the corresponding belt tension, on the instrument's LCD display panel.

## 4.0 PRELIMINARY COMPUTATIONS

Before beginning the measurement process, the following parameters must be determined. As previously noted, the Belt Density (d) and Length of Free Belt Span (L) are fixed for any particular installation. The belt and pulley manufacturer or supplier can usually supply those parameters. Refer to chart in 10.0, for typical densities. If this information is not readily available, proceed to determine them, as follows:

### 4.1 Belt Density (d = kg/m or lb/ft)

1. Weigh the entire belt to determine kg or lb.
2. Measure the developed length of the entire belt, in meters or feet.
3. Calculate  $d = \text{kg/m or lb/ft}$ .

### 4.2 Length of Free Belt Span (L)

1. Referring to the fig. 2, measure L, the belt segment that will be vibrated. It is equal to the belt length between tangential points where the belt contacts opposite pulley wheels or sheaves.

OR

2. Calculate L, using the following formula:

$$L = \sqrt{C^2 - [(D1 - D2)/2]^2}$$

where

L = Free Span length (m or feet)

C = Center-to-center (c:c) distance between pulley centers.

D1 = Pitch diameter of larger pulley, P1

D2 = Pitch diameter of smaller pulley, P2.

*All dimensions are in meters (m) or feet (ft).*

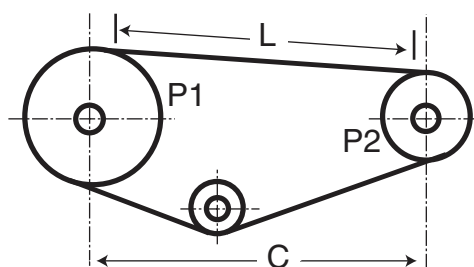
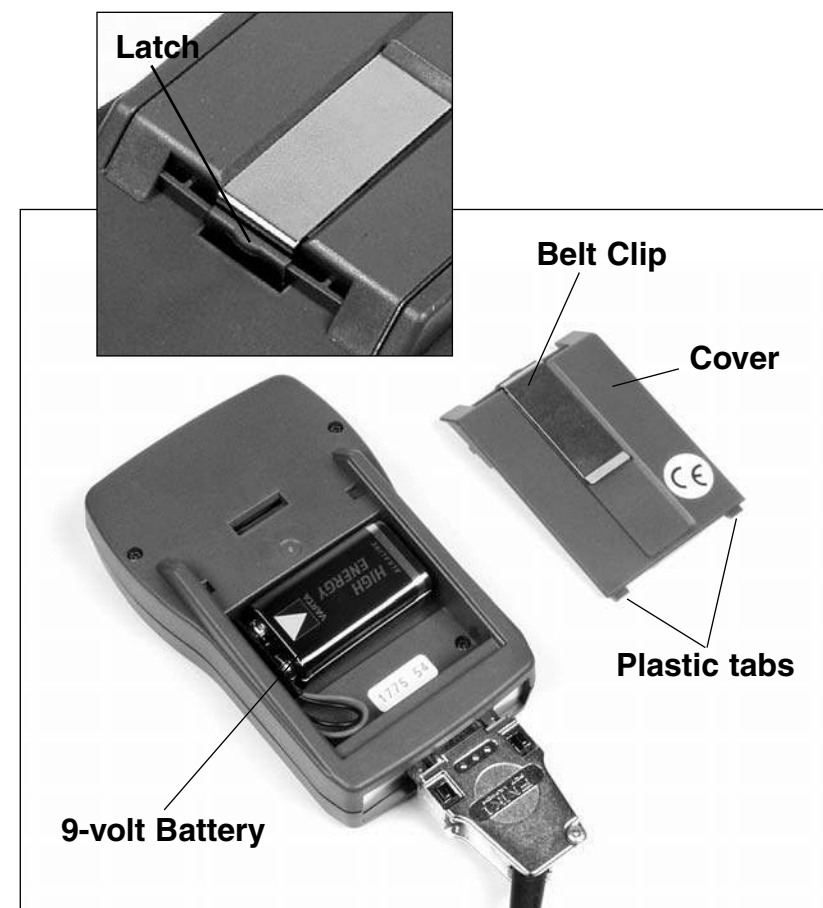


Figure 3. Measuring Free Belt Span (L)

## 9.0 BATTERY INSTALLATION & REPLACEMENT

The BTM gauge is shipped with a 9-volt DC alkaline battery. To install it, or replace it when the display shows LOW BAT, proceed, as follows:

1. Turn the gauge over. Using your forefinger press down on the battery compartment latch, located just above the belt clip. Pull the battery compartment cover towards you and off.
2. Install the new battery being sure that the terminals are completely attached.
3. Replace the cover by inserting the two plastic tabs into the slots at the base of the compartment and press forward until the latch clicks shut.



