Time Electronics
Calibration, Test and Measurement

User Manual

1010
DC Voltage Calibrator

Version 1.2
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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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1 Introduction

1.1 Description

The 1010 is an extremely accurate battery/mains powered voltage calibrator sourcing up to 10 volts in 5 ranges with a resolution up to 0.01µV.

Outstanding accuracy, and stability is achieved by using an LTC advanced subsurface Zener bipolar reference source; this features a very low drift of 2ppm/°C max TC, coupled with the use of low temperature coefficient resistors.

Power is provided by a mains/rechargeable battery power unit. A front panel indicator monitors the battery charge condition.

The circuit design provides automatic standardisation against the internal reference and allows up to 30mA output current with less than 0.1 ohms output resistance. Short circuit overload protection is provided; and a normal-off-reverse, (positive-off negative) switch controls the output signal.

1.2 Specifications

Ranges: 0-9.9999V in 5 ranges

0-9.9999V in 100µV steps
0-999.99mV in 10µV steps
0-99.999mV in 1µV steps
0-9.9999mV in 0.1µV steps
0-999.99uV in 0.01µuV steps

Accuracy: 10V & 1V ranges: ± 0.02% of setting + ± 0.005% of range
100mV range: ± 0.05% of setting + ± 0.005% of range, ± 1µV
10mV & 1mV Ranges: ± 0.05% of setting + ± 0.005% of range, ± 4µV

Setting Resolution: 5 digits on all ranges.

Output Resistance: Less than 0.1 ohm (typically 0.05 ohm) on 10V, 1V and 0.1V ranges. 1 ohm on lower ranges.

Maximum Output Current: 25mA max. on 10V, 1V & 0.1V ranges (an internal short circuit current limit is set at approx 30mA). Lower ranges can be loaded up to the short circuit current value although it should be noted that loads less than 1kΩ will give greater than 0.1% error.

Maximum Overload: The instrument can withstand a continuous short circuit on the output.

Output Voltage Stability: Less than 30 ppm/°C (0 to +50°C)
Less than 5 ppm/V variation in supply voltage.
Less than 75 ppm/year not cumulative.
Less than 10 ppm/hr at constant temperature.

Output Polarity: Positive or negative (Normal – Reverse) switch selected. A centre ‘off’ position on this switch provides a short circuit on the output for 1010 voltage source.

Output Noise Level: 10, 1 & 0.1V ranges, less than 10 ppm of setting ± 2µV (0-10 Hz).
10mV & 1mV ranges, less than ± 0.05µV (0-10 Hz)

Dimensions: W 217 x H 160 x D 193 mm.

1.3 Power Unit

The 1010 is supplied with a internal mains/battery power unit. This can be configured when ordered for either 115V or 230V AC, 50/60Hz. See section 2.7.

1.4 Circuit Description

The calibrator designed with a precision LTC 5V reference device which offers both outstanding accuracy and temperature coefficient specifications. This provides the input to a FET chopper amplifier system which operates in a feed-back stabilised mode, and has a gain value determined by a set of precision metal film resistors which are selected by a 5 decade digital thumbwheel switch bank. The output voltage is variable from 0 to 9.9999 volts in 5 ranges. An output resistance of typically 0.05 ohms is maintained on the top three ranges; the maximum output current that can be drawn on these ranges is automatically limited to 25mA. This is designed to protect the electronic circuitry in the event of accidental short circuit etc.

The lower ranges have an output resistance of 1 ohm and will supply current up to the short circuit value (30mA), see output resistance in specifications. To ensure complete reliability of the switch bank, each digit thumbwheel switch employs twin parallel gold plated contacts - even if a contact fails the 1010 still functions correctly.

