Time Electronics
Calibration, Test and Measurement

# User Manual

## 7000
## RTD Calibrator

Version 1.3

11-23

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This also applies to any schematics, drawings and diagrams contained herein.

This manual provides operating and safety instructions for the Time Electronics product. To ensure correct operation and safety, please follow the instructions in this manual.

Time Electronics reserves the right to change the contents, specifications and other information contained in this manual without notice.

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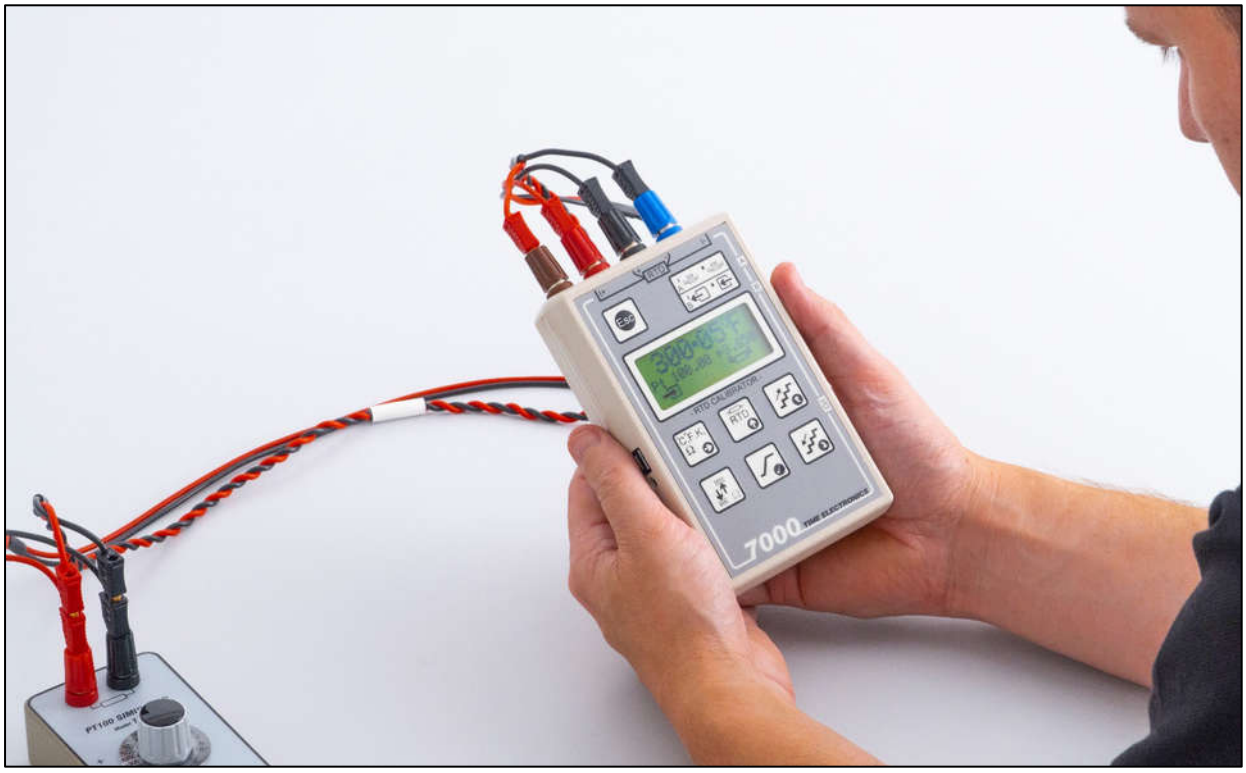
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# 1 Introduction




The 7000 is a portable process control test instrument that combines a precision digital thermometer (using RTD probes) with an RTD/ohms calibrator. Compact and easy to use, it solves the problem of making high accuracy temperature measurements without using bulky mains powered instrumentation.

Powered from internal long life rechargeable batteries or an external mains adaptor, it is equally valuable in laboratory, workshop or the field. It can also be used as an external temperature reference for dry block and other precision temperature baths.

If used with a certified probe the unit performs as a highly accurate thermometer. Readout is available in ºC; ºF and ºK.