## 8.0 TROUBLESHOOTING

Measurement deviations of up to  $\pm 10\%$  for several measurements taken on the same drive belt are, as a rule, not caused by a measurement error or fault in the unit. In most cases, measurement deviations are due to the mechanical tolerances of the drive systems. If no measurement results are displayed despite careful preparations, this may be due to one of the following two reasons:

### 1. The drive belt vibrates below the minimum measurement limit of 10 Hz.

#### *Remedy*

Tighten the belt or, if the Free Span length is very long and open, support the belt in order to shorten the length. Enter the shorter Free Span belt length (L) before repeating measurement.

### 2. Either no or low measuring values are displayed despite the drive belt being correctly tensioned.

#### *Remedy*

It may be that the light from the measuring probe is not sufficiently reflected. To improve reflection, affix a piece of light-colored reflective tape to the belt or slightly moisten the belt at the measuring point.

## 5.0 PREPARING THE GAUGE FOR USE

**NOTE:** Prior to first time use, install a new 9-volt DC alkaline battery, as shown in Section 9.0, page 9.

### 5.1 Selecting the Language

1. Press ON/OFF key to turn power ON. The software version number appears, followed by Measurement Units **frequ. [Hz]** or **tens. [N]** and **menu = enter**.
2. Press ENTER  and then DOWN  ONCE, until display reads **sprachwahl (language)**, etc. If correct, exit the program by pressing the ON/OFF key. If not, proceed.
3. Press ENTER . Display will show current language selection (flashing).
4. Press UP  and DOWN  keys to scroll to the desired language.
5. Press ENTER  to accept.
6. Press ON/OFF to turn power OFF.

*The selected language will be retained in memory. To change the language, repeat this procedure.*

