Time Electronics
Calibration, Test and Measurement

User Manual

1021 Milliamp Source with Null Indicator

Version 1.5
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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.

Contents

1 Introduction

1.1 1021 DC Milliamp Source

Features

- 3 ranges:
  0 to 99.99 mA in 10 µA steps
  0 to 9.999 mA in 1 µA steps
  0 to 999.9 µA in 0.1 µA steps
- Accuracy 0.02 %
- 25 ppm/hr stability
- Up to 40 V output drive
- Short circuit and overload protected
- Safety terminals
- Removable protective cover
- Supplied with rechargeable batteries

Description

The 1021 is a precision DC current calibrator suitable for sourcing applications from micro-amp levels up to 100 mA. Three output ranges are available; 0 to 99.99 mA in 10 µA steps, 0 to 9.999 mA in 1 µA steps, and 0 to 999.9 µA in 0.1 µA steps. Output voltage is adjustable between 14 and 40 volts, with a maximum output power of 2.4 watts.

High accuracy and long-term stability make the 1021 suitable for a wide range of testing workload. In process applications it can be used to calibrate and verify current sensitive transducers and their associated indicating and recording devices. For the semiconductor industry the unit can be used as a constant current source for parameter measurements. It can also be used to measure DC current accurately by using the null facility to back off the unknown current. Resolution of 1 µA is possible.

Operation of the 1021 is fast and simple operation. The user needs to only to switch on, check the battery condition, select the range, and set the required current using the thumbwheel switches. Useful features include an LED voltage limit indicator, that shows when the 1021 is unable to supply sufficient drive voltage to maintain the set output current. The instrument is also short circuit and overload protected.

The 1021 is housed in a robust metal case and a removable protective cover is supplied as standard. The front panel safety terminals are compatible with 4 mm shrouded plugs, as well as standard plugs, bare wires, and spade terminals. Rechargeable batteries enable portable operation and a mains recharger is supplied with the unit. Complete recharge time is 10 to 12 hours although sufficient charge for a few hours of operation can be obtained with only 30 minutes charge.

1.2 Specifications

Output:	**0 to 99.99 mA in 3 ranges:** 0 to 99.99 mA in 10 µA steps 0 to 9.999 mA in 1 µA steps 0 to 999.9 µA in 0.1 µA steps
Accuracy:	± 0.02 % of setting ± 0.02 % of range, ± 0.2 µA
Drive Voltage:	Adjustable between 14 and 40 volts. Maximum output power 2.4 watts.
Out of Limit Warning:	A front panel indicator provides indication of insufficient drive voltage.
Output Polarity:	Normal or Reverse (positive or negative), switch selected. A centre OFF position provides an open circuit to the output terminals.
Output Stability:	Better than 60 ppm per ºC (-10 ºC to +50 ºC). Better than 25 ppm per hr (at constant temperature).
Null Sensitivity:	Adjustable from ± 25 mA to ± 25 uA.
Load Regulation:	Better than 20 ppm per volt change in output.
Power Supply:	8 NiMH rechargeable batteries with external mains re-charger.
Dimensions:	200 x 75 x 110 mm (215 x 100 x 120 mm incl. protective cover).
Weight:	1 kg (1.4 kg incl. protective cover).
Options:	9027 carry case (user must remove protective cover). Calibration certificates: Traceable (factory) or accredited (ISO 17025).

2 Controls

Case Terminal
Isolated, and connected to the 1021 case only. The case provides an electrostatic screen and can be earthed for rejection of noise pick-up.

Sensitivity Control Dial
For adjusting the Null indicator sensitivity. The range of adjustment is from 25 mA (fully anti-clockwise) to 25 uA (fully clockwise).

Null Indicator
For reading off an unknown current when the instrument is used in Null mode.

Source/Null Switch
Set to Source or Null as required mode of operation.

Power
On/Off button.

Output Terminals
Output current via two front panel safety terminals. Connect by wire compression, spade terminal, 4mm shrouded or standard plug insertion.

Output Polarity Switch
Set output polarity. Centre position provides an open circuit on the output terminals.

Voltage Limit Indicator
Indicates when the 1021 is unable to supply sufficient drive voltage to maintain the set output current (e.g. the maximum drive voltage of the instrument)

Output Current Setting
Selected on a 4-digit thumbwheel switch.

Output Current Range
3 selectable buttons.

Battery Level Indicator
Green: Ready for use
Red: Change or re-charge batteries.

V/OP
The 1021 is overload protected and a front panel indicator shows when insufficient drive voltage is available. Drive output voltage is adjustable between 14 volts and 40 volts, with a maximum output power of 2.4 watts. Adjustment is by using a small flat bladed (2-3mm) tool.

