The CLAVIS hand held Belt Tension Meter (Type 4)

The industry standard meter now has an enhanced specification:-

- 30-600Hz Range
- Clavis Patented sensor
- 160 hour battery life
- Meter calibration checker
- Interchangeable sensors
- Carrying case
- Calibration Certificate

The Clavis hand held beltmeter can be used for all belt tension gauging applications. It produces readings which accurately reflect the tension in the belt, consistently and without operator skill. CLAVIS tension meters were introduced in 1988.

The equipment consists of a small sensing head which is held across the belt to be measured. The belt is then tapped to induce the belt to vibrate at its natural frequency. The vibrations are detected and the frequency of vibration is then displayed on the measuring unit.

The unit is suitable for measuring tension in all types of power transmission belts, ranging from toothed timing belts, poly-vee belts, and simple vee belts. The frequency measurement range is from 30Hz to 600Hz which covers most automotive applications. A general purpose head is supplied. A range of interchangeable sensing heads with differing dimensions is available upon request.

A low frequency range Type 3 beltmeter is also available with a frequency measurement range from 10Hz to 300Hz. This meter is useful for wide belts with large spans. An optical sensor head (which only needs access to one side of the belt from distances of up to 50mm) may be used with this meter to extend the frequency range down to 4Hz.

Theory of operation

The Clavis belt tension meter measures the natural frequency of vibration of a belt span. This frequency is directly related to the tension in the belt. As the tension in the belt is increased the frequency of vibration also increases.

The relationship between the measured frequency and the tension of the belt should be determined from a calibration test on the belt span. A Clavis calibration rig is available for those users of this instrument who wish to perform their own calibrations, or we can undertake your calibration in our laboratory. Alternatively the relationship between belt tension (T) and frequency of vibration (f) may be calculated from knowing the mass per unit length of the belt (m), and the belt span (l), using the expression;

$$T=4ml^2f^2$$

Where T is in Newtons, F in Hertz, l in metres, and m in Kg/metre. However as the belt does have some flexural stiffness the predicted tension for a given frequency will be slightly greater than the actual tension. This is most noticeable on short belt spans where the belt bending stiffness is the greatest. For belt spans greater than 250mm a calculation based on the above expression will provide results within 10% of the actual values.

Operational Use

1. Connect the sensing head to the lower central socket, and turn on the unit by pressing the ON/OFF button.

2. Hold the sensing head steady across the belt span.

3. Tap the belt gently near mid span using the handle of a small screwdriver or similar, to cause the belt span to vibrate.

4. The meter will now display the frequency of vibration, and BLEEP to indicate that a valid reading has been taken.

5. If a reading is not obtained check that the sensing head is not touching the belt, and try again.

Rechargeable batteries provide 40 hours of operation (dry batteries provide 160 hours). The meter automatically switches off 10 minutes after the last reading is taken, to prolong battery life. A 'LO BAT' indicator on the display shows when the unit needs recharging. The charging socket is adjacent to the sensing head connector. An overnight charge will fully restore the batteries. During charging the 'LO BAT' indicator will flash. The meter may be powered directly from the charger if required.

Additional notes

The range of the meter is from 30 to 600Hz. Readings below 30Hz will cause the display to flash '030' and then clear to '000'. Readings above 600Hz will cause the display to flash '600' and likewise clear to '000'.

In most applications the meter is used to make comparative tension checks. Often two or three spans may be available on which to take measurements. As the frequency depends upon the span length, the span to be used for measurement must be defined. Normally it is found that the longer spans are easier to vibrate than the very short span lengths. If the belt tension adjuster is on the measurement span, ensure that the variation in span length created by the adjuster will not be significant.

