1018
Multi Function
V I R DC Calibrator

Technical Manual

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Contents

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

1. Introduction

A high performance portable D.C. calibrator with a null measuring capability. It is suitable for use in the field or laboratory for calibrating and testing a wide range of transducers e.g. thermo-couples, 4-20mA and 0-10V transmitters, and PRTs. The 1018 has the following features,

- **D.C. Volts 100 nV to 100 V**
- **D.C. Current 100 nA to 100 mA**
- **Resistance 10 milliohm to 10 Kohm**
- **0.005% (50ppm) accuracy**
- **1 ppm setting resolution**
- **Stability <5ppm/day, <25ppm/yr**
- **Noise < 1ppm (0.1 to 1 Hz)**
- **Deviation 0 to +/- 0.999%**
- **Null Indicator 1 uV resolution at max sensitivity**
- **Null Readout 0 to +/- 1V fsd**
- **Zero and Sensitivity Controls**
- **Mains/Battery operation**
- **Portable 29 x 11 x 25 cm 2.4 Kg**

Ranges
5 DC voltage ranges from 10mV to 100V each with a 6 digit (1ppm) resolution. 1 DC current range 100mA with a 100nA (1ppm) resolution. Resistance from 0.01ohm to 10Kohm is available in 0.01ohm steps.

Power
Either mains or re-chargeable battery. Battery operation enables good performance where earth loop and noise pick-up occurs.

Stability v Temperature and Time
Outstanding performance is due to the use of special computer selected reference diodes and the latest in resistor technology. The special low-thermal emf terminals reduce errors when working with micro-volt signals.

Digital Deviation Control
Allows the output to be increased or decreased in % terms from 0 to +/-0.999%. This can be used to provide a direct read-out of error against a nominal value e.g. 1.80000V with a +0.030 deviation would indicated a 0.03% error. This simplifies the recording of results for calibration certificates and immediately shows if the unit being calibrated is within specification.

Null Measure
This function enables the 1018 to be used as a high performance differential voltmeter to resolve differences as small as 1 micro-volt. An edgewise meter on the front panel indicates the null signal(difference), and zero and sensitivity adjust controls are provided for adjustment. A rear panel output of the null voltage signal is provided for driving chart recorders or data loggers. It is suitable long term analysis and stability checking work. Pre-setting the sensitivity control provides a known null sensitivity e.g. 10 ppm/div on a chart recorder.

2. Specifications

Voltage Ranges/Accuracy

0 - 9.99999mV in 10nV steps, ± 0.02% of setting ± 0.005% of range
0 - 99.9999mV in 100nV steps, ± 0.01% of setting ± 0.004% of range
0 - 999.999mV in 1µV steps, ± 0.005% of setting ± 0.002% of range
0 - 9.99999V in 10µV steps, ± 0.005% of setting ± 0.002% of range
0 - 99.9999V in 100µV steps, ± 0.01% of setting ± 0.004% of range

The above accuracies are independent of thermal emfs which can be up to 3uV depending on the type of leads and connections used. This should be allowed for in the expected accuracy.

Output resistance: 10mV & 100mV: 10R. 1V & 10V: <300mR. 100V: <2R
Drive current max: 10&100mV: as 10R o/p res. 1V&10V: 0.15A. 100V: 10mA.
Short circuit current: 350mA limited

Current Range/Accuracy

0 - 99.9999mA in 0.1uA steps, ± 0.02% of setting + ± 0.004% of range
Drive voltage max: 10V

Resistance Range/ Accuracy

0 - 9.99999kR in 0.01R steps, ± 0.05% of full scale
Power rating : 0.25W per resistor
End resistance : less than 250 milliohms

Deviation Control

0% to 0.999% in 0.001% steps; Deviation accuracy: V&I output, 0.5%

Temperature Coefficient

<5 ppm per degC

Long Term Stability

<5ppm/day <15ppm/90day, <25ppm/year

Short Term Stability/Noise

10mV range: <0.2uV/sec, <0.3uV/10sec, <0.4uV/min
100mV range: <0.2uV/sec, <0.4uV/10sec, <0.6uV/min
1V range: <0.2uV/sec, <0.5uV/10sec, <1uV/min
10V range: <1uV/sec, <2.0uV/10sec, < 5uV/min
100V range: <40uV/sec, <100uV/10sec, <500uV/min
100mA range: <0.2uA/sec, <0.3uA/10sec, <0.5uA/min

Warmup and Settling time

<10 minutes to full accuracy. Settling: < 0.5sec, 100V range, 3sec max

Output Connections

The output is via 4mm low thermal emf shrouded sockets (0.2uV/degC). A mains earth socket is provided for screening purposes. A three position output switch allows the output to be reversed or disconnected as required. A rear panel connector is provided for the null amplifier output, 0 to +/-200mV representing the indicator full scale.