Re-charge Socket
For charging the battery pack.

Battery Compartment
8 x AA rechargeable batteries.

3 Operating Instructions

3.1 Preliminaries

The 1021 is supplied complete with factory fitted rechargeable batteries and an external mains charger; the batteries are charged prior to shipping. Before operation, the battery charge condition should be checked on the battery level indicator and re-charged if required. It is important to recheck the battery charge condition during use when the instrument is supplying currents in excess of a few tens of mA, since the additional load may reduce the battery voltage to below the minimum level.

3.2 Normal Operation

OPERATING NOTE - CAUTION:
It is important to understand the voltage capability and the voltage limit indicator of the instrument to ensure that requirements are within limits.
Under no circumstances must an additional voltage be connected in series with the output of the 1021 in an attempt to increase the voltage capability as this will cause damage to the output circuitry.

To source mA, follow the steps below:

1. Power on the unit.	
2. Check the battery level indicator on the top of the unit: Green: Ready for use. Red: Change or recharge batteries.	
3. Select required range with push button. *On the 1021 select "source" on the function switch.*	
4. Dial required output current.	
5. The output current polarity can be selected on the front panel switch.	

3.3 Measurement of Current

To measure mA, follow the steps below:

1. Power on the unit.	
2. Check the battery level indicator on the top of the unit: Green: Ready for use. Red: Change or recharge batteries.	
3. Select NULL on the front panel function switch.	
4. Select NORM output.	
5. Adjust SENS fully anti-clockwise (minimum sensitivity).	
6. Select RANGE consistent with the current to be measured.	
7. Connect the unknown current such that it flows into the + ve terminal.	
8. Adjust the digit switch and sensitivity control for null balance on the LED indicator (green centre LED).	
9. When balance at the required sensitivity is reached, the value of the unknown current can be read directly from the thumbwheel digit switch settings.	

3.4 Voltage Compliance Adjustment - V O/P

The minimum voltage compliance of approximately 14 V is obtained by turning the V O/P control fully anti-clockwise. With full clockwise adjustment approximately 40 V is obtained.

The voltage level is checked by measuring across the output terminals when the voltage limit LED is illuminated.

It is recommended that the voltage level is set to the minimum required for the work in hand.

3.5 Overload Conditions

The instrument can withstand either a short or open circuit on the output terminals indefinitely. Overload conditions can result if an attempt is made to drive current into the instrument by applying a voltage to the output terminals. In most cases this will cause the internal output fuse (F2) to blow but could still damage the output circuitry.

3.6 Battery Recharging

Under normal conditions the 1021 should be switched off during battery recharge. Full recharge takes 10 to 16 hours. The battery charging rate is such that the battery cannot be damaged by overcharging.

It is not recommended that the 1021 be operated during battery recharge although output currents of a few milliamps at low compliance voltage can be obtained without discharging the batteries. It should be noted however that additional electrical noise will appear on the output due to the indirect mains power connection.

4 Electrical Noise Pick-Up

In addition to the inherent electrical noise from internal circuitry of the instrument, the output can contain fluctuations with originate from outside sources. The effects of noise on current sources in % or parts per million (P.P.M.) in general, this fraction becomes larger as the signal level is reduced. The 1021 current source has a very high output resistance to ground (greater than 100 M ohms). As with all high impedance circuits it is prone to pick-up of electrical signals via capacitance coupling.

The output terminals of the 1021 can be compared with the input of a high input impedance audio amplifier as far as noise pick-up is concerned. Therefore, for high performance work at low current levels it is important to use screened leads. It is also important to consider the effects of earthing when using the 1021 to calibrate mains powered equipment.

The major source of electrical noise pick-up is the 50/60Hz mains. This noise is generally present to a greater or lesser extend in all environments where mains power is available. This noise pick-up is capacitively coupled and is AC. In most applications, although superimposed on the DC output, it will not affect the DC accuracy. This is the case with small amount of pick-up; but at high levels (several volts peak to peak) the output circuitry of the 1021 is overloaded by the noise signal and it converts it into a DC offset with results in an error in the output.

It is important to realise that when measuring electrical noise at the output terminals of the 1021, the voltage noise measurements must be divided by the load resistance to give the current noise.

A certain amount of noise is generated internally by the 1021 and when high load resistances are used this can be seen on the output terminals as a series of voltage spikes. The effect of this voltage noise on the output current is very small and does not affect the DC accuracy.

Two of the more common sources of noise are discussed below:

4.1 Mains Power Lines

As has been stated previously, mains power lines are probably the largest source of noise often covering a wide spectrum of frequencies. The most effective solution is to locate its source and provide suitable filtering such as capacitor suppression on arcing contacts.

