Time Electronics
Calibration, Test and Measurement

User Manual

1024
DC Current 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 1024 is an accurate and stable battery/mains powered DC current calibrator, sourcing up to 99.999 mA in 5 ranges with a resolution up to 0.1 nA. This enables the instrument to be portable and convenient for use in the laboratory, field, or industry.

The null balance system enables the 1024 to be used for making accurate current measurement in addition to its basic function as a calibrator. Operation is by backing the current source output against the current to be measured, with the difference being displayed on a sensitive centre zone null meter. At the null point, there is no voltage drop across the 1024.

The 1024's 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 precision metal film resistors of less than 10ppm/°C, this ensures that the accuracy and stability of the initial calibration is maintained for the calibration period. Excellent zero stability is ensured by the use of a high performance FET chopper amplifier system.

Operation is from the internal re-chargeable battery pack, or mains supply. A front panel indicator that also serves as a supply on-off display, monitors the battery charge condition. The battery indicator shows a red light when the battery pack should be recharged. Charging is performed by the instruments own internal charger/power supply. Simply plugging the 1024 into a mains supply will charge the batteries. Operation of the 1024 may be continued when plugged into the mains supply.

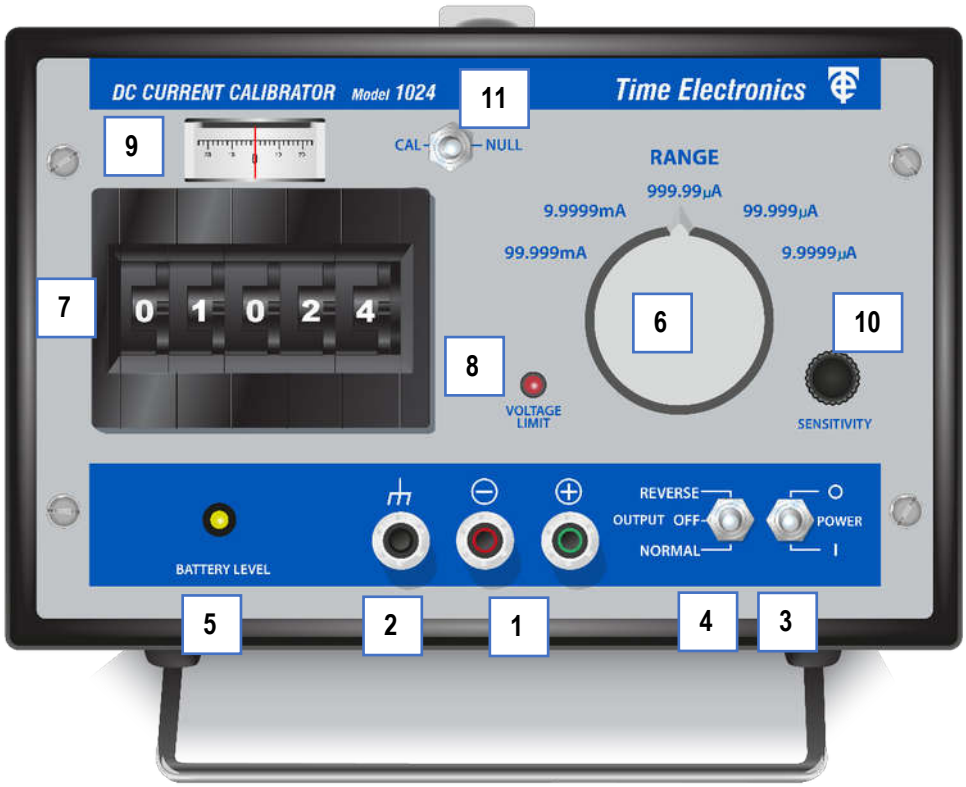
Applications include calibration and testing of current sensitive transducers; calibration and linearity tests on digital and electronic current meters; and semiconductor parameter measurements e.g. diode conduction voltages at specified current levels.

1.2 Specifications

Output:	**0 to 99.999 mA in 5 ranges** 0 to 99.999 mA in 1 µA steps 0 to 9.9999 mA in 100 nA steps 0 to 999.99 µA in 10 nA steps 0 to 99.999 µA in 1 nA steps 0 to 9.9999 µA in 0.1 nA steps
Accuracy:	± 0.02% of setting, + ± 0.005% of range, + ± 0.2 nA
Compliance Voltage:	15 V with new batteries or mains power (11 V with minimum allowable battery level)
Regulation:	Load: Better than 5 ppm/V Supply: Better than 5 ppm/V
Output polarity:	Positive or negative switch selected. A centre off position provides an open circuit on the output terminals
Out of limit warning:	A front panel indicator provides a warning of insufficient drive voltage
Output stability:	Less than 30 ppm/°C (0°C to + 50°C) Less than 10 ppm per hour at constant temperature Less than 75 ppm per 6 months
Output noise:	99.999, 9.9999 mA & 999.99 µA ranges: less than 5 ppm of FS 99.999 and 9.9999 µA ranges: less than 10 ppm of FS ± 0.1 nA
Null sensitivity:	Adjustable from ± 25 mA to ± 25 µA FS via front panel control. Maximum resolution is 0.5 µA.
Power supply:	Time Electronics power unit type PU2 which is housed in the rear of the 1024. The PU2 will power the 1024 direct from the mains or an internal rechargeable battery pack. The battery is automatically charged when mains power is connected.
Dimensions:	W 217 x H 160 x D 193 mm
Weight:	3.3 Kg