Calibration

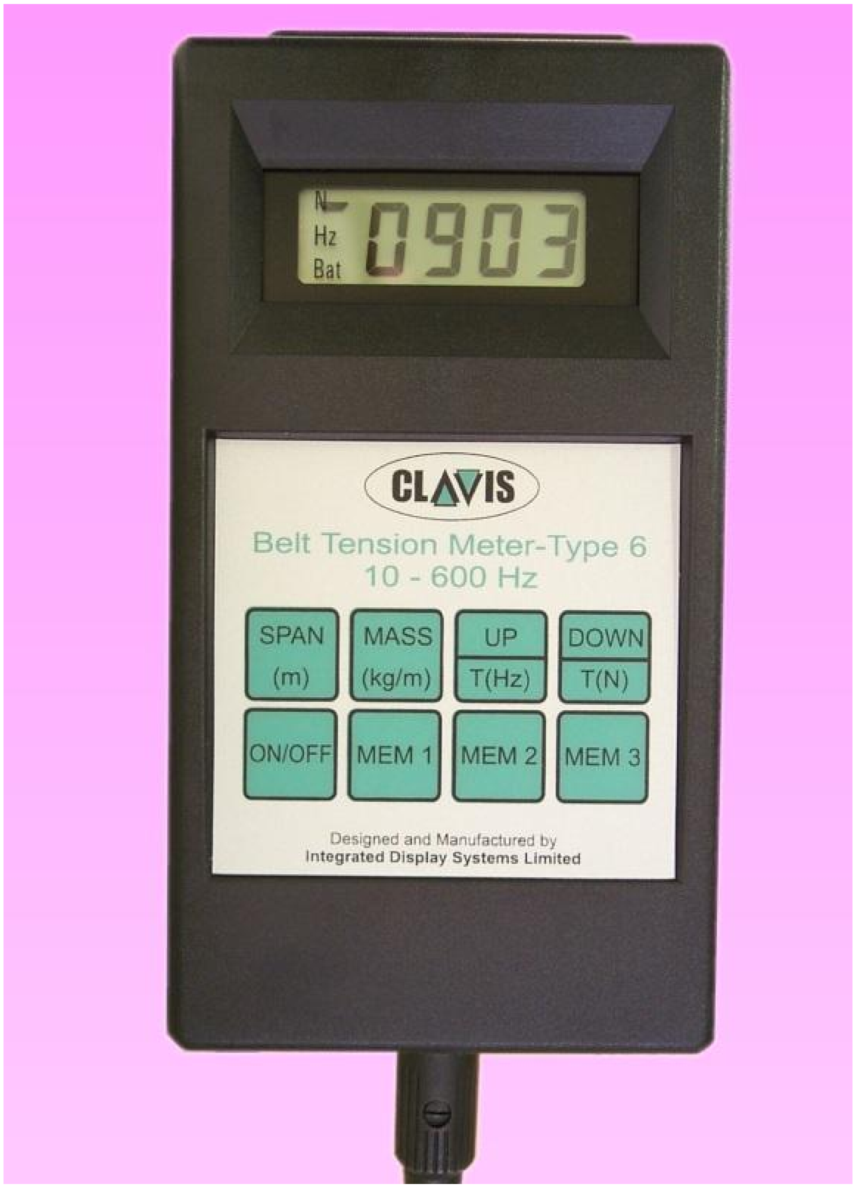
The Clavis Belt Tension Meter is based upon a microprocessor using digital signal processing techniques. A 8.0000 MHz quartz crystal provides the fundamental frequency reference which should ensure, for the life of the instrument, an accuracy of;

+ or - 1 digit below 100Hz
+ or - 1% of reading above 100 Hz

A high precision steel resonator is supplied for an easy spot frequency check of calibration. The resonator should be tapped on a hard surface and held steady between the jaws of the sensor. The meter should read 250Hz with a tolerance of + or - 1%. It is important that both the sensor and the fork are held still, otherwise doppler frequency change may occur due to relative motion.

However as with all gauging equipment a more comprehensive calibration check should be made periodically. A Clavis Belt Tension Meter Calibrator is available for this purpose, or the unit may be returned to the manufacturer for a calibration check and the issue of a certificate of calibration.