The 7000 is specifically designed to automate and to speed up the task of calibrating instrumentation used in the process control industry. Simply enter in engineering units (ºC, ºF or ºK) the desired zero and span values and the calibrator will automatically calculate the standard five calibration points (0, 25, 50, 75 and 100%).

The 7000 calibrator is powered by a rechargeable NiMH battery pack. The charger electronics are contained within the unit enabling the calibrator to be charged from any 12 Volt DC supply.

## 1.1 Modes of Operation

### 1.1.1 Source Monitor mode (4 wire)

**Typical functions**

- Check RTD probes by measuring their resistance at known temperatures.
- Measure resistance values.
- Indicate temperature when connected to an RTD probe.
- Pre-programmed with a particular RTD's characteristics for very high accuracy.

Excitation current.....1 mA on all ranges.

Resistance range.....0.01 Ω to 2.6 kΩ.

Resolution.....0.01 Ω.

Accuracy.....See specifications on next page.

Auto re-calibration.....Every 0.6 secs.

Temperature stability.....Better than 0.0015 % per °C.

Max/Min values.....Logged automatically.

The 7000 may be used with a calibrated and certified probe to produce a highly accurate thermometer. The performance can be further enhanced by programming the actual characteristic of the probe into the unit.

### 1.1.2 Simulator Mode (4 wire)

**Typical functions**

- Output resistance of precise known value.
- Simulate an RTD value from an RTD table chart.
- Simulate an RTD value using the internal table.

Excitation current.....0.6 mA to 1 mA.

Resistance range.....0.01 Ω to 2.6 kΩ.

Resolution.....0.01 Ω.

Accuracy.....See specifications on next page.

Auto re-calibration.....Every 0.6 secs.

Temperature stability.....Better than 0.0015 % per °C.

Enhanced performance may be achieved by programming the unit to simulate the characteristic of a particular probe. Five fixed step points (0, 25, 50, 75, 100%) are available between a user set minimum (0 %) and a maximum (100 %). Programmable ramp function is also available.

## 1.2 Technical Specifications

### Standard RTD types (non-standard RTD types user programmable)

| Element | Alpha coefficient | Temp range °C | Accuracy °C | Temp range °F | Accuracy °F |
|---|---|---|---|---|---|
| Pt100 DIN | 0.003850 | –200 to 250 | 0.05 | –330 to 480 | 0.10 |
| | | 250 to 849 | 0.07 | 480 to 1560 | 0.14 |
| Pt100 US | 0.003916 | –100 to 250 | 0.05 | –150 to 480 | 0.10 |
| | | 250 to 457 | 0.07 | 480 to 850 | 0.14 |
| Pt200 DIN | 0.003850 | –200 to 300 | 0.05 | –330 to 570 | 0.10 |
| Pt500 DIN | 0.003850 | –200 to 250 | 0.05 | –330 to 480 | 0.10 |
| | | 250 to 630 | 0.07 | 480 to 1160 | 0.14 |
| Pt1000 DIN | 0.003850 | –200 to 250 | 0.05 | –330 to 480 | 0.10 |
| | | 250 to 630 | 0.07 | 480 to 1160 | 0.14 |
| Ni 120 | 0.006180 | –100 to 200 | 0.05 | –150 to 390 | 0.10 |
| Ni 1000 | 0.006180 | –100 to 200 | 0.05 | –150 to 390 | 0.10 |

### Resistance Accuracy

| Range (Ω) | Monitor (Ω) | Generator (Ω) |
|---|---|---|
| 20 to 400 | 0.03 | 0.03 |
| 400 to 800 | 0.10 | 0.10 |
| 800 to 1200 | 0.20 | 0.20 |
| 1200 to 2600 | 0.50 | 0.50 * |

*plus additional error of 0.05 % of output value. If excitation current is less than 1 mA.