2 Operation

2.1 Front Panel Controls



1. Output terminals

The 1024 output current is from two front panel 4 mm safety terminals which are suitable for wire compression, 4mm spade, and 4mm shrouded or standard plug insertion. The output current will flow from the + (red) terminal when the polarity switch is ‘normal’ (positive).

2. Case terminal

The isolated 4 mm case terminal is connected only to the instrument case. The case provides an overall electrostatic screen for the 1024 and can be earthed as required to improve rejection of noise pick-up.

3. Power On-Off

A toggle switch interrupts the internal DC supply line to the circuitry (off or on).
Indication of supply condition is provided by the battery level indicator.

4. Output Polarity

A change-over toggle switch enables the output current polarity to be reversed. A centre ‘off’ position provides an open circuit on the output terminals.
Switch identification: Normal-Off-Reverse equates to Positive-Off-Negative.

5. Battery Level

The battery (or mains power supply PU2) output is continuously monitored on a front panel indicator which also serves as a supply 'on-off' indication. A red illumination indicates when the batteries need recharging, green indicates the unit is ready for use.
Note: The battery pack will continue to charge as long as the mains supply is connected.

6. Range Selector Knob

One of the five output ranges can be selected.

7. Digit Switches

A 5-decade thumbwheel switch enables the output current level to be set with a resolution of 0.01% of full scale.

8. Voltage Limit

An LED indicator shows when the 1024 is unable to supply sufficient drive voltage to maintain the set output current.
Example: The 1024's maximum drive voltage (voltage capability) is 15 V. This means that it is able to supply a current of 1 mA into 15 kΩ but NOT 1 mA into 16 kΩ. In the latter condition the voltage limit indicator would display.

The above is an example, but the same applies for any product of current & load resistance that exceeds 15 V. Non-resistive loads are still bound by the same output voltage limit with the indicator displaying when the voltage at the output terminals reaches approx. 15 V.

Note: When the 1024 is operated from partly discharged batteries, the voltage limit is reduced to a minimum of about 10 V for nearly fully exhausted cells. The battery level indicator gives a clear indication of battery state.

9. Null Meter

Scaled 25-0-25 for displaying the difference current when the 1024 is used in the null mode.

10. Sensitivity Control

A continuously variable control for adjusting the null meter sensitivity, range of adjustment is from 25mA minimum (fully anticlockwise) to 25µA maximum (fully clockwise).

11. Source - Null Switch

A two-position toggle switch selects the mode of operation. In the SOURCE position the 1024 operates as a current source while the null position allows measurement of current.

Important Note: Under no circumstances must an additional voltage be connected in series with the 1024 output in an attempt to increase the voltage capability. This practice will cause damage to this 1024's output circuitry. *Under certain conditions the voltage capability can be increased to a maximum of 50 V. This requires special circuit modifications and is only applicable to certain ranges. Please consult Time Electronics for information.*

2.2 Operating Procedure

2.2.1 Normal Operation

Operation of the 1024 is self-explanatory from the front panel controls and specifications. It is important to understand the 1024's voltage capability and voltage limit indicator to ensure that your requirement is within the limit. It is also important to read the section on output noise if your requirement is for current levels of less than a few tens of microamps.

When the 1024 is operating from batteries and required to supply currents in excess 10 mA it is important to check the battery condition with the load connected since the battery's condition may be adequate for sourcing low output currents but not higher current.

Measurement of an unknown current:

1) Select 'NULL' position on the front panel function switch.

2) Select 'NORMAL' output.

3) Adjust 'SENS' for minimum sensitivity (fully anticlockwise).

4) Select range consistent with the expected current to be measured.

5) Connect the unknown current to the terminals in the same polarity i.e. unknown current flows into the + Ve terminal.

6) Adjust digit switch and sensitivity control for null balance (0) on meter as required.

7) When balance at required sensitivity is reached the unknown current is equal to the digit switch setting.

Overload conditions

The 1024 can withstand indefinitely either short or open circuit on the output terminals. Overload conditions can easily result if any attempt is made to drive current into the 1024 by applying a voltage to the output terminals. In most cases this will cause the output fuse (See Section 2.5) to blow but can still cause damage to the output circuitry.