The CLAVIS hand held Belt Tension Meter (Type 6)



Introduction

The correct tension in a drive belt is essential to maximise the life of the belt and the drive components. Slippage in timing belts due to the tension being too low can have catastrophic consequences. The CLAVIS hand held Beltmeter introduced in 1988 is a significant advance by applying acoustic principles to belt tension measurements. The meter produces readings which accurately reflect the tension in the belt consistently without any operator dependence. The device is in use throughout the world, both as a production tool for accurate belt tension setting, and as a quality control gauge. The CLAVIS belt tension meter is both approved and recommended by all of the major manufacturers of drive belts. The sensor head is a CLAVIS patented design and offers superior performance over any other meter of this type

Method of Use

The equipment consists of a small sensing head which is held across the belt to be measured. The belt is then tapped to induce the belt to vibrate at its natural frequency. The unit is suitable for measuring tension in all types of power transmission belts, ranging from toothed timing belts, poly-vee belts, and simple vee belts. A general purpose sensor head is supplied, however a range of sensing heads of differing dimensions are available upon request.

Newton Display Version

The TYPE 6 version of the meter has all the capability and functions of the Type 4 meter but with the following additional facilites.

The frequency range is from 10.Hz to 600Hz, which will cover virtually all belt tension measuring applications.

The display may show the belt tension in Newton Force units of measurement.

This value is calculated from the belt span and belt mass data, which is entered into the meter. Up to 3 sets of data may be stored in the meter for easy recall. The display may be changed from a Hz to a Newton Force reading by the press of a single key. Rechargeable batteries provide 30 hours of continuous operation. Automatic power off occurs 2 minutes from the last use of the meter. A carrying case and a mains supply charger is supplied with the meter.

(Alternatively the TYPE 5 meter is available which produces a kgF display)

Specification

Model No	**TYPE 6**
Range	**10.0 - 600Hz, 10 – 9999 Newtons**
Accuracy	**+/- 1% (100 - 600Hz), +/- 1 digit (10 - 100Hz)**
Span Range	**0.001 - 0.999m**
Mass Range	**0.001 - 0.999kg/m**
Temperature	**-10 to 60 degree Celcius**
Weight	**280g**

Key Functions

This key is used to turn the meter on and off. Pressing the key once switches the meter on, pressing this key a second time switches the meter off. The meter will automatically switch off 10 minutes after the last reading has been taken.

This key is used to set the span when a result in Newtons is required. The span key should be held down, and the UP or DOWN keys used to set the span length in metres. Pressing the span key alone, shows the current belt span.

This key is used to set the mass when a result in Newtons is required. The mass key should be held down, and the UP or DOWN keys used to set the mass of the belt in Kg/metre. Refer to the table of Kg/metre values for further assistance for determining this value. Pressing the mass key alone shows the current belt mass.

This key has two functions. The first use is to increase either the SPAN or MASS parameters when used in conjunction with these keys. The second use is to switch back to the Hz measurement mode, from the Newton mode. The meter always enters the Hz measurement mode when switched on.

This key has two functions. The first use is to decrease either the SPAN or MASS parameters when used in conjunction with these keys. The second use is to switch to the Newton measurement mode. For valid Newton results the SPAN and MASS parameters of the belt must be set. If a '000' Newton reading is displayed accompanied by 3 BEEPS', this indicates that the Newton result is out of range.

MEM1 to MEM3 provide 3 identical memory functions for saving the parameters of 3 frequently used belt types. To save the parameters of a belt, the SPAN and MASS must first be set by using the above keys. After either the SPAN or MASS keys have been used, the appropriate MEM key should be pressed. The MEM key should be pressed before the SPAN or MASS value is cleared from the display, which occurs after 3 seconds.To recall a saved entry, the appropriate MEM key should be pressed. The recalled parameter can be displayed by pressing the SPAN and MASS keys.

Definition of SPAN and MASS

SPAN: The span is measured from the point of contact on one pulley to the point of contact on the other pulley. It is NOT the centre distance between pulleys.