### 1.2.1 General Specifications

**Operating temperature** .....–10 to 50 °C. Storage temperature –30 to 70 °C.

**Operating humidity** .....0 to 90 % non-condensing at 25 °C.

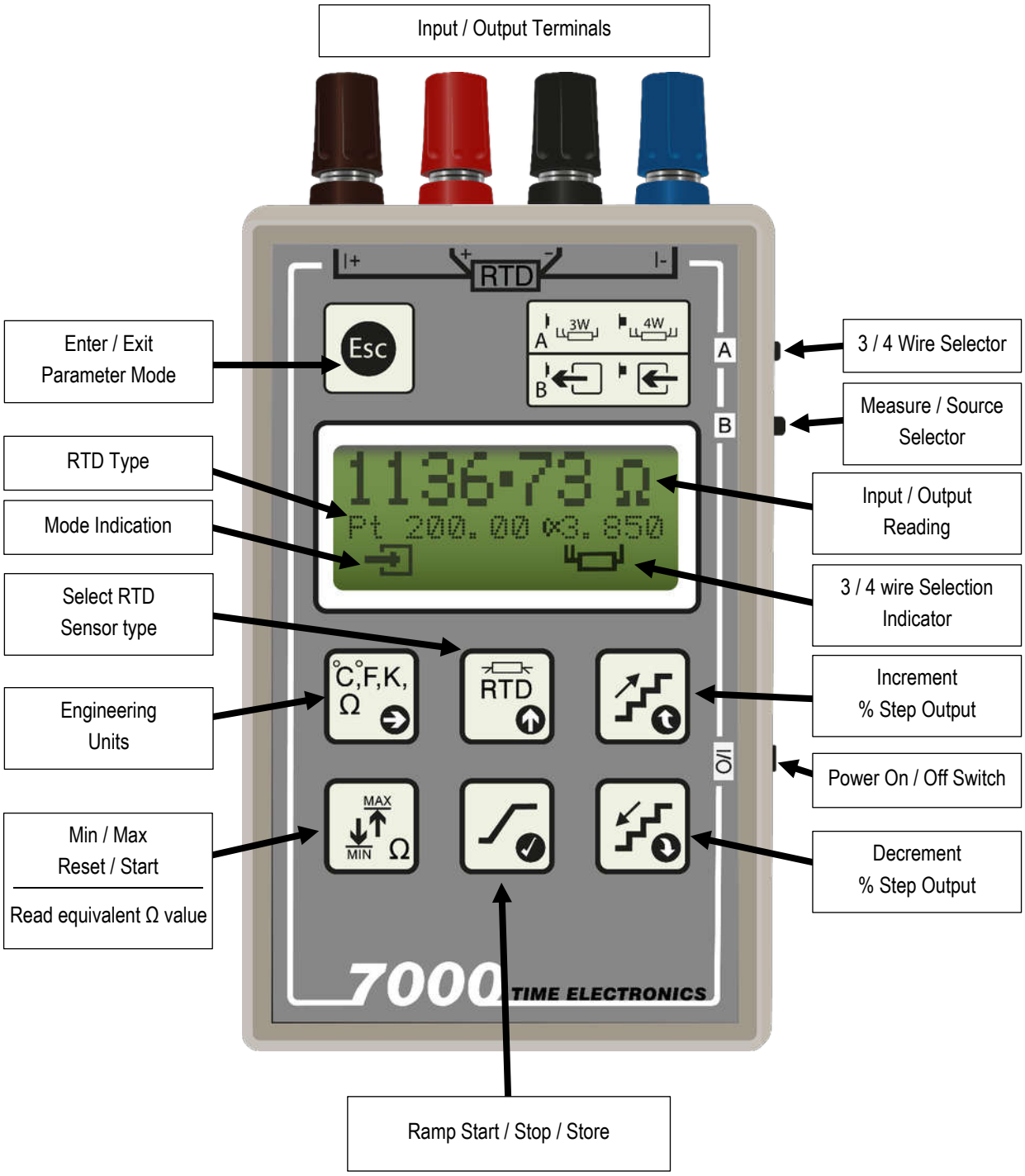
**Dimensions/Weight**.....H 165 x W 90 x D 45 mm / 0.42 kg.

**Power** .....Internal rechargeable NiMH battery pack. Battery life typically 24 hours. Auto power-down feature. Full recharge from being exhausted will take approximately 16 hours with the unit switched off. External mains adaptor (option) can be used.