2.3 Output Noise

a) Inherent Noise

The electrical noise on the output current consists of chopper intermodulation, thermal noise and random variations. These are generated inside the 1024 and originate from the active circuitry. At current levels of greater than about 1mA the noise fluctuations are those of the accurate voltage reference circuitry.
At currents below a few hundred microamps it becomes difficult to differentiate between the 1024 inherent noise and picked-up noise.

b) Noise Pick-up

In addition to the inherent noise from the 1024 circuitry the output can contain fluctuations which originate from outside sources.
As with voltage signals the effects of noise on current signals are usually measured as a fraction of the signal (in % or PPM) and in general this fraction becomes larger as the signal level is reduced.

Care must be taken in attempting to understand the cause and effect of noise pick-up on precision current sources such as the 1024, and it is not proposed that this manual should cover them in detail.

It is important when confronted with a problem of noise pick-up to stop and think logically about the cause and effect, as a good deal of time can be wasted by indiscriminate screening and earthing.

This is particularly important when dealing with current signals since many of the effects are the exact opposite from those for voltage signals. For example, earthing one side of a voltage signal may reduce the noise pick-up but earthing the same side of a current signal may increase the pick-up.

Before looking at possible sources of noise pick-up it is also important to consider the way in which the presence of noise is being detected. In many cases it will appear as an incorrect readout.

Special care must be taken if additional equipment (such as an oscilloscope or DMM) is connected for the detection of noise - there is a possibility that this can introduce further noise.

Two of the more common causes of noise pick-up are discussed below. The actual level of pick-up cannot be predicted and will depend on a number of factors.

1) 50-60 Hz Mains Supply: This is probably the largest single source of noise pick-up. The noise from this source can be divided roughly into two parts.

a) 50-60 Hz Signal pick-up - is generally caused by the close proximity of unscreened mains cables or mains powered equipment. The effects of this type of noise can usually be considerably reduced by correct screening and earthing.

Important Note:
When the 1024 is operated from mains power, special attention should be paid to the possibility of noise pick-up occurring. Battery operation is recommended for applications requiring the lowest noise pick-up condition.

b) Transient Signal pick-up - is generally caused by heavy load switching on the mains from equipment such as electric motors, electric ovens, etc. Its effect on the 1024 is to cause a transient variation in the output which can last longer than the actual duration of the noise.

This is because the 1024 has been transiently over-loaded and needs time to recover. The noise is often in the form of a burst of radio frequency energy which in addition to being carried in mains cables is also radiated into the atmosphere.

It is often difficult to detect its presence due to its transient nature and short duration (down to a few 10's of microseconds). The effects of this sort of noise on radio and television reception are well known and a transistor radio is often a useful tool in locating the source of the noise.

This type of noise often covers a very wide spectrum of frequencies and the most effective solution is to locate its source and provide suitable filtering - such as conventional capacitor suppression on arcing contacts.

2) Common Mode Noise: Additional noise and variation of the output current can be caused by large common mode voltages. These occur when the 1024 is used to calibrate any input which is above ground potential or has an AC component with respect to ground.

When powered by the internal battery the 1024 has inherently a very high DC common mode rejection, but it is not recommended under normal circumstances that 100 V 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.

2.4 Mains Power Unit

2.4.1 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 to 70 mA) for the battery and automatically reduces this to a trickle rate (3 to 4 mA) 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 to 7 V (0 to 100 mA load).

With mains disconnected (and battery fully charged): DC 15.5 to 14.5 V (0 to 100 mA load).

Mains input range: 110 to 250 V AC / 40 to 60 Hz. IEC mains input fuse is 20 mm F1A.

The capacity of the rechargeable battery is approximately 600 mA Hrs. This allows about 10 hrs of typical use of the 1024.

To fully recharge the battery requires 14 to 16 hours with mains connected.

2.4.2 Constructional details PU2

The PCB is located on the rear panel by 4 screws and is spaced off approx. 10 mm. 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 20 mm 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.

2.4.3 240 V to 110 V conversion

The PU2 mains transformer has two primary 115 V windings, these are connected in series for 240 V or in parallel for 110 V AC mains.

The following procedure should be adopted to convert from 240 V to 110 V.

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

2) Remove mains power unit from 1024.

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 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).

5) Replace the screening cover.

3 Constructional Layout Details

The complete instrument assembly (except the power unit) is mounted on the front panel.
A 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 front panel locating 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

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 1024'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 (part number 094-9512).

Module replacement

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. 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 overstress the plug & socket, it can cause a poor connection.*
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 recalibrate as described in section 4.2 on the following page.

