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Tensions that exceed the tension range of the instrument by more than 100% may cause permanent damage to the measuring spring and must be avoided under any circumstances.

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## 1.0 OPERATING PRINCIPLE

The ZEF and ZED Digital Tension Meters accurately measure the running line and static tensions of yarns, man-made fibers, buffered optical fibers, fine wires and similar process materials. They employ the 3-roller principle of tension measurement where the outer two reference rollers remain fixed during measurement to establish a wrap angle over the center sensing roller. The center roller is part of a precision strain gauge sensing system that accurately measures the resulting force on the roller. This force is converted into an accurate line tension value using a factory calibration curve stored in the microprocessor.

The ZE models are controlled using only 2 keys; *power and auto zero*. The Auto Zero key permits the user to operate this tension meter in any angle required by the application, while maintaining the highest accuracy.

The ZEF and ZED models are battery powered and are covered by a one-year warranty.

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## WARRANTY

ELECTROMATIC Equipment Co., Inc. (ELECTROMATIC) warrants to the original purchaser that this product is of merchantable quality and confirms in kind and quality with the descriptions and specifications thereof. Product failure or malfunction arising out of any defect in workmanship or material in the product existing at the time of delivery thereof which manifests itself within two years from the sale of such product, shall be remedied by repair or replacement of such product, at ELECTROMATIC's option, except where unauthorized repair, disassembly, tampering, abuse or misapplication has taken place, as determined by ELECTROMATIC. All returns for warranty or non-warranty repairs and/or replacement must be authorized by ELECTROMATIC, in advance, with all repacking and shipping expenses to the address below to be borne by the purchaser.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE OR APPLICATION. ELECTROMATIC SHALL NOT BE RESPONSIBLE NOR LIABLE FOR ANY CONSEQUENTIAL DAMAGE, OF ANY KIND OR NATURE, RESULTING FROM THE USE OF SUPPLIED EQUIPMENT, WHETHER SUCH DAMAGE OCCURS OR IS DISCOVERED BEFORE, UPON OR AFTER REPLACEMENT OR REPAIR, AND WHETHER OR NOT SUCH DAMAGE IS CAUSED BY MANUFACTURER'S OR SUPPLIER'S NEGLIGENCE WITHIN TWO YEARS FROM INVOICE DATE.

Some State jurisdictions or States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. The duration of any implied warranty, including, without limitation, fitness for any particular purpose and merchantability with respect to this product, is limited to the duration of the foregoing warranty. Some states do not allow limitations on how long an implied warranty lasts but, notwithstanding, this warranty, in the absence of such limitations, shall extend for one year from the date of invoice.

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## APPENDIX: GUIDE ROLLERS

You should regularly inspect the guide rollers to be sure that they are running easily and smoothly. You can replace the rollers yourself, as necessary. When ordering spare rollers, please indicate the tension meter model and the serial number (both given on the rear side of the tension meter) in your spare parts order.

### ZEF Guide Rollers:

V-Grooved	Line Speed m/min max	Roller Material
Standard	900	Hardcoated aluminum
Code K	2000	Hardcoated aluminum
Code T	450	Plastic (POM) black
Code W	450	Nickel-plated steel

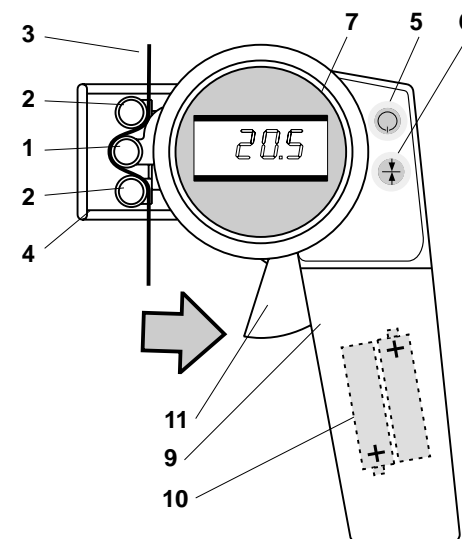
### ZED Guide Rollers:

V-Grooved	Line Speed m/min max	Roller Material
Standard	2000	Hardcoated aluminum
Code K	3500	Hardcoated aluminum
Code H	5000	Plasma-coated aluminum
Code T	450	Plastic (POM) black
Code W	450	Nickel-plated steel