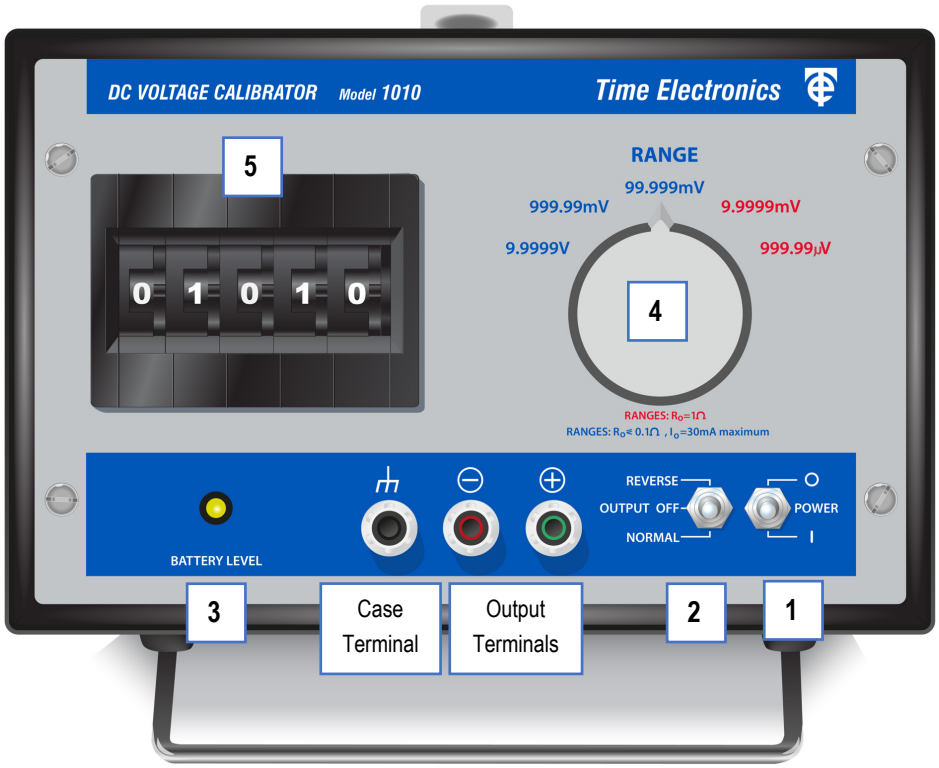
1.5 Applications

The uses of the instrument include the calibration applications of conventional voltage potentiometers. A 1010 in these applications has the advantage of requiring no standardisation and being able to supply much higher output currents without loss of accuracy. Long term stability is inherent since standardisation is not required.

Other applications as a precision voltage source include calibration, linearity and gain stability measurements, etc., on D.C. amplifiers, digital and electronic voltmeters, transducers and as a variable low current power supply or backing-off voltage. The 10 ppm/HR stability and low noise levels are of particular interest when an extremely stable voltage is required rather than a high accuracy calibration source.

2 Operation

2.1 Front Panel Controls



1. Power on/off

A miniature toggle switch interrupts the low voltage DC supply line to the circuit module. Indication of supply on/off is provided by the battery level indicator.

2. Output polarity

A change-over toggle switch enables the output polarity to be reversed. A centre position provides a short circuit on the 1010 output terminals.

3. Internal rechargeable battery level

The battery level is continuously monitored on a front panel LED indicator which also serves as a supply on-off indication. When green the unit is powered on and battery level is good. When red, the batteries need recharging.

4. Output voltage range

Selected by a 5-position rotary switch.

5. Output Voltage Setting

Selected on a 5-digit thumbwheel switch. The resolution of setting is 0.01% of full scale.

2.2 Operating Procedure

Operation of the 1010 is self explanatory from the front panel controls and specification. Normal precautions concerning overload and incorrect range selection, should be observed.

1. Power on the 1010.
2. Check the battery level.
3. Select the required range.
4. Set the required output voltage.
5. Set the output polarity to apply voltage to the unit under test.

Note: When the output switch is set to the 'OFF' position, there is a short circuit on the output terminals. This can also be used for quick zeroing of output.

2.2.1 Operating Position

Unlike many potentiometers and devices incorporating standard cells, the 1010 DOES NOT require operation or transportation in a particular position.

2.2.2 Output terminals

The selected output voltage is connected to the front panel safety terminal binding posts which are suitable for twisted stripped wire compression connection, spade terminals, or by 4mm shrouded or normal plug insertion.

2.2.3 Case terminal

The case terminal is connected only to the instrument case and is isolated from the circuitry. The case provides an overall electrostatic screen for the 1010 and can be earthed as required to improve rejection of noise pick-up.