**Optional extras**.....7633: Mains adaptor 230 V AC. Optional 110 V AC version.
C183: Traceable calibration certificate (Factory)
C194: Accredited calibration certificate (ISO 17025)

# 2 Front Panel Controls

## 2.1 Main Controls and Display



## 2.2 Button Operations

The 7000 is powered on by a switch on the side of the unit.

The instrument has dual function buttons that allow the user to switch between operations and parameter setups.

Normal operating mode is the source and measure usage of the unit.

Parameter mode is the setup mode.

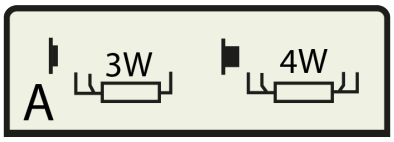


| | |
|---|---|
|  | **Enter/Exit Parameter Mode**<br>The Esc key enables the user to move from Normal operating mode to the Parameter set-up mode. The Parameter Set-up Mode is used to change stored operating parameters.<br>• Sensor element value<br>• 0% and 100% Source Output values<br>• Ramp rate and Ramp Dwell period |
|  | **Engineering Units and Digit Select**<br>The engineering units key enables the user to select the units of measurement or generation. In parameter mode this key is used to select the digit of the parameter value that is to be changed. This function operates in a wraparound fashion so that the cursor will return to the first digit if continuously operated. |
|  | **RTD Sensor Type and Increment Digit**<br>The sensor key allows the user to select the required Alpha and RTD element.<br>8 programmable elements and three factory set Alpha co-efficient values are included.<br>In Parameter Mode this button is used to increment the digit selected by the "Engineering Units" key. |
|  | **Max/Min**<br>In Measure Mode this key initialises the Max/Min function setting the starting values to the current measured value. Press Max/Min again, RTD or CFKΩ, the 7000 unit will disengage the Max/Min function. |
|  | **Ramp**<br>In Source Mode this key starts and stops the ramp function.<br>In Parameter Mode this key is used to accept and store the programmed value. |
| <br> | **Increment and Decrement**<br>In Source Mode these keys are used to increment and decrement the stepped output from 0% to 100% in five steps.<br>In Parameter Mode these keys allow the user to select the parameter to change |

# 3 Connections

An RTD (Resistance Thermometer Device) temperature measurement relies on the fact that the probe, in a repeatable manner, predictably changes its resistance for changes in temperature. Connecting lead resistance will influence the reading. In a process installation where the probe is situated some distance from the measuring instrument the lead resistance may introduce significant reading errors. For a particular process applications the temperature measuring instrument is selected based on the required range, resolution and accuracy. This in turn influences the choice of probe and type of connection. There are three commonly used wiring connection arrangements (2, 3 and 4 wire).

The 7000 is designed to operate with all three wiring configurations. The top side button is used to select the appropriate connection type.



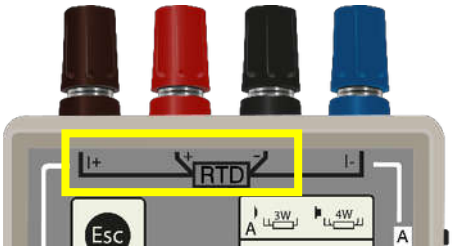

## 3.1 2-wire

This is the least accurate as the resistance in the length of the two uncompensated transmission wires will affect the sensor reading. Therefore, this type of connection is not normally recommended. To connect in this mode, select 3-wire and add external links between the black and blue terminals and brown and red terminals. Keep the connection as short as is practical.




## 3.2 3-wire

Process instruments using 3-wire connections arrange input circuitry in such a way as to compensate for lead resistance changes. The transmission leads should be of equal length and as short as possible.




## 3.3 4-wire

The 4- wire connection provides the most accurate measurement. The leads are compensated for, so can be any convenient length. To connect in this mode select 4-wire and connect as shown.



# 4 Basic Operation

## 4.1 Measurement Mode

In the measure mode the 7000 is able to give a temperature read out in ºC, ºF and ºK from a variety of standard RTD probes.