## 2.0 OVERVIEW

### 2.1 Operating elements

1. Measuring roller
2. Guide rollers
3. Measured material
4. Filament guide
5. ON/OFF & ZERO key
6. DAMP (damping) key
7. Display
8. Black Phillips screws for battery compartment  
(not shown, see page 4)
9. Battery cover
10. Batteries (2 x AAA)
11. Thumbpiece



### 2.2 Complete kit

Your tension meter is provided as a complete kit, including:

- Tension meter
- AAA batteries (2x)
- 1 Phillips screwdriver
- Operating instructions
- Carrying case

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### 3.0 BATTERY INSTALLATION / REPLACEMENT

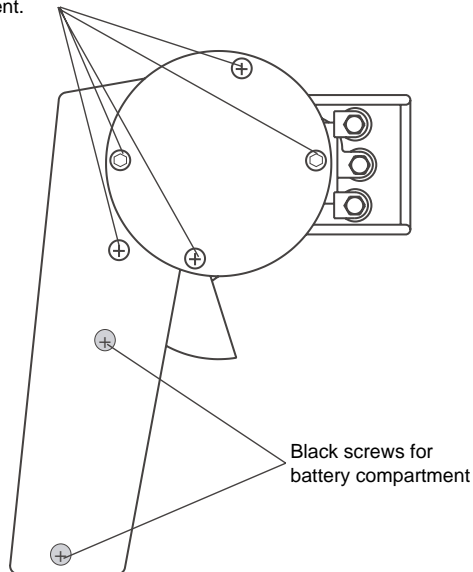
**First use:** Before you can begin taking measurements with your tension meter, you need to install the two AAA batteries provided as part of the complete kit.

1. Remove the two **BLACK** screws located on the back side of the handle. See diagram below.
2. Remove the battery cover from the front side of the handle.
3. Insert the two AAA-sized, 1.5 Volt batteries. Insure that they are installed in the correct polarity as shown on the label.
4. Close the battery cover from the front side and tighten the screws from the back side. **DO NOT OVERTIGHTEN.**

**NOTE:** If the instrument will not be used for a long period of time, the batteries should be removed.

**Battery replacement:** If the Low battery symbol  and blinking arrow ▼ are shown on the display, battery power is low and the batteries need to be replaced immediately. Operating the tension meter under low battery power may cause measurement errors.

**IMPORTANT:** The holding screws for the measuring spring located on the rear side of the tension meter must not be loosened under any circumstances. Loosening these screws may alter the calibration of the instrument.



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### 7.0 SPECIFICATIONS

<b>Accuracy</b>	±1% Full Scale, ±1 digit
<b>Overrange</b>	10% Full Scale
<b>Overload Protection</b>	200% Full Scale
<b>Measuring Principle</b>	Strain Gauge
<b>Measuring Roller Deflection</b>	0.5mm (maximum)
<b>Signal Processing</b>	Didigital 12 bit A/D converter
<b>Damping</b>	Variably adjustable electronically (averaging)
<b>Measuring Frequency</b>	Approx. 5 kHz internally
<b>Display Rate Update</b>	2x per sec
<b>Display Type</b>	3-digit LCD, 10mm height <i>Model ZEF-100:</i> 3.5-digit LCD
<b>Auto Power Off</b>	Automatically after approx 3 minutes of non-use
<b>Battery Type</b>	2 pcs., AAA (1.5 V)
<b>Battery Life</b>	30 Hours Continuous Use (Approx.)
<b>Roller Material</b>	Hard-coated Aluminum (standard) POM Plastic (Optional), specify suffix "-T"
<b>Operating Temperature</b>	50 to 100 °F (10 to 45 °C)
<b>Housing Material</b>	High-Impact Plastic (POM)
<b>Dimensions</b>	6.2 x 3.3 x 1.3" (157 x 85 x 32 mm)
<b>Weight</b>	200 grams (Approx.)

The new calibration should be verified following the procedure in section 4.3. If this procedure shows a deviation, you can recalibrate the tension meter again or restore the factory calibration as described in section 6.4

If the verification of the calibration according to section 4.3 shows a deviation beyond the allowable tolerance and reliable operation is no longer possible, the instrument has to be returned to the the factory for recalibration.