This noise is usually produced in one of the following ways:

1. 50/60Hz signal pick-up - This 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.

2. Transient signal pick-up - This is generally caused by heavy load switching on the mains such as electric motors, electric ovens, etc. Its effect is to cause a transient variation in the output which can last longer than the actual duration of the noise. This is because the instrument has been transiently overloaded and requires time to recover.

4.2 Common Noise Mode

Additional noise and variation of the output current can be caused by large, common mode voltages. These occur when the instrument is used to calibrate any input which is above ground potential or has an AC component with respect to ground. Under normal circumstances, it is recommended that a 100v DC common mode is not exceeded. The AC common mode rejection is determined by the capacitive unbalance to ground of the output terminals and associated connections.

5 Circuit Description

5.1 Power Supply

The power supply circuit board is mounted on a removable bracket which runs the length of the instrument. Eight NiMH (AA) size cells located in two plastic holders' power a switch mode regulator through a 1A fuse. The batteries may either be of the NiMH rechargeable type (as fitted and recommended) or of the Alkaline non rechargeable type. The switch mode regulator supplies a stabilised +8 V, a stabilised -7 V and a variable stabilised 14 V to 40 V at 2.4 W. The regulator circuitry incorporates a cut-out which operates should the battery voltage fall below approximately 7 V.

Battery life depends primarily upon the output current and voltage setting. At output currents of less than a few mA the life of a fully charged battery should be up to 20 hours.

5.2 Mains Recharger

The mains recharger is a separate unit. It will fully charge the batteries in 12 to 16 hours.

The standard recharger requires a mains input of 200 V to 240 V at 50/60 Hz. A recharger requiring 100V to 120V at 50/60 Hz is also available but should be specified when ordering.

The recharger is connected to the 1021 by a miniature 2 pin plug and socket shaped to ensure correct polarity.

5.3 Circuit Module and Range Switch

The active circuitry and range switch of the 1021 are located on a printed circuit board which is mounted on the rear of the front panel. Connection to this board is by a 9-pin connector.

The active circuitry is encapsulated and contains the precision reference circuit and output stage. A single F250mA 20x5mm fuse (F2) that is mounted on the power supply board protects the output.

Four trimmers for calibration are mounted on the printed circuit board (See Fig 1, page 13).

6 Maintenance and Repair

6.1 Maintenance

Dismantling the Instrument
Remove rubber protection boot and then removal of four 2.0 mm CSK screws enables the blue cover to be taken off which provides access to all parts of the instrument.
The range switch assembly can be removed by disconnecting the 9-pin connector and removing the two front panel locating screws.

Fuse Replacement
The power supply and output fuses are mounted on the power supply printed circuit board and are easily accessible on removing the instrument cover. Fuses are rated at F1A (F1), and F250mA (F2), and have dimensions 20mm length by 5mm diameter. The fuses are available from Time Electronics Ltd or your local supplier.

6.2 Repair

NOTE: No repair work should be undertaken by the customer while the instrument is under warranty as such work may render the warranty invalid.

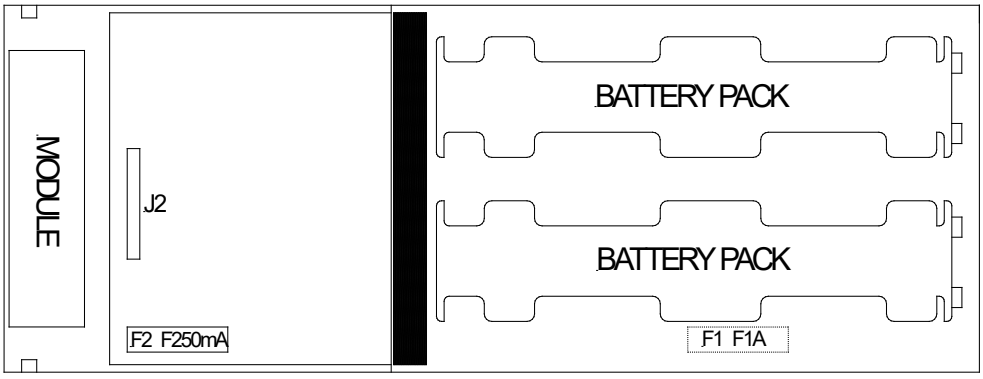
Some of the precision components used in this instrument are not readily available and make repairs by the customer difficult if these components are damaged.

Overload conditions can cause a fuse failure which will be indicated by one of the following:

a) Instrument inoperative and battery level indicator at zero.
Possible cause – F1, F1A supply fuse blown.

b) Battery level indicator displaying but no output at the output terminals.
Possible cause – F2, F250mA output fuse blown.