4 Repair and Recalibration

4.1 Repairs

Access to the circuitry is by removing the front panel which is located by 4 screws. Two preset trimmers are provided. One provides adjustment of the zero and the other full scale. If readjustment is necessary, the output should be set up against suitable standards.

Due to the precision nature of many of the components used in the 1024, they are not readily available to enable the customer to undertake repairs.

Repairs to the power unit (Section 2.4) and the front panel components can be undertaken by the customer provided suitable tools are available. Spare parts can be obtained from Time Electronics or their authorised dealer.

Important Note: It is important that no repair work is undertaken by the customer while the 1024 is under warranty. Such work may invalidate the warranty.

Overload conditions can cause the fuses to blow and the following conditions will be observed:

(1) The instrument is inoperative; the battery level indicator does not operate when the 1024 is switched on. Possible causes are:

a. Main fuse blown (on PU2 power unit).

b. PU2 output fuse blown.

c. Front panel PCB supply fuse blown.

(2) The battery level indicator displays but no output appears at the output terminals. Possible cause is:

a. Front panel PCB output fuse F1 blown.

4.2 Recalibration

The 1024 is calibrated when it leaves the factory and should not require further adjustment for at least 12 months unless the circuit module or any of the calibration determining components have been changed.

It is important before considering recalibration to ensure that an apparent error in output current is not due to inadequate measuring equipment or noise pick-up. (See Section 2.3). The latter is a common cause of trouble at low settings of output current particularly when mains power is being used.

It is also important to ensure that the correct equipment is available before attempting recalibration. There are two ways in which the 1024's output can be checked accurately. These are:

a) By a current balancing method using an external Standard DC Current Source of known accuracy and a nanometer with ranges from ± 1 nA to 100 μA. It is then possible to display the difference between the 1024 output and the standard current source.

b) The 1024's output can be converted to voltage by using precision resistors on the 1024 output. High performance resistors are required with accuracies of better than 0.01%, 1 Ω, 10 Ω, 100 Ω, 1 kΩ and 1 0kΩ are usually adequate. The low values must have excellent stability at currents up to 100 mA if errors are not to be introduced due to the temperature rise in the resistor under load.

Power dissipation is 1 watt in the 10 Ω at 100 mA.

The voltage across the precision resistors can be measured by normal voltage measuring techniques provided adequate precautions against noise pick-up are taken, these are more likely to occur with the higher resistor values.

Method a) is to be preferred since the problems of noise pick-up, conversion and dissipation errors, and thermal emf's are much less.

It is also recommended that the 1024 be operated in its battery powered mode for all calibration procedures. This is to reduce the possibility of noise pick-up which can give erroneous results.

A total of 8 multiturn trimmers are provided, 3 for zero adjustment and 5 for range full scale calibration. The sequence of adjustment is important since some of the trimmers affect more than one range.

The calibration procedure is as follows:

Ensure the internal battery pack is fully recharged.

Remove the front panel and locate the 7 trimmers, VR1-VR5 are located on the front panel PCB The other 2 trimmers are located on the side of the encapsulated module and marked 'CAL' and 'ZERO'.

Switch on the 1024 and allow the circuits to stabilise for a few minutes. Ensure that no draughts or direct heating (e.g. sunlight) affect the 1024's circuitry.
Calibrate at a stable temperature of between 20 and 24 °C if possible.

4.2.1 Calibration Procedure

For serial numbers 1218K6 and later.
Before commencing calibration procedure, fully rotate all 5 digit switches 3-4 times to enable self-cleaning of contacts.

1) Set the 5-digit switches to zero and select 99.999 µA range.
   Adjust output to zero (± 0.5 µA) with 'ZERO TRIMMER' on module.

2) Select 9.9999 µA range and adjust output to zero (± 0.3 nA) with VR1.

3) Set digit switch to 99999 and select 99.999 µA range.
   Adjust output to 99.999 µA ± 5 nA with 'CAL TRIMMER' on module.

4) Select 9.9999 µA range and set output to 9.9999 µA ± 1 nA with VR2.

5) Select 999.99 µA range and set output to 999.99 µA ± 50 nA with VR5.

6) Select 9.999 mA range and set output to 9.999 mA ± 500 nA with VR4.

7) Select 99.999 mA range and set output to 99.999 mA ± 5 µA with VR3.
   See note below.

Note: If method (b) is being used for calibration (7) above, a highly stable 10 Ω resistor is required since 1 watt is dissipated in the resistor. A 1 Ω may be used as an alternative if a suitable 10 Ω is not available. 0.1 watt will be dissipated in a 1 Ω resistor.

4.2.2 Linearity

The linearity of the output is not adjustable and is determined by the precision resistors mounted on the digit switch. These have been selected and adjusted in the factory and should not require further alteration.

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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Unit 5, TON Business Park, 2-8 Morley Road,
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Web Site: www.timeelectronics.com

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.