### 6.3 Error Messages during calibration

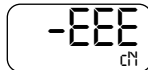
The following error message might be displayed during the calibration of the tension meter:

If the display momentarily shows



The weight suspended from the measured material is too heavy.

2. The display momentarily shows

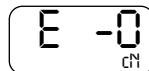


The weight suspended from the measured material is too light.

### 6.4 Restoring factory calibration

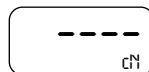
You can restore factory calibration at any time using the following procedure:

1. Press and hold the DAMP and ON/OFF keys for about 6 seconds until the display shows



2. Release the ON/OFF key first, and the the DAMP key.

3. Press and hold the ON/OFF and DAMP keys again. Keep the keys depressed until the display shows - - - - for about 1 second.

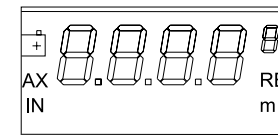



4. The tension meter switches off and the factory default calibration has been restored.

## 4.0 TAKING MEASUREMENTS

### 4.1 Turning the power ON

1. Turn on the power by pressing and the ON/OFF key (#5). The display momentarily shows the tension range and the software version and subsequently carries out a self-test and the zero adjustment. (see also section 4.3) .



2. The display shows  and the tension meter is ready to operate.



### 4.1 Turning the power OFF

*Auto Power Off:* The tension meter switches off automatically after 3 minutes of non-use

*Manual Power Off:* Press and hold the ON/OFF key for 5 seconds.

### 4.3 Performaing a Zero Adjustment of the measuring position (Auto Zero)

The tension meter is factory calibrated for a vertical material path. Every time the tension meter is switch on, zero adjustment is automatically carried out for the current measuring position. Whenever the measuring position is changed after switch on, a zero adjustment needs to be performed following the directions below.

**NOTE:** The Zero Adjustment for the new material path only remains effective until the instrument is switched off.

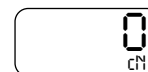
1. Turn on the power as shown in section 4.1 above.
2. Place the Tension Meter in the desired measuring position simulating the angle that the meter will be held when the material is threaded through the three rollers.

**NOTE:** Do not insert process material at this time. Be sure to hold the meter steady.

3. Press and hold the ON/OFF /ZERO key (#5). The display will show four zeros.



4. After another second or two, the display will change to show one zero.



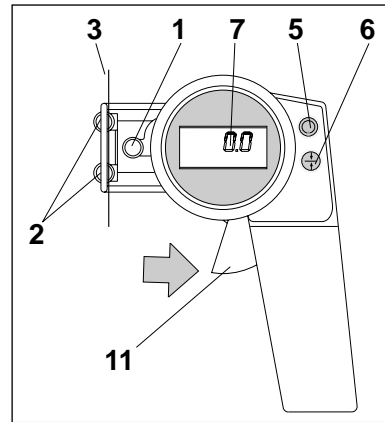
The Tension Meter is now adjusted for the new material path and is ready to measure.

#### 4.4 Taking Tension Measurements

Before beginning, turn on the meter and, if necessary, perform a Zero Adjustment (sec 4.3) and/or Damping Factor adjustment (sec 5.0).

##### To insert the process material:

1. Open the 3-roller system by squeezing the thumbpiece as much as possible. The outer rollers will extend out away from the instrument.
2. Position the tensionmeter so that the process material contacts the Filament Guide and passes between the outer rollers and the center measuring roller.
3. **Slowly** release the thumbpiece, allowing the outer rollers to return to their original position.



**NOTE:** Do not let the outer rollers “snap-back” as this could damage the instrument or adversely effect the calibration.

**IMPORTANT:** Make sure the the process material is properly threaded through the 3-rollers and is running smoothly. If not, remove the material by squeezing the thumbpiece and attempting steps 1 thru 3 again.

##### To take a measurement:

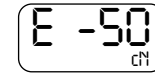
After completing the steps above, the digital display will show the tension reading calibrated in grams or cN. The display will be updated 2 times per second with a new value.

**NOTE:** For display in grams units, model number must include “-G” suffix.

##### To remove the process material:

1. Push the thumbpiece as far as it will go in the direction of the arrow.
2. With the outer rollers extended, move the instrument away from the material.
3. Slowly release the pressure on the thumbpiece until the outer rollers return to their original position.