Fuse Location



7 Recalibration

The instrument is calibrated before it leaves the factory and should require no further adjustment for at least 12 months unless the circuit module or any of the calibration determining components have been damaged.

Before considering recalibration, the customer should ensure that any apparent error in output current is not due to inadequate measuring equipment or noise pick-up. The latter can be misleading at low settings of output current. You should also ensure that the correct equipment is available before attempting recalibration.

There are 2 ways the 1021 can be recalibrated:

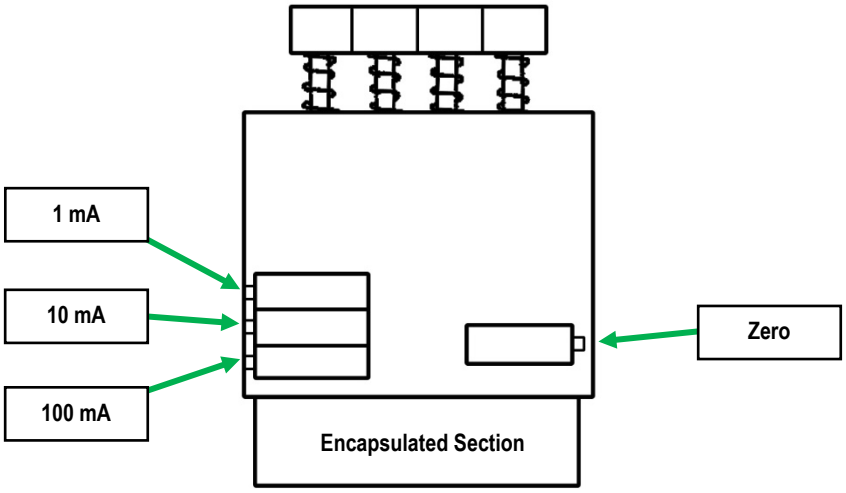
(a) The output current can be converted to a voltage by connecting a precision resistor across the output terminals. 3 values are required, 100Ω, 1 kΩ and 10 kΩ. The resistors must be accurate to better than 0.01% and have a good stability under load. The 10 Ω will dissipate 0.1 W at 100 mA and therefore must have a temperature stability good enough to ensure that it remains within 0.01%.
The voltage across the load resistor can be measured with a high performance multimeter (50 ppm accuracy on the 1 V DC range, and greater than 100 MΩ input).

(b) The output current can be measured directly on a high performance multimeter (50 ppm accuracy on 1 mA, 10 mA and 100 mA ranges).

7.1 Calibration Procedure

Access to the recalibration trimmers is by removing the instrument's cover which is located by four small screws. There are 4 multi-turn trimmers which are all located on the switch/module assembly. These are marked ZERO, 1mACAL, 10mACAL and 100mACAL.

Fig. 1: 1021 Trimmer Locations



Then switch on the instrument and allow the circuits to stabilize for a few minutes. Ensure that there are no draughts or direct heating causing temperature gradients in the circuitry. Calibration should be carried out at a stable temperature between 23 °C ± 5 °C.

1. Select the 100 mA range, set all digits to zero, adjust the 'ZERO' trimmer to give 1 micro amp output.
For recalibration method (a) the precision 1 kΩ resistor should be connected to the output terminals. Note the zero adjustment is unipolar i.e. it is not possible to adjust the output to less than zero.

2. Select the 1 mA range and set all digits to 9999. Adjust the '1MACAL' trimmer to bring the output to exactly 1 mA.
For recalibration method (a) the 1 kΩ precision resistor should be used.

3. Select the 10 mA range and set all digits to 9999. adjust the '10MACAL' trimmer to bring the output to exactly 10 mA.
For recalibration method (a) the 100 Ω precision resistor should be used.

4. Select the 100mA range and set all digits to 9999. Adjust the '100MACAL' trimmer for exactly 100 mA output.
For recalibration method (a) the 10 Ω precision resistor should be used.

7.2 Linearity

The linearity of the output is determined by specially matched resistors mounted on the rear of the digit switches. The matching is done when the 1021 is manufactured. Under normal operating conditions the high performance of these resistors ensures that the 1021 linearity will remain within specification for the instrument's lifetime.

Should the resistors be damaged or become faulty a replacement procedure should be adopted ensuring that the replacement resistor(s) is matched to the others on that digit bank. The 1 kΩ values should be matched to 0.01%, the 100 Ω to 0.05%, the 10 Ω to 0.5% and the 1 Ω to 5%.

8 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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Email: mail@timeelectronics.co.uk
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.