Null Measure

Sensitivity: Max 1uV. Min 200mV fsd. Input R:>1Mohm. Rem o/p +/-200mV

Power Supply

The 1018 can be powered continuously from a 230V 50/60 Hz (110V to order) mains supply, or from the internal rechargeable battery pack. A front panel LED indicates when the batteries are low.

Operating Temperature:

0 to 50degC (32 to 120degF). 15 to 25degC for optimum performance.

Operating Humility:

10 to 90% non-condensing 25degC (77degF)

Dimensions

290 x 250 x 110mm (11.5 x 10 x 4.3ins) Weight 2.4kg (5.4lb)

3. Circuit and Power Supply Description

The calibrator employs a temperature compensated zener diode as the basic reference source. This provides the input to a precision amplifier system which operates in a feedback stabilised mode. The gain value is determined by a set of precision resistors which are selected by a 6 decade thumbwheel switch. The output voltage is variable from 0V to 99.9999V in 5 ranges.

An output resistance of typically 300 milliohms is maintained on the 1V and 10V ranges and a maximum drive current of at least 150 mA is available. The 100V range has an output resistance of less than 2 ohm with a maximum drive current of 10mA. The 10mV and 100mV ranges have an output resistance of 10 ohms and the user should be aware of loading errors - a 10Kohm load will produce a 0.1% error.

When the 100mA current source range is selected, the output current is sensed by a precision resistor. The voltage generated across this resistor is used to control the output drive voltage, so regulating the output current. The maximum drive voltage from the current source is 10V

The resistance range operates by directly switching the thumbwheel switch to the output terminals. The range of resistance is 10 milliohms to 10 Kohms. However the user must be aware of the end resistance which is approximately 0.25 ohms - this must be compensated for.

The deviation control operates by injecting a current into the reference circuitry which either increases or decreases the reference voltage. A front panel switch allows positive/zero/negative deviation to be selected. The deviation is selected on a 4 decade thumbwheel switch similar to the output thumbwheel switch. The maximum setting is .9999 and this represents 0.9999 %. The resolution is 0.0001 % or 10ppm. The accuracy of the deviation adjustment is better than 0.5% which allows accurate measurement of deviation from the nominal set value.

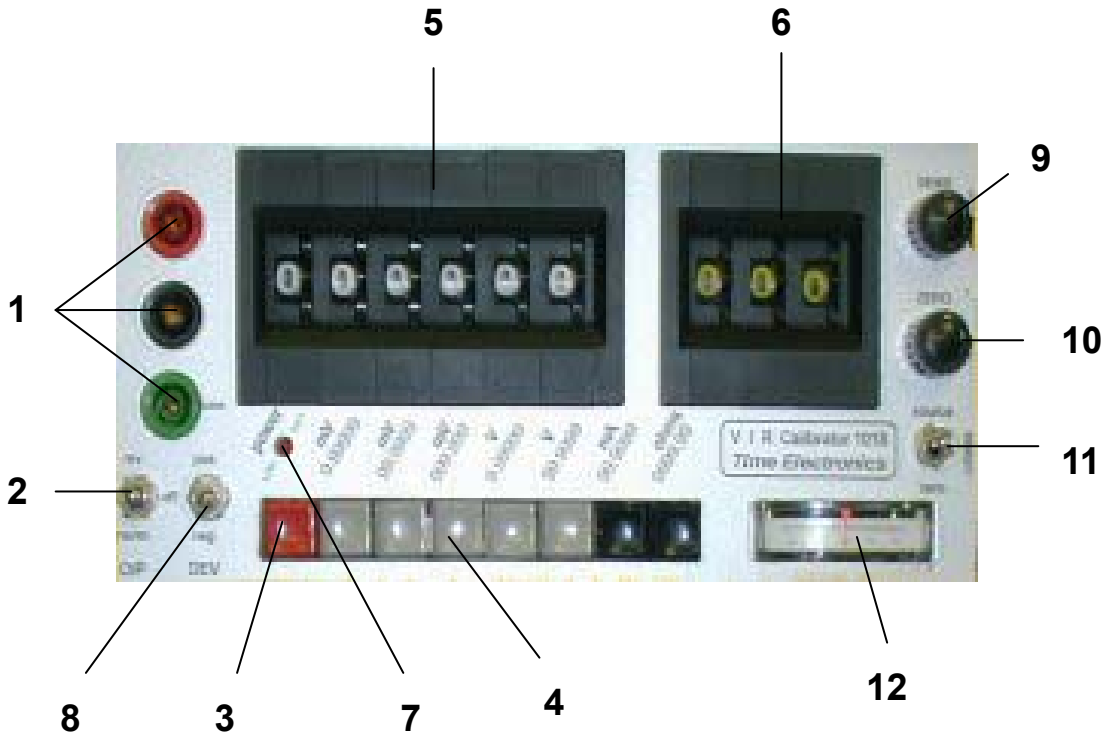
To ensure complete reliability of the thumbwheel switches they are gold plated and employ twin controls. Therefore even if a contact fails, the unit will continue to work correctly.