2.3 Output noise

The electrical noise on the output voltage consists of chopper intermodulation, thermal noise and random variations. Thermal noise becomes more significant on the lower ranges (see Thermal EMFS).

In general, the total noise level is less than 20ppm of setting ±2µV for the 10v, 1v and 100mV ranges over the frequency range 0 - 10 Hz and less than ±0.2µV (0-10 Hz) for the lower ranges. Lower noise levels can be obtained by connecting a low pass filter on the output terminals.

2.4 Common mode noise

Additional noise and variation of the output voltage can be caused by large common mode voltages. These occur when the 1010 is used to calibrate (or measure) any input which is above ground potential or has an AC component with respect to ground.

When the battery is powered, the 1010 has inherently a very high DC common mode rejection, but it is not recommended that 100V DC common mode be exceeded. The AC common mode rejection is determined by the capacitive unbalance to ground of the output terminals and associated connections. The 1010 is checked before despatch with 30Vpp 50 Hz common mode voltage on the output terminals.

2.5 Thermal emfs

When the 1010 is used to provide precision voltages of less than about 1mV, care must be exercised to avoid errors due to thermal emfs. These occur where temperature differences are present at the junctions of dissimilar metals, e.g. a normal solder to copper junctions has a thermal emf of approximately 3µV/°C. Errors inside the 1010 under temperature stable conditions are typically less than ±0.2µV.

2.6 Fuses (main PCB)

The DC supply line and output fuses are mounted on the INSIDE of the front panel printed circuit board. Access is by removing the instrument front panel as described in Section 3. Both are 20mm 250mA types. Spare fuses can be obtained directly from Time Electronics Ltd, from your local supplier, or an authorised distributor.

2.7 Mains Power Unit

2.7.1 Type PU2

The PU2 incorporates a rechargeable Nickel-metal hydride battery pack and charge controller. The design is arranged to enable the PU2 to provide power directly from the mains to power the instrument, and / or recharge the battery pack.

Alternatively, the PU2 can power the instrument from the rechargeable battery pack if mains power is not connected.

When mains power is connected, the charger provides the correct charge current (40-70mA) for the battery and automatically reduces this to a trickle rate (3 - 4mA) when the battery is fully charged. This means that it is impossible to overcharge the battery.

The DC performance is as follows:

- With mains connected: DC output 15.5 - 7V (0 - 100mA load).
- With mains disconnected (and battery fully charged): DC 15.5 - 14.5V (0 - 100mA load)
- Mains input range: 110 - 250V AC 40 - 60 Hz. IEC mains input fuse is 20mm F1A.

The capacity of the rechargeable battery is approximately 600mAH. This allows about 40 - 50 hrs continuous use of the 1010. To fully recharge the battery requires 14-16 hours with mains connected.

2.7.2 Constructional details PU2

The P.C.B. is located on the rear panel by 4 screws and is spaced off approx. 10mm. A metal cover protects and screens the PCB and components. The output connectors and output fuse are located outside the cover.

The cover is fixed to the rear panel by 4 screws. Later versions of PU2 have a 20mm F500mA fuse located inside cover.

Important Note:
Take care when checking and dismantling a PU2. Even though disconnected from the mains, there is still sufficient power stored in the rechargeable battery to cause catastrophic damage to the electronic circuitry if inadvertent short circuits occur. These can easily occur when the metal cover is being removed.

2.7.4 240V to 110V conversion

The PU2 mains transformer has two primary 115V windings, these are connected in series for 240V or in parallel for 110V AC mains. The following procedure should be adopted to convert from 240V to 110V.

1) Isolate instrument from mains power, remove rear IEC mains input connector.

2) Remove 4 rear panel holding screws, withdraw panel / mains power unit from 1010.

3) Remove PCB metal screening cover.

Note: Take care not to short any part of the circuitry when converting a PU2.

4) Connect mains transformer primary windings in parallel by removing the centre series link, rewire the two mains input windings to the transformer in parallel (as shown on the side of the transformer), replace the screening cover. Check safety of mains input.

5) Refit the rear panel, and test.