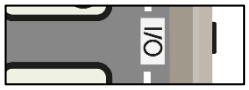
- Establish the process instrument probe type input requirement (e.g. Pt100 DIN alpha coeff. 0.003850)
- Establish the required engineering units and temperature range (e.g. –100 to 150°C).
- Check that the probe type and range are compatible, ie within the specification range –200 to 250 ºC (refer to the specifications section).
- Establish the required input wiring connection type (3 or 4 wire)
- Set the 3/4 wire select button 'A' to the required connection.
    - **IN** position for 3-wire
    - **OUT** position for 4-wire




- Connect the calibrator to the process instrument. See the wiring connections on previous page.



- Turn on the calibrator via the side switch.



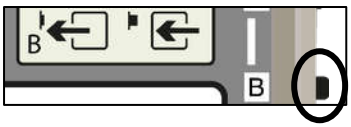

- Select the engineering units by repeatedly pressing until the required units are displayed.




- Select the type of RTD by repeatedly pressing until the desired RTD is displayed (e.g. Pt 100 DIN  a3.850).




- Select measure mode by releasing selector button 'B' to the **OUT** position.




The calibrator will display the reading from the RTD probe in the selected engineering units.

### Error messages

If the display shows over range ^^^.^^:

- Incorrect RTD type selected.
- Incorrect wiring 2, 3 or 4 wire.
- Sensor probe open circuit.
- Measured temperature is outside of the range.

## 4.2 Source Mode

An RTD (Resistance Temperature Detector) probe resistance varies with temperature. The resistance for a given temperature is different depending on the type of probe.

For process applications the type of probe and instrument is selected based on the required temperature range and resolution. In the Source Mode the 7000 unit can simulate the most commonly used probes to facilitate the calibration of RTD type input process instruments.

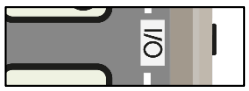
- Establish the process instrument probe type input requirement (e.g. Pt100 DIN alpha coeff. 0.003850)
- Establish the required engineering units and temperature range (e.g. –100 to 150°C).
- Check that the probe type and range are compatible, ie within the specification range –200 to 250 ºC (refer to the specification section).
- Establish the required input wiring connection type (3 or 4 wire)
- Set the 3/4 wire select button ‘A’ to the required connection.
    - **IN** position for 3-wire
    - **OUT** position for 4-wire




- Connect the calibrator to the process instrument. See the wiring connections on previous page.



- Turn on the calibrator via the side switch.



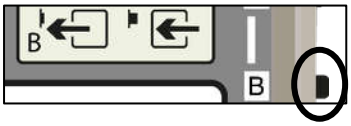

- Select the engineering units by repeatedly pressing until the required units are displayed.




- Select the type of RTD by repeatedly pressing until the desired RTD is displayed (e.g. Pt 100 DIN  a3.850).




- Select measure mode by releasing selector button ‘B’ to the **IN** position.




- Determine the current Zero and Span settings by repeatedly pressing



The lower part of the display will show the 0, 25, 50 ,75 and 100% calibration points and their corresponding temperature values.

- To change the Zero & Span refer to Setup procedure Section 5.1.
- To calibrate using the Manual Step Function refer to Section 4.3.
- To calibrate using the Ramp Function refer to Section 4.4.

## Error messages

The display shows over range ^^^.^^ or Output unable to settle:

- Incorrect wiring. Check polarity.
- Excitation current from the circuit under test is too high or low. Range is 600µA to 1mA depending on the probe type.
- Circuit under test is multiplexed.

## 4.3 Manual Step Function

In the source mode a single key press will step the output though the five calibration points. This considerably speeds up the calibration process as it removes the time consuming and tedious process of having to manually adjust for each calibration point.

The following assumes that the calibrator has already been set up for the correct connection, source mode, RTD type and range as described in Source mode (Section 4.2)

- Ensure that the calibrator is set for Step Function. The display should now show a step symbol in the bottom section.



- If it does not, select the step function by pressing which toggles the Step and Ramp functions.



- The display should now indicate the step symbol.




- To step through the % calibration points press either:
  - To increase the output



  - To decrease the output



- To read the equivalent ohms value press



## 4.4 Ramp Function

In Source Mode the calibrator unit may be set to ramp from zero (0%) to span (100%) dwelling for a time period at the top and bottom limits.