MASS: The mass parameter is the mass per unit length of the belt measured in kilograms per metre. It may be determined by weighing the belt in kg, and dividing the result by the total length of the belt in metres. The table below details the MASS for generic synchronous belts. (See also the table at the end of this document for Gates belt data).

BELT TYPE	MASS kg/m	BELT TYPE	MASS kg/m	BELT TYPE	MASS kg/m
4T2	.004	25T5-DL	.068	25AT5	.085
6T2	.007	16T10	.077	32AT5	.109
10T2	.011	25T10	.120	50AT5	.170
4M	.005	32T10	.154	16AT10	.101
6M	.007	50T10	.240	25AT10	.158
10M	.012	75T10	.360	32AT10	.202
4T2.5	.006	100T10	.480	50AT10	.315
6T2.5	.009	32T10-DL	.182	75AT10	.473
10T2.5	.015	50T10-DL	.285	100AT10	.630
4T2.5-DL	.006	16T10-DL	.091	32AT20	.339
6T2.5-DL	.010	25T10-DL	.143	50AT20	.530
10T2.5-DL	.016	32T20	.269	75AT20	.795
6T5	.014	50T20	.420		
10T5	.024	75T20	.630		
16T5	.038	100T20	.840		
25T5	.060	32T20-DL	.355		
6T5-DL	.016	50T20-DL	.555		
10T5-DL	.027	10AT5	.034		
16T5-DL	.043	16AT5	.054		

RS232 Serial Port

The format of the RS232 serial output is as follows;

Data Bits:	8
Stop Bits:	1
Parity:	NO
Baud Rate:	9,600

Each time a measurement is successfully taken, the meter after the 'BEEP', transmits the ascii character string. The following are examples of transmitted output for the alternative meter modes;

Hz Mode:

10.0 HZ
75.8 HZ
103 HZ

Kgf Mode (Type 5):

06.2 KGF
27.8 KGF
843 KGF

Newton Mode (Type 6):

0010 N
0287 N
6523 N

Between the numeric value and the units of measurement there is an ascii space character (decimal 32). Each character string is terminated by an ascii 'Carriage Return', (decimal 13)

When the meter is first switched on, an identifying message string is transmitted of the following form;

CLAVIS TYPE 5 - REV 6.071294 or CLAVIS TYPE 6 - REV 7.010699

Calibration

All Clavis Belt Tension Meters are supplied with a certification of calibration valid for one year.

The meter is based upon a microprocessor using digital signal processing techniques. A 8.0000 MHz quartz crystal provides the fundamental frequency reference which should ensure, for the life of the instrument, an accuracy of;

+ or - 1 digit below 100Hz
+ or - 1% of reading above 100 Hz

A high precision steel resonator is supplied for an easy spot frequency check of calibration. The resonator should be tapped on a hard surface and held steady between the jaws of the sensor. The meter should read 250Hz with a tolerance of + or - 1%. It is important that both the sensor and the fork are held still, otherwise doppler frequency change may occur due to relative motion.

However as with all gauging equipment a more comprehensive calibration check should be made periodically. A Clavis Belt Tension Meter Calibrator is available for this purpose, or the unit may be returned to the manufacturer for a calibration check and the issue of a certificate of calibration.

Standard Accessories supplied with the Type 6 Meter

Type 6 Meter
Universal Type 3 sensing head
Rechargeable Batteries
Battery Charger
Carrying Case
Calibration Resonator
Certificate of Calibration

Manufacture and Warranty

All **CLAVIS** belt tension measuring and setting equipment is designed and manufactured in England by;

Integrated Display Systems Limited,
Maurice Road,
Wallsend,
Tyne and Wear,
NE28 6BY

Tel: +44 (0) 191 262769
Fax: +44 (0) 191 2620091

Email: sales@clavis.co.uk
Web: www.clavis.co.uk

All of the handheld tension meters include a warranty for a period of 12 months from the date of purchase.