3 Constructional Layout Details

The complete instrument assembly (except the Power Unit) is mounted on the front panel. The main printed circuit board which carries the components and range switch is located immediately behind the front panel. The panel and PCB can be removed as follows:

1) Remove Power Unit - located in instrument rear by 4 screws.

2) Disconnect supply - connected to power unit by 2 press stud connectors.

3) Remove the four front panel holding screws.

4) Withdraw front panel and PCB - the power supply lead can also be withdrawn through a hole in the plastic power supply cover.

For recalibration the power supply can be connected without rehousing in the case.

3.1 Chopper amplifier module

3.1.1 Description

The module contains the F.E.T. Chopper amplifier, a precision LTC 5V reference device, and associated circuitry. It is a fully encapsulated module and connections are via a 16-pin connector moulded into it.

The modular form of the 1010’s basic circuitry protects it from damage due to adverse conditions and thermal gradients which could give rise to thermal emf errors.

Being a non-serviceable part, a replacement module should be ordered from Time Electronics Ltd in the case of failure or malfunctioning of the module. The replacement part number is 094-9512.

3.1.2 Module replacement

Note: Isolate instrument from mains power, remove rear IEC mains input connector

1) Remove and disconnect power unit located in instrument rear by 4 screws.

2) Remove front locating screws.

3) Carefully withdraw the front panel and associated printed circuit board (PCB). The power supply lead can also be withdrawn through a hole in the plastic supply cover.

4) Remove 4 nuts which locate the module on the pcb.

5) Withdraw the module from the PCB.

6) Remove 4 nuts remaining on module mounting studs. Put these nuts on the new module. Replace new module in reverse order ensuring the connector pins align correctly - it may be necessary to bend slightly the mounting studs in order to obtain smooth alignment of the 16 pin plug and socket.

Note: It is important not to stress the plug and socket, since poor connection will result.

7) Adjust the position of the module above the PCB with 6 nuts on the module side of the PCB. When the module is parallel the plug and socket just closed, the nuts on the opposite side of the PCB can be tightened. It is important to ensure that no strain is put on the connector when the nuts are finally tightened.

8) Set Module zero and re-calibrate as described on the following page.

4 Re-calibration

This is performed with the panel and PCB outside the case.
Please see Fig. 1 for trimmer layouts.

4.1 Zero

The F.E.T. chopper amplifier zero must be set before calibration can be done. The zero is set when the instrument is manufactured and under normal operation will not require readjustment. If a new circuit module is fitted or readjustment is found necessary, the following procedure should be adopted.