The following assumes that the calibrator has already been set up for the correct connection, source mode, RTD type and range as described in Source mode (Section 4.2)

- Ensure that the calibrator is set for Ramp Function. The display should now show a ramp symbol in the bottom section. 
- If not, press Ramp until the display shows the ramp symbol and start to ramp. 
- The output will ramp continuously from zero to span and back to zero dwelling at the limits. 

- To reverse ramp direction, press either Increment or Decrement buttons.  
- If the button is pressed again twice the ramp will return to the ramp start, i.e. if ramping up it will return to 0% and if ramping down it will return to 100%.
    - To restart the ramp up from 0% press 
    - To restart the ramp from 100% press 

The Dwell period T1 (seconds) and Ramp rate Ω/S (ohms/second) are programmable. To change them follow the Ramp rate and Dwell time Set-up Procedure Section 5.2.

- To re-enter the Manual Step Function press 

## 4.5 Max/Min Log Function

In Measure Mode the calibrator is able to log the measured maximum and minimum values.

The following assumes that the calibrator has already been set up for the correct connection, measure mode, RTD type and range as described in Measure Mode Section 3.1.

- To enter the Max/Min function press 


- The **minimum** input value will be recorded and displayed in the lower left-hand corner of the display.
- The **maximum** input value will be recorded and displayed in the lower right-hand corner of the display.
- The maximum and minimum values will be updated if a new high or low is reach during the session.
- To exit the Max/Min function and clear the stored values press 

# 5 Operating Parameters Setup Procedures

## 5.1 Element, Zero and Span Setup Procedure

Normal calibration is carried out at five standard points. To set the 5 calibration points it is only necessary to set the zero (0%) and span (100%) limits. The calibrator will calculate the intermediate values (25, 50, and 75%)

- Select Source by pressing 'B' button **IN**.




- Access the Parameter mode functions to set the required zero and span limits by pressing the ESC button.




### 5.1.1 Setting Zero and Span limits

The display will show the current zero (%) limit in the top section of the display with the cursor under the +/- sign.

- To change the zero value, move the display cursor under the digits to be changed by pressing.




- To change the digits repeatedly pressing




- To store the new values press



- Select the span (100%) limit by repeatedly pressing until the display shows the current span (100%) limit. The cursor will be positioned under the +/- sign.



- To change the span value, move the cursor under the digits to be changed by pressing




- To change the digits repeatedly pressing




- To store the new values press



- To exit the parameter function, press the ESC button



### 5.1.2 Element Set-up Procedure

- Select Measure by releasing button ‘B’ to the **OUT** position 


- Select the correct Alpha curve, repeatedly pressing 


- Access the Parameter mode functions to set the RTD element value press 


- The display will now show the current RTD and Alpha values, with the cursor under the + symbol. 


- To change the element value, move the display cursor under the digit to be changed by pressing 


- To change the digits repeatedly pressing 


- To store the new values values and exit setup press 

The calibrator is now set for the correct RTD type and range to calibrate the process instrument for the five standard calibration points (0. 25, 50, 75 and 100%).

## 5.2 Ramp Rate and Dwell time Setup Procedure

In the Source mode the calibrator unit may be set to ramp from zero (0%) to span (100%) dwelling for a time period at the limits. The Ramp rate (Ω/Sec) and Dwell period (secs) are programmable.

### 5.2.1 Changing the Ramp rate

- Enter the Parameter mode by pressing 

- Then repeatedly press
until the display shows **Ω**/S 
- Move the cursor under the digits to be changed by pressing 

- To change the digit repeatedly press 

- To store the Ramp rate value press 

### 5.2.2 Changing the Dwell period

- Repeatedly press
until the display shows T1. 
- Repeat steps 3 to 5 above to enter and store the new value.

# 6 Battery and Re-Charging

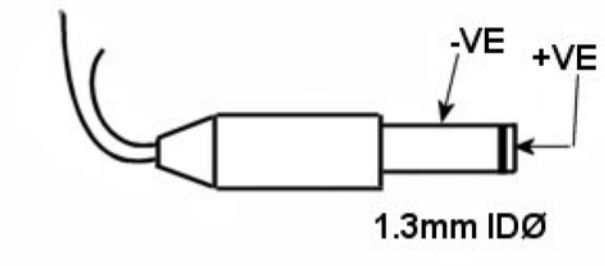
The 7000 is powered by a rechargeable NiMH battery pack that gives approximately 24 hours operation.

