7000
RTD Calibrator

Technical Manual

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Unpacking Check List

1.	Calibrator	7000
2.	Mains charger	7633
3.	One pair of test leads	9542
4.	Manual	2765
5.	Carry pouch	9023

All Time Electronics' instruments are subject to continuous development and improvement and in consequence may incorporate minor detail changes from the information contained herein.

Contents

1. Introduction

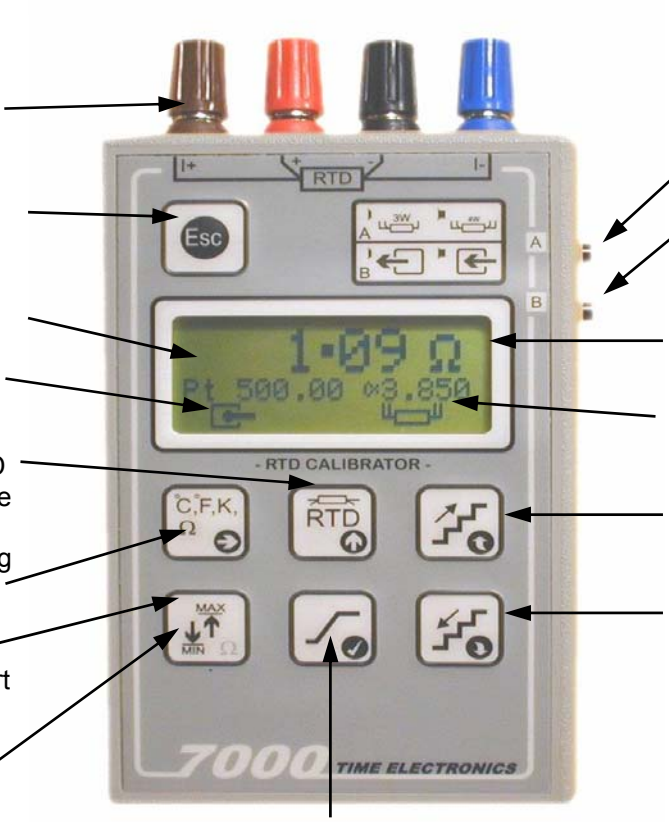
The 7000 Resistance Temperature Detector (RTD) is a Microprocessor-based hand-held calibrator. The calibrator is capable of accurately simulating and measuring the most commonly used RTD probes, which facilitates the calibration of process RTD input instruments without the need for expensive probes and the use of slow 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 NiCad battery pack. The charger electronics are contained within the unit enabling the calibrator to be charged from any 12 Volt dc supply.

2. Front Panel Controls



Enter/Exit Parameter Mode

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.

Sensor element value,
0% and 100% Source Output values.
Ramp rate and Ramp Dwell period.

Engineering Units and Digit Select

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 functions operates in a wrap around fashion so that the cursor will return to the first digit if continuously operated.

RTD Sensor Type and Increment Digit

The sensor key allows the user to select the required Alpha and RTD element . Eight programmable elements and three factory set Alpha co-efficient values are included.

In Parameter Mode this key is used to increment the digit selected by the “Engineering Units” key.

Max/Min

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

In Source Mode this key starts and stops the ramp function.

In Parameter Mode this key is used to accept and store the programmed value.

Increment and Decrement

In Source Mode these keys are used to increment and decrement the stepped output from 0% to 100% in five steps.

In Parameter Mode these keys allow the user to select the parameter to change

3. Normal Operating Modes

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). An economy and accuracy trade-off exists between the type of connection.

The 7000 unit is designed to operate with all three wiring types.

2 Wire

Economy is achieved by having only two wires but accuracy suffers due to uncompensated lead resistance. 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.

3 Wire

Process instruments using 3 wire connections arrange input circuitry in such a way as to compensate for lead resistance changes. A degree of economy is achieved with reasonable accuracy.

4 Wire

The four wire connection is the least economical but provides the most accurate measurement.

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

3.1 Measurement mode

RTD Type and Engineering units Set-up Procedure

- 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 deg. C)
- Check that the probe type and range are compatible e.g. within the specification range –200 to 250 deg. C (refer to the specification section 8.0)
- Establish the required input wiring connection type (3 or 4 wire)
- Set the 3/4 wire select switch ‘A’ to the desired connection. (IN position for 3 wire and OUT position for 4 wire).
- Connect up the calibrator to the process instrument.

3 wire connection

4 wire connection

- Switch on the calibrator.
- 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

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.

3.2 Source Mode

An RTD (Resistance Temperature Detector) probe resistance varies with temperature. The resistance for a given temperature is different dependant 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 is able to simulate the most commonly used probes to facilitate the calibration of RTD type input process instruments.