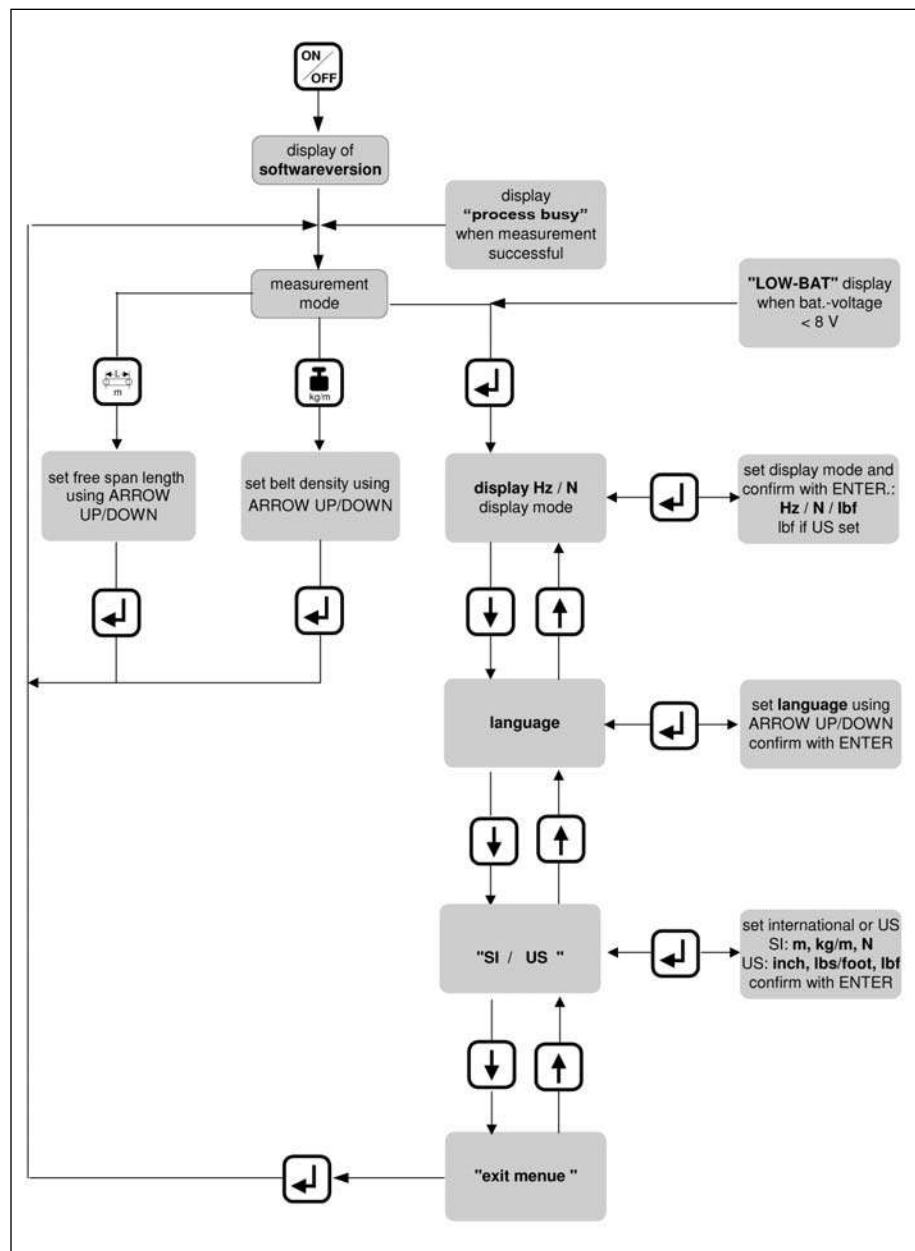
### 5.2 Setting The Measurement Units

1. Press ON/OFF key to turn power ON. Display will show: **V 8.0** and then **frequ. [Hz]** or **tens. [N]**, depending on last setting, and **menu = enter**.  
If setting is **CORRECT**, no further action is required. If **INCORRECT**, proceed:
2. Press ENTER . Display reads **display Hz/N/lbf**.
3. Press ENTER . *Flashing* display now reads, **display in Hz** or **display Tension** (N or lbf).
4. Press DOWN . Display will now start *flashing*, showing the other units (Hz or N/lbf).
5. Press ENTER  to accept the *flashing* units of measurement (Hz or N/lbf). Display now shows **display Hz/N/lbf**.
6. Press ON/OFF key to turn power off.

### 5.3 Setting The Engineering Units (International or U.S.)

1. Press ON/OFF key to turn power ON. Display shows **menu = enter**.
2. Press ENTER  once and then DOWN  TWICE until display reads **SI / US**.
3. Press ENTER . Display will show current engineering units selection.
4. Press UP  and DOWN  keys to scroll to the desired engineering units, either International (SI) or U.S.
5. Press ENTER  to accept.
6. Press ON/OFF key to turn the power off.

## 6.0 MENU STRUCTURE



## 7.0 MEASURING PROCEDURE

**WARNING:** All measurements and adjustments must be made with the belt at a standstill.

1. Switch on the BTM-400PLUS by pressing the ON/OFF pad key.
2. Check that the belt density (kg/m or lb/ft) and Free Belt Span (L) settings for the belt involved have been entered into the microprocessor by pressing the corresponding pad keys. When the key is pressed, the display will flash the last value of the parameter selected. If correct, press ENTER  to confirm the setting. If incorrect, press the UP  or DOWN  key to adjust to the correct value, then press ENTER  to accept revised value.
3. Tap or pluck the drive belt at the middle of the Free Belt Span so that it begins to vibrate. Hold the sensor probe approximately at the center of the L span, and at a distance of 3 to 20 mm above the belt, with its light directed to the belt. Refer to Figure 3. Readings will appear on the display
4. Successful measurement is acknowledged by an acoustic signal and the indication "process busy" appears on the display.
5. The measured value is displayed in Hz or N/lbf, as pre-selected.

NOTE: If frequency (Hz) alone is of interest, disregard step 2, above.

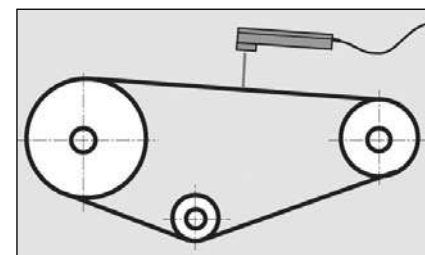


Figure 4. Measuring Free Belt Vibration Frequency

### Keys on the membrane keypad

- Belt Density
- Free Span Length
- ENTER
- ARROW UP
- ARROW DOWN
- ON/OFF

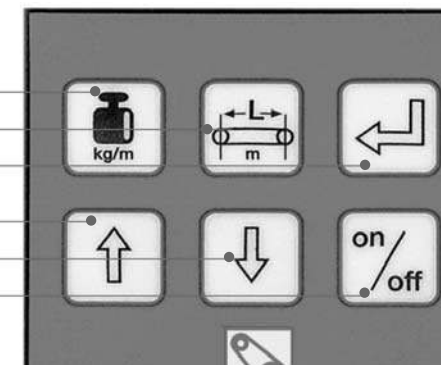


Figure 5. Keypad

## **BELT TENSION METER BTM-400PLUS**



**Operating Instructions**