To facilitate recharging of the internal batteries, the 7000 calibrator incorporates a low voltage re-charger, this means that as well as the provided mains charger, any 12V DC power source may be used, including a fuse (250mA) protected car battery.

**Time for full battery charge:**

- Calibrator switched off = 16 hours.
- Calibrator switched on = 21 hours.

Battery charger connector polarity




Spare battery packs can be obtained from Time Electronics Ltd. Part #: 7629

# 7 Maintenance and Troubleshooting

## 7.1 Maintenance

**Front Panel Keypad and Connections**
The front panel should be cleaned by wiping with a damp cloth.
Solvents must not be used to clean the panel as damage may result.

**Display**
The LCD display should not be exposed to strong sunlight for prolonged periods.

**Usage and Storage**

*Temperature*

The operating and storage temperature limits for the calibrator are -30 to 70 ºC (-22 to 158 ºF).

*Humidity*

The operating and storage relative humidity limits for the calibrator are 10 to 90 % non-condensing at 25 ºC (77ºF).

## 7.2 Troubleshooting

Error messages may appear depending on the usage and setup of the unit and application.

**Measure - Error messages**

The display shows over range ^^^.^^

- Incorrect RTD type selected.
- Incorrect wiring 2, 3 or 4 wire.
- Sensor probe open circuit.
- Measured temperature is outside of the range.

**Source– Error messages**

The display shows over range ^^^.^^ or Output unable to settle

- Incorrect wiring. Check polarity.
- Excitation current from the circuit under test is too high or low. Range is 600 µA to 1 mA dependant on the probe type.
- Circuit under test is multiplexed.

# 8 Recalibration

### 8.1.1 Overview

The 7000 is designed around a PIC microcontroller that takes its analogue readings from a 24bit sigma delta A/D. To limit the drift in the A/D there is a background calibration of the A/D at regular intervals. The operation of the 7000 is based on a ratio technique that compares the voltage across the unknown resistance to the voltage across an internal precision resistor. The internal precision resistor defines the maximum reading from the instrument as approximately 2.6 kΩ, and is used as the full scale adjustment (gain trim).

The zero offset adjustment is done by storing calibration factors in the microcontroller's non-erasable EEProm memory. This memory also contains the Pt100 scale factors.
The EEProm is programmed at manufacture and should not need readjustment. However, should it become corrupted it will be necessary to return the whole unit to Time Electronics for re-programming.

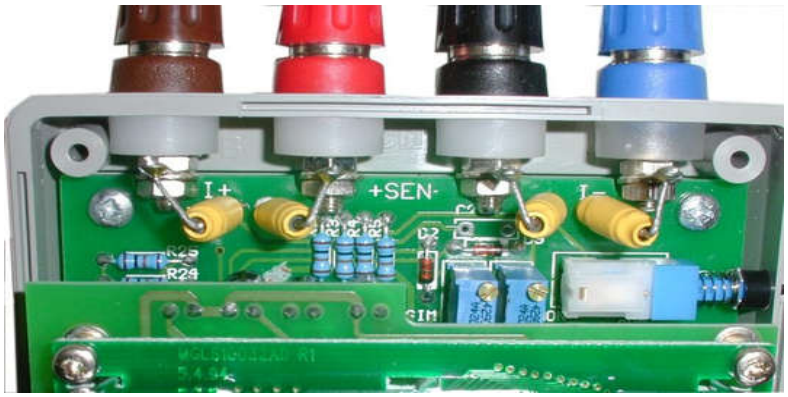
### 8.1.2 Equipment required for re-calibration

1. A precision resistance measuring instrument - such as a Time Electronics 5075 7.5-digit multimeter. The accuracy of this instrument will define the overall calibration accuracy. It should have an accuracy of better than 0.01 ohms over the range 0 to 2.6 kΩ. It must also be suitable for 4-wire measurement, and its excitation current needs to be 1mA in the range 20 to 360Ω. Auto-ranging should be turned off to ensure the 1mA excitation current is maintained.