RTD Type and Engineering Units Set-up Procedure

- 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 deg. C)
- Check that the probe type and range are compatible e.g. within the specification range –200 to 250 deg. C (refer to the specification section 8.0).
- Establish the required input wiring connection type (3 or 4 wire)
- Connect up the calibrator to the process instrument.
- Set the 3/4 wire select switch to the desired connection. (IN position for 3 wire and OUT position for 4 wire)

3 wire connection

4 wire connection

- Switch on the calibrator.
- 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 a3.916)

- Select Source mode by pushing selector switch ‘B’ to position B (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 Set-up procedure Section 4.1.

- To calibrate using the Manual Step Function refer to Section 3.3.

- To calibrate using the Ramp Function refer to Section 3.4.

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 100µA to 3 mA dependant on the probe type.
- Circuit under test is multiplexed.

3.3 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 3.2)

- 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 

3.4 Ramp Function

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 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 3.2.

- Ensure that the unit is set-up for the Ramp Function. The display should show the ramp symbol in the bottom section of the display.

- If not, press  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 Up-Step  or Down-Step 

If the button is pressed again twice the ramp will return to the ramp start ie 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 (seconds) and Ramp rate (ohms/sec) are programmable. To change them follow the Ramp rate and Dwell time Set-up Procedure Section 4.2.

- To re-enter the Manual Step Function press 

3.5 Max/Min Log Function

In the 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 

4. Operating Parameters Set-up Procedures

4.1 Zero & Span Set-up Procedure

Normal calibration is carried out at five standard points.
To set the five 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%)

- Access the Parameter mode functions to set the desired zero and span limits by pressing 

Setting Zero and Span limits

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

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

- To change the digits repeatedly press 

- To store the new values press 
- Select 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 press 

- To store the new values press 

- To exit the parameter function 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%).

4.2 Ramp Rate and Dwell time Set-up 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 (ohms/sec) and Dwell period (secs) are programmable.

Changing the Ramp rate

- Enter the Parameter mode by pressing 

- Repeatedly press  until the display shows **W**/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 

Changing the Dwell period

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

5. Operating Precautions

5.1 Display

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

5.2 Usage and Storage

Temperature

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

Humidity

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

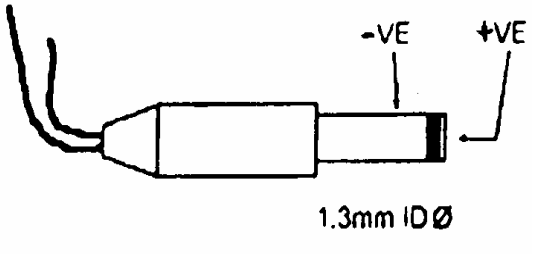
6. Battery Life, Health and Replacement

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

To recharge the batteries, connect a 12V dc, 100 mA supply to the 1.3 mm charger socket. The 7000 unit houses the battery charger electronics so that any 12V dc power source may be used including a car battery.

Time for full battery charge:
Calibrator switched off = 14 hours.
Calibrator switched on = 20 hours.

Battery charger connector polarity



7. Maintenance and Troubleshooting

7.1 Recalibration

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 2.6K Ohms, 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.

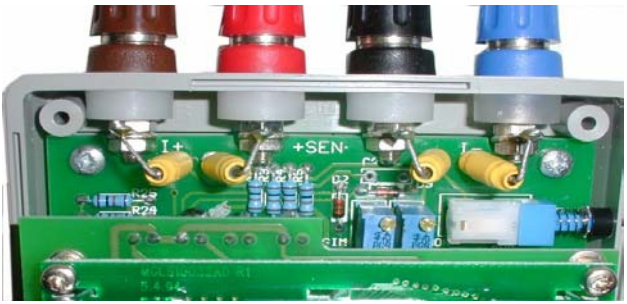
Equipment required for re-calibration

1) Precision resistance measuring instrument - such as Time Elec tronics' 5075 precision 7.5 digit DMM. The accuracy of this instru ment will define the overall calibration accuracy. It should have an accuracy of better than 0.01 ohms over the range 0 to 2.6K ohms. It must also be suitable for 4-wire measurement, and its excitation current needs to be 1mA in the range 20 to 360 ohms. Auto-ranging should be turned off to ensure the 1 mA excitation current is maintained.
2) Stable transfer resistors 20 ohms to 360 ohms.

Monitor mode calibration

1) Allow the unit to warm up for 15 minutes before calibration. And ideally carry out the calibration at 20 degC. 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 ohms e.g. Ref 20R = 20.002 and Ref 360R = 360.105.
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 20R resistor to the unit and note the deviation from its reference reading. This should be less than 0.03 ohms
6) Connect the 360R resistor to the unit and adjust VR2 (right hand trimmer) to make the display read the reference value of the 360R.