6. Release the DAMP key when the value shown on the display is fairly stable (the reading may fluctuate slightly).



7. The display shows E -50.

If the display show E -10 again, the value was not accepted. Check that the suspended weight and the material path between the guide rollers and the measuring roller and repeat the procedure from step 4

##### 2nd calibration point

1. Hang a weight which corresponds to 50% of the tension range from the measured material as shown in fig 1, page 9. *The weight must not swing.*
2. Push the thumbpiece as far as it will go in the direction of the arrow.
3. Thread the process material between the guide rollers and the measuring roller as shown in section 4.4, page 6. Slowly release pressure on thumbpiece until the guide rollers return to their original position

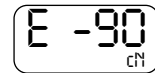
4. Press the DAMP key. As long as the DAMP key is depressed, the display shows a decimal value which is higher by approximately 800 than the first decimal value.



5. Write down the decimal value.

6. Release the DAMP key when the value shown on the display is fairly stable (the reading may fluctuate slightly).

7. The display shows E -90.

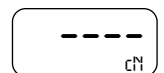


If the display show E -50 again, the value was not accepted. Check that the suspended weight and the material path between the guide rollers and the measuring roller and repeat the procedure from step 4

##### 3rd calibration point

1. Hang a weight which corresponds to 90% of the tension range from the measured material as shown in fig 1, page 9. *The weight must not swing.*
2. Push the thumbpiece as far as it will go in the direction of the arrow.
3. Thread the process material between the guide rollers and the measuring roller as shown in section 4.4, page 6. Slowly release pressure on thumbpiece until the guide rollers return to their original position

4. Press, hold briefly and release the DAMP key. The display shows four dashes for about 1 second. The tension meter switches off. The new calibration has been stored.



If the display show E -90 again, the value was not accepted. Check that the suspended weight and the material path between the guide rollers and the measuring roller and repeat the procedure from step 4

**NOTE:** Before reading the value on the display, move the instrument up and down (vertical material path) or back and forth (horizontal material path) to compensate for any friction caused by the instrument.

- The tension value on the display should be equal to the value of the suspended weight. If the procedure shows a deviation, you can recalibrate the instrument following the direction in section 4.3. If this does not solve the problem, and the process material is the same as the factory calibration material (or very similar in diameter and rigidity), the unit may be out of calibration. In this case, please contact the factory.

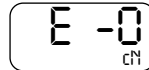
## 6.2 Static Calibration of the ZE

*Materials:* One cN weight each, corresponding to 10%, 50% and 90% of the tension range

**Note:** Static calibration must be carried out with a vertical material path. Before beginning, turn off the gauge and remove any process material from the rollers.

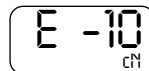
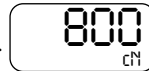
### To select the calibration mode:

- Press and hold the DAMP and ON/OFF keys for about 6 seconds until the display show E -0.
- Release the ON/OFF key first and then the DAMP key.



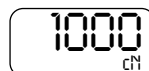
### To calibrate the zero point:

- Press the DAMP key. As long as the DAMP key is depressed, the display shows a random decimal value between 500 and 1200.
- Write down the decimal value.
- Release the DAMP key when the value shown on the display is fairly stable (the reading may fluctuate slightly).
- The display shows E -10.



### 1st calibration point:

- Hang a weight which corresponds to 10% of the tension range from the measured material as shown in fig 1, page 9. *The weight must not swing.*
- Push the thumbpiece as far as it will go in the direction of the arrow.
- Thread the process material between the guide rollers and the measuring roller as shown in section 4.4, page 6. Slowly release pressure on thumbpiece until the guide rollers return to their original position
- Press the DAMP key. As long as the DAMP key is depressed, the display shows a decimal value which is higher by approximately 200 than the first decimal value.
- Write down the decimal value.



## 5.0 DAMPING MODE

The tension meter is equipped with Electronic Damping which ensures steady readings when tension fluctuates. This is achieved by averaging the measured values at the set update rate.

**NOTE:** Before switching on the damping mode, it is recommended that you measure the first values without damping enabled.