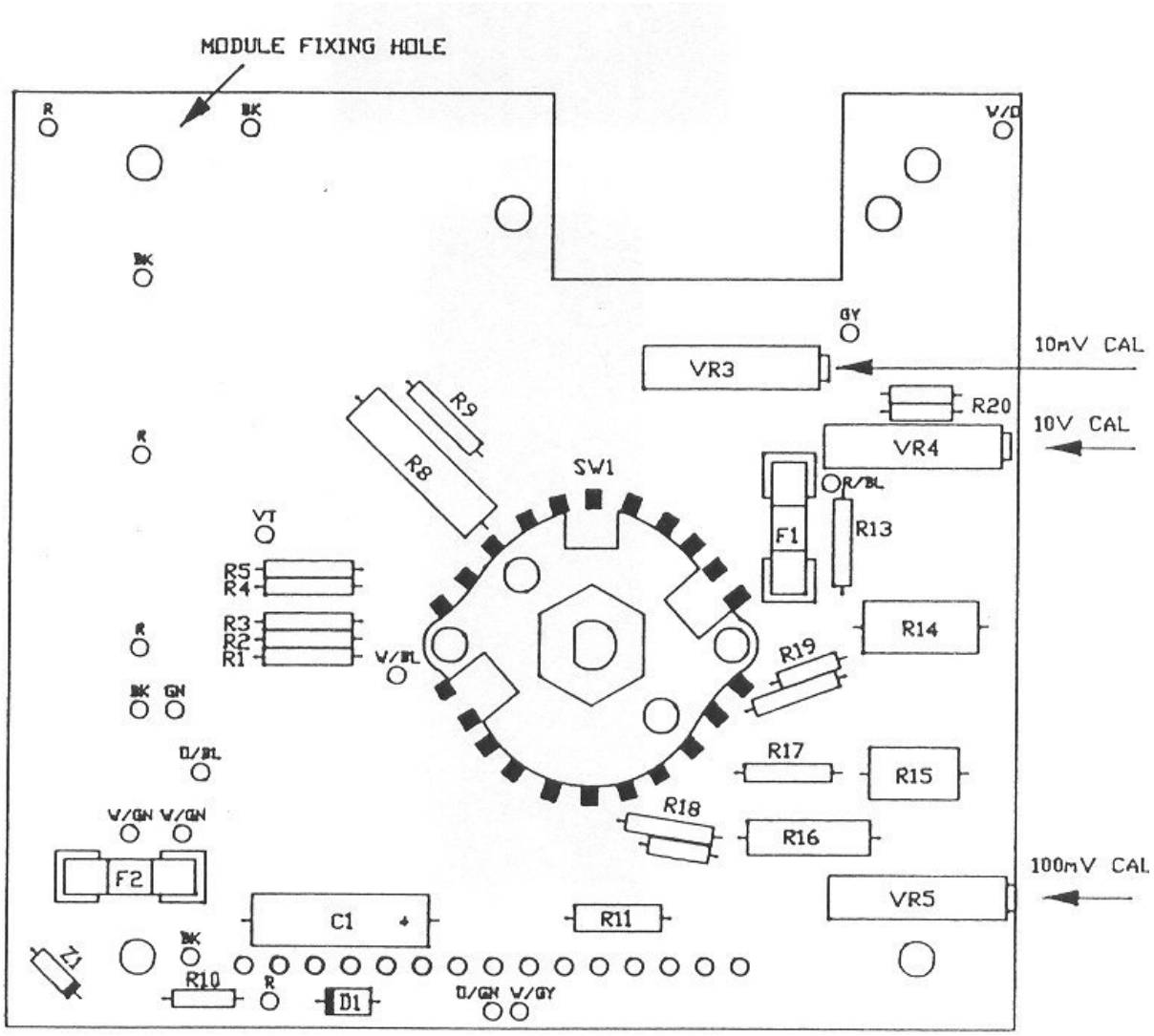
1) Connect power supply.
2) Select 99.999mV range.
3) Set all digits to zero.
4) Set output polarity to normal.
5) Connect a null meter to output terminals. The meter sensitivity should be ±100µV FSD with a resolution better than 10µV. It is possible to use a Time Electronics 1007 for this purpose, although any micro-volt null meter or sensitive D.V.M. may be used.
6) Adjust the zero-trimming pot on the module for less than ±10µV reading on the meter. The zero trimmer is marked on the module label.
7) Check the zero reading for the other 4 ranges. The readings should be as follows:
   - 999.99uV range less than ±0.25µV
   - 9.9999mV ranges less than ±0.75µV
   - 999.99mV ranges less than ±40µV
   - 9.9999V ranges less than ±100µV