Generate mode calibration

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

Note: Ensure that the DMM resistance range provides a 1 mA excitation current for the measurement.

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

7.2 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.

7.3 Troubleshooting

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 600µA to 1mA dependant on the probe type.
- Circuit under test is multiplexed.

8. Specification

Monitor Mode (4-Wire) Functions

Excitation current: 1mA on all ranges
Resistance range: 0.01 ohms to 2.6K ohms
Resolution: 0.01 ohms
Accuracy: See tables.
Reading update rate : Every 0.6 secs.
Temperature stability: Better than 0.0015%/deg C
Max/Min values: Logged automatically—user selectable.
The characteristics of a particular probe can be programmed into the 7000 calibrator to provide a higher level of accuracy.

Simulator Mode (4-Wire) Functions

Excitation current: 0.6mA to 1mA.
Resistance range: 0.01 to 2.6 K ohms
Resolution: 0.01 ohm
Accuracy: See tables.
Reading update rate : Every 0.6 secs
Temperature stability: Better than 0.0015%/degC.
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.
Ramp rate: 0 to 135 ohms/second
Dwell time: 0 to 135 seconds

Standard RTD type

Element		Celsius		Fahrenheit	
	Alpha Coeff.	**Range**	**Accuracy**	**Range**	**Accuracy**
Pt 100 DIN	0.003850	-200 to 250	0.05 degC	-330 to 480	0.10 degF
		250 to 849	0.07 degC	480 to 1560	0.14 degF
Pt 100 US	0.003916	-100 to 250	0.05 degC	-150 to 480	0.10 degF
		250 to 457	0.07 degC	480 to 850	0.14 degF
Pt 200 DIN	0.003850	-200 to 300	0.05 deg C	-330 to 570	0.10 degF
Pt 500 DIN	0.003850	-200 to 250	0.05 degC	-330 to 480	0.10 degF
		250 to 630	0.07degC	480 to 1160	0.14 degF
Pt 1000 DIN	0.003850	-200 to 250	0.05 degC	-330 to 480	0.10 degF
		250 to 630	0.07 degC	480 to 1160	0.014 degF
Ni 120	0.006180	-100 to 200	0.05 degC	-150 to 390	0.10 degF
Ni 1000	0.006180	-100 to 200	0.05 degC	-150 to 390	0.10 degF

	Range ohms	**Monitor**	**Generator**
	20 to 400	0.03 ohms	0.03 ohms
Resistance	400 to 800	0.10 ohms	0.10 ohms
accuracy	800 to 1200	0.20 ohms	0.20 ohms
	1200 to 2600	0.50 ohms	0.50 ohms*

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

Non standard probes are user programmable
Probes with non-standard resistance values at 0°C (e.g. 104.2 ohms) may be simulated by selecting a suitable alpha co-efficient and programming the 104.2 resistance value into the Calibrator.

General Information

Operating temperature range: –10 to 50 oC (14 to 122 oF)
Battery power: NiCd rechargeable
Mains power: External mains adapter.
Battery life: > 30hrs
Case: Impact resistant ABS
Size: 157 x 90 x 45 mm (6 x 3.5 x 1.8 ins)
Weight: 0.55 kg (19 oz)

Ordering Information

RTD Temperature calibrator	7000
Mains adapter 230V AC	7633
Mains adapter 110V AC	7633
NPL Traceable Calibration Certificate	9183
UKAS Calibration Certificate	9194

9. Guarantee & Servicing

Guarantee Period

This unit is guaranteed against defects in materials and workmanship for a period of **one year** from its delivery to the customer.

We maintain comprehensive after sales facilities and the unit can, if necessary be returned to us for servicing. During this period, Time Electronics Ltd will, at its discretion, repair or replace the defective items. For servicing under guarantee, the instrument type and serial number must always be quoted, together with details of any fault and the service required. The purchaser of the instrument must prepay all shipping charges. Time Electronics Ltd will pay return shipping charges.

This guarantee is void if servicing has been attempted by an unauthorised person or agent. If, during the guarantee period, failure is due to misuse or abuse of the unit, the repair will be put in hand without delay and charged unless other instructions are received.

Service After Guarantee Period

Even after the guarantee period has expired, Time Electronics Ltd., can still service your instrument. As the manufacturer, we have the specialised knowledge needed to keep your instrument in peak condition and we also maintain a comprehensive spare parts service.

Please enclose details of the service required and your full company details including a contact name when returning for servicing.

Returning Instruments

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:-

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