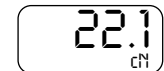
### 5.1 To switch on damping

- Press the DAMP key (see #6 on page 2). The display shows the set damping factor.
- Release the DAMP key. The display shows DAMP below the current measured value.



### 5.2 To switch off damping

- Press the DAMP key. The display no longer shows DAMP below the current measured value.



### 5.3 Changing the Damping Factor

The tension meter is factory preset to a factor of 07. The tension values are thereby averaged for the display in the following way:

$$\frac{7 \text{ old values} + 9 \text{ new values}}{16}$$

The damping factor can be modified in 15 steps from 01 = **low damping**

$$\frac{1 \text{ old values} + 15 \text{ new values}}{16}$$

to 15 = **high damping**

$$\frac{15 \text{ old values} + 1 \text{ new value}}{16}$$

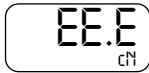
### To change the damping factor

- Press and hold the DAMP key. the display now shows the set damping factor.
- You can now change the damping factor with the ON/OFF key. **HOW**
- Release the DAMP key and the meter switches back to the measuring mode.

## 5.4 Error Messages

### Error Message 1

The display shows



**Cause:** The upper limit of the tension range was exceeded by more than 10%

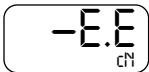
**Solution:** Reduce the line tension

**OR**

AUTO ZERO is no longer possible. Recalibrate the instrument following the procedure in section 4.3

### Error Message 2

The display shows




**Cause:** The lower limit of the tension range has fallen by more than 10%

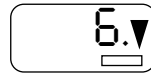
**Solution:** Insert the process material properly

**OR**

AUTO ZERO is no longer possible. Recalibrate the instrument following the procedure in section 4.3

### Error Message 3

If the display shows the  symbol and a blinking arrow, the batteries must be replaced immediately; otherwise measurements obtained may not be reliable



## 6.0 CALIBRATION

The ZEF and ZED Tension Meters are calibrated with laboratory-grade weights suspended from factory standard nylon monofilament of diameters shown in the table below. Any significant difference in diameter and rigidity between the end-user's process material and the factory standard material may result in some error. For most applications, the error is not significant and can be ignored since readings are generally treated as production setup values or are used for comparative purposes.

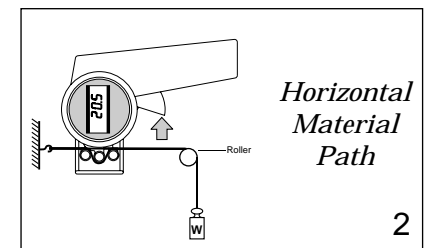
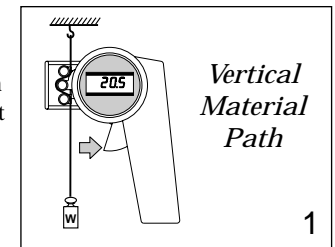
STANDARD CALIBRATION MONOFILAMENT SAMPLES		
Model Number	Tension Range	Monofilament Diameter
ZEF-100-G	0.5 - 100.0 g	0.12 mm
ZEF-200-G	1 - 200 g	0.12 mm
ZED-500-G	1 - 500 g	0.20 mm

In those cases where highest accuracy is required, a correction chart showing "Readings" vs. "Actual Tensions" can be made by the end-user or, optionally, a *Special Calibration* can be performed using the process material supplied by the customer. Please specify when ordering. If a Special Calibration is requested, please supply a ten (10) foot sample of the process material.

It is suggested that the calibration of this Tension Meter be checked on regular intervals to insure that the instrument is performing properly. A periodic calibration check will help identify when (and if) the gauge goes out of calibration due to unreported damage, overload, or other unknown reason.

### 6.1 Static verification of measuring accuracy

1. Hang a weight which corresponds to the tension to be measured (pay attention to the correct unit of measure) from the measured material as shown in figure 1.
2. Push the thumbpiece as far as it will go in the direction of the arrow,
3. Thread the process material between the guide rollers and the measuring roller .
4. **Slowly** release pressure on the thumbpiece until the outer rollers return to their original positions.



**NOTE:**

When using a Horizontal Material Path, use a roller (or other free rotating guide), see fig. 2, prior to fixing the known weight.



# OPERATING MANUAL

**MODELS ZED AND ZEF**