Examples for the conversion between Hz and Belt Tension in other Engineering Units

The relationship between Tension and Frequency is given by the following expression

$$\mathbf{T = 4\,M\,L^2\,F^2}$$

T = Tension in Newtons
L = Span Length in metres
F = Frequency in Hz (as measured on the CLAVIS meter)
M = Mass per unit length of the belt, in kg/metre

For a **4 rib alternator belt** as fitted to CE-14 diesel, the weight of the belt is 0.103kg. The length of the belt is 1.038m, therefore

M = 0.103/1.038
M = 0.1

For a **5 rib alternator belt** as fitted to BE146, the weight of the belt is 0.096kg. The length of the belt is 0.868m, therefore

M = 0.096/0.868
M = 0.11

Example 1 - BE146

Setting frequency is 220Hz. What is the tension in lbs?

Top span length is 0.17m (where the frequency measurement was taken).
Mass per unit length is 0.11 for a 5 rib belt

T = 4 x 0.11 x (0.17 x 0.17) x (220 x 220)
T = 610N

To produce results in kg force divide by 9.81

T = 610/9.81 = 62 Kgf

To produce results in pound force, convert the kgf reading by multiplying by 2.2

T = (610/9.81) x 2.2 = 136.4 lbs

Example 2 - BE146

Setting tension is 140lbs. What should the frequency be?

140 lbs = 140/2.2kg = 63.6kg
63.6kg = 63.6 x 9.81N = 624N

$T = 4\,M\,L^2\,F^2$

We know that the span length (ie. the distance between the point of contact on one pulley, to the point of contact on the second pulley) is 0.17m, that the mass per unit length of a 5 rib belt is 0.11kg/m, and the setting tension is 624N. Therefore:

$624 = 4 \times 0.11 \times (0.17 \times 0.17) \times F^2$
$F^2 = 624/ (4 \times 0.11 \times 0.17 \times 0.17)$
$F^2 = 49{,}072$
F = 221Hz

GATES BELT DATA

Grams/metre length/millimetre width

PowerGrip timing belt

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

PowerGrip HTD belts

3M (3mm)	-	2.4
5M	-	3.9
8M	-	6.2
14M	-	9.9
20M	-	12.8
Twin Power 3M	-	2.7
Twin Power 5M	-	4.6
Twin Power 8M	-	7.2
Twin Power 14M	-	12.3

PowerGrip GT2 belts

8MGT (8mm)	-	5.8
14MGT (14mm)	-	9.7

PowerGrip GT belts

2MR (2mm)	-	1.4
3MR (3mm)	-	2.8
5MR (5mm)	-	4.1

Poly Chain GT2v belts

8MGT (8mm)	-	4.7
14MGT (14mm)	-	7.9

Polyflex V-belts (grams/m/belt or strand)

3M Single	-	4.2 / belt
5M Single	-	11.2 / belt
7M Single	-	27.5 / belt
11M Single	-	56.1 / belt
5M-JB	-	13.1 / strand
7M-JB	-	34.3 / strand
11M-JB	-	74.0 / strand

Micro V-belts (grams/m/ribs)

H section	-	5.9 / rib
J section	-	8.4 / rib
K section	-	20.0 / rib
L section	-	30.9 / rib
M section	-	124.1 / rib

Hi-Power belts

Z	-	70
A	-	126
B	-	211
C	-	373
D	-	721
E	-	1031

Hi-Power MN belts

Z non cogged	-	56
Z cogged	-	51
A	-	99
B	-	156
C	-	240

Super HC belts

SPZ	-	75
SPA	-	137
SPB	-	227
SPC	-	413
8V	-	616

Super HC MN belts

SPZ	-	62
SPA	-	110
SPB	-	184
SPC	-	313.5

Quad-Power II belts

XPZ	-	69
XPA	-	122
XPB	-	192
XPC	-	328.5

PowerBand belts

9J	-	107
15J	-	258
SPB	-	284
SPC	-	445
8V	-	706
3VX-PB	-	79
6VX-PB	-	216

Note – For Powerband figure given is grams/metre/strand