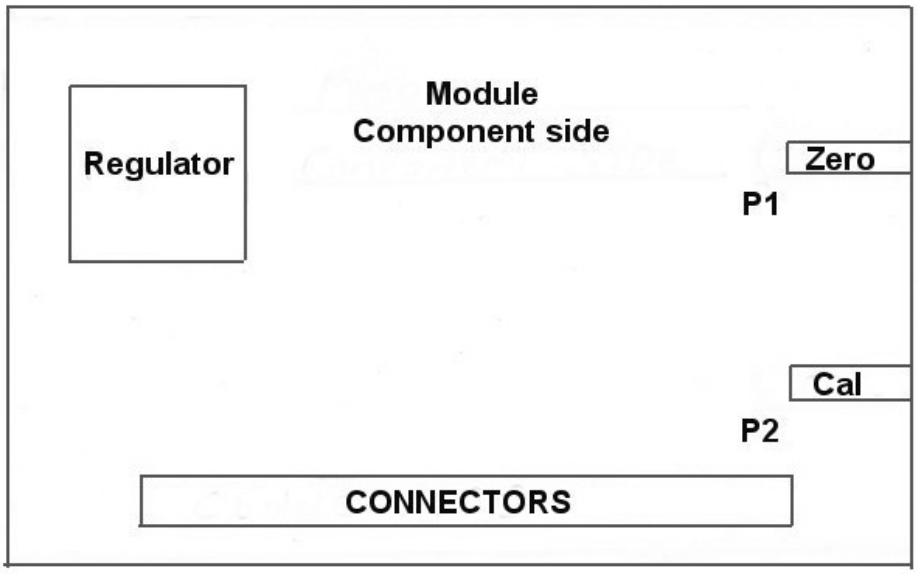
4.2 Full Scale

Fine adjustment of the 1010 output voltage is provided by 4 trimmers. One is located on the module is marked ‘CAL’ and provides equal adjustment of the output voltage for ranges. The other 3 trimmers are located on the front panel pcb, and provide individual adjustment for the 10V, 100mV and 10mV ranges. Since a common attenuator is used for the 10mV and 1mV ranges, the 1mV range is automatically calibrated when the 10mV range is calibrated. All the trimmers are set up when the instrument is manufactured and normally will not need readjustment. If a new circuit module is fitted or readjustment found to be necessary the procedure below should be adopted.

It is important to note that the maximum range of adjustment provides about ±0.2% variation in the output voltage. If errors of greater than this magnitude are occurring there is no point in attempting to recalibrate using the trimmers and a fault condition will be occurring somewhere in the unit.

Fig. 1 **1010 Trimmer Layouts**





4.3 Calibration Procedure

1) Ensure zero has been set as in section 4.1.

2) Connect power supply.

3) Select 999.99mV range, normal output polarity, and output digits to 99999.

4) Connect a suitable accuracy voltage standard with microvolt null meter to the output terminals. The voltage standard should have 0.005% accuracy or better and ranges from 10mV to 10V full scale. The null meter should have a resolution of better than 1µV and preferably have calibrated ranges. A high performance D.V.M. can be used for calibrating.

5) Adjust the CAL trimmer on the module for better than 50µV null balance against an output of 999.99mV from the standard. Note that the maximum range of adjustment of this trimmer is 0.3%.

6) Select 9.9999V range and adjust the 10V range trimmer (VR4), for less than 500µV null balance against an output of 9.9999V from the standard. Maximum range of adjustment of this trimmer is 0.08%.

7) Select 99.999mV range and adjust the 100mV range trimmer (VR5) for less than 5µV null balance against an output of 99.999mV from the standard.

8) The specification allowances for these 3 ranges are as follows:
   - 9.9999V range, +/- 2.5mV.
   - 999.99mV range, +/- 250µV.
   - 99.999mV range, +/- 55µV.

4.4 10mV and 1mV Range Calibration

The two ranges are obtained by resistive attenuation of the 10V and 1V ranges.
The attenuation factor is 1000:1. The calibration of the attenuator is via the 10mV range trimmer (VR3). Maximum range of adjustment is 0.16%.

The Attenuator is set up when the 1010 is manufactured and normally requires no further adjustment. If, however, any of R2-R5 have been damaged by overload they will require replacing with equivalent types.

After replacing the resistors recalibration may be necessary beyond the range of the 10mV trimmer. The 1010 output should be checked against a 9.9999mV output from the standard and adjusting resistors (either R6 or R7) selected to bring the calibration within range of adjustment of the trimmer, which can then be adjusted for the final calibration as described above.

The calibration should be done on the 9.9999mV range and due account taken of any thermal emf's generated in soldering the adjustment resistor in position.

Note: It is important to ensure that the zero and calibration have been set before commencing.

The specification allowances for these ranges are as follows: -

- 9.9999mV range: ±5.75µV.
- 999.99µV range: ±0.75µV.

5 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.

Product Registration

You can register your product at: www.timeelectronics.com/contact/product-registration
Registering your product will enable us to maintain a record of purchase for your warranty. You can also use the web form to provide feedback about our products and services.

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:

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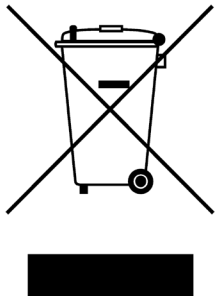
Disposal of your old equipment



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.