2. Stable transfer resistors 20 Ω to 360 Ω.

### 8.1.3 Measure mode calibration

1. Allow the unit to warm up for 15 minutes before calibration. Ideally carry out the calibration at 23 ºC ± 5 ºC. It is recommended that the unit is fully charged prior to calibration.
2. Measure the transfer reference resistors on the precision DMM in 4-wire mode and note their exact values to a resolution of 0.001 Ω e.g. Ref 20 Ω = 20.002 Ω and Ref 360 Ω = 360.105 Ω.
3. Open the unit's case by removing the 4 rear panel screws.
4. Switch on and select the monitor mode 4-wire and set to reading in ohms (not C, K or F).
5. Connect the 20 Ω resistor to the unit and note the deviation from its reference reading. This should be less than 0.03 Ω.
6. Connect the 360Ω resistor to the unit and adjust VR2 (right hand trimmer) to make the display read the reference value of the 360 Ω.




### 8.1.4 Source mode calibration

1. Connect the unit to the precision DMM and select Source mode.
   Set 0% = 20.00Ω and 100% = 360.00 Ω.
2. Select 0% and check the reading on DMM is within 0.003 Ω of 20.00 Ω.
3. Select 100% and adjust VR1 (left hand trimmer) to read 360.00 Ω +/- 0.03 Ω.

Note: Ensure that the DMM resistance range provides a 1 mA excitation current for the measurement, this can be checked by connecting a mA meter in series with one of the I sense leads (brown or blue terminals).

**Note:** If the results for the 20 Ω measurements are out of specification it is necessary to return the unit to Time Electronics for re-calibration

# 9 Warranty and Servicing

## Warranty

Time Electronics products carry a one-year manufacturer's warranty as standard.

Time Electronics products are designed and manufactured to the highest standards and specifications to assure the quality and performance required by all sectors of industry. Time Electronics products are fully guaranteed against faulty materials and workmanship.

Should this product be found to be defective, please contact us using the below details. Inform us of the product type, serial number, and details of any fault and/or the service required. Please retain the supplier invoice as proof of purchase.

This warranty does not apply to defects resulting from action of the user such as misuse, operation outside of specification, improper maintenance or repair, or unauthorized modification. Time Electronics' total liability is limited to repair or replacement of the product. Note that if Time Electronics determine that the fault on a returned product has been caused by the user, we will contact the customer before proceeding with any repair.

## Calibration and Repair Services

Time Electronics offers repair and calibration services for all the products we make and sell. Routine maintenance by the manufacturer ensures optimal performance and condition of the product. Periodic traceable or accredited calibration is available.

## Contacting Time Electronics

**Online:**
Please visit **www.timeelectronics.com** and select Technical Support from the Contact links. From this page you will be able to send information to the Time Electronics service team who will help and support you.

**By phone:**
+44 (0) 1732 355993

**By email:**
mail@timeelectronics.co.uk

## Returning Instruments

Prior to returning your product please contact Time Electronics. We will issue a return merchandise authorization (RMA) number that is to accompany the goods returning. Further instructions will also be issued prior to shipment. When returning instruments, please ensure that they have been adequately packed, preferably in the original packing supplied. **Time Electronics Ltd will not accept responsibility for units returned damaged.** Please ensure that all units have details of the service required and all relevant paperwork.

Send the instrument, shipping charges paid to:

**Time Electronics Ltd**
Unit 5, TON Business Park, 2-8 Morley Road,
Tonbridge, Kent, TN9 1RA.
United Kingdom.

Tel: +44(0)1732 355993
Fax: +44(0)1732 350198

Email: mail@timeelectronics.co.uk
Web Site: www.timeelectronics.com

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### Disposal of your old equipment



1. When this crossed-out wheeled bin symbol is attached to a product it means the product is covered by the European Directive 2002/96/EC.
2. All electrical and electronic products should be disposed of separately from the municipal waste stream via designated collection facilities appointed by the government or the local authorities.
3. The correct disposal of your old appliance will help prevent potential negative consequences for the environment and human health.
4. For more detailed information about disposal of your old appliance, please contact your city office, waste disposal service or return to Time Electronics.