Power Supply

This unit provides both mains and battery power. The batteries are automatically charged when the mains is connected. The power supply is mounted on the rear panel of the unit. The power supply can be set for 220V or 240V AC 50/60 Hz. A 115V version is available to order. **The front panel 'LOW BATT' LED is illuminated when the batteries are OK and gradually fades as the batteries discharge. The 1018 will operate correctly until the LED goes out.**

When the mains is connected, the charging circuitry provides a charge current (40 – 45mA) for the battery and automatically reduces this to a trickle charge of 3 – 4mA when the battery is fully charged. This means that it is impossible to over-charge the battery. Approximately 30 – 40 hours use may be obtained between charges, depending on the output setting.

4. Front Panel Controls



1 Output Terminals - positive / negative / case

2 Output switch - reverse / off / normal

3 POWER Switch

4 Range Select Switches

5 Output Digit Switch. Selects the value of output

6 Deviation Digit Switch. Selects the value of deviation

7 Battery LED. Shows the state of the batteries

8 + / off / - Deviation Control

9 Null Sensitivity Control

10 Null Zero Control

11 Function Switch - ‘source’, ‘measure’ or ‘zero’

12 Null Indicator

5. Operation

Preparing for Use

After switching on the power and checking that the battery level is OK indicated by the 'low batt' LED being fully lit. If it is dim or not lit you must recharge the batteries by plugging the unit into the mains supply. It will take approximately 12 – 14 hours to fully recharge the battery pack. However, the 1018 may used while it is connected to the mains supply, irrespective of the battery state.

Basic operation

Before switching on it is wise to disconnect any load from the output terminals. Set the output switch to 'off' before switching on, then select the required range and dial up the required output value on the digit switch. The output terminals can then be connected and the signal connected by operating the output switch.

Note – When the output switch is set to the 'off' position, there is a short circuit on the output terminals.

Caution against minor electric shock must be exercised when using the 100V range. Also take care not to overdrive any equipment connected to the unit (the max output current is limited to about 10mA). Always check your wiring and connections carefully before switching on.

Thermal emfs

When using the unit to provide a precision voltage of less than 1mV, care must be taken to avoid Thermal emfs. These occur where temperature differences are present at the junctions of dissimilar metals, e.g. A normal solder to copper junction has a thermal emf of approximately 3uV/°C. Errors in the unit under stable temperature conditions are typically less than 2uV. Always check the output from the unit with zero set. If very accurate low level calibration is required a correction in the output setting must be made to compensate for the thermal emfs.

Using the Deviation Control

Note : The digital deviation function operates only on the voltage and current outputs, not on the resistance output.

To apply a percentage deviation to the output, select either positive or negative deviation with the control switch and dial up the percentage deviation required on the digit switch.

Direct % error read-out when calibrating:
The output is set to the required nominal value. The Deviation function should then be used to bring the reading on the unit being calibrated to the nominal value. The Deviation setting is then the accuracy of the unit in % of the nominal. This method of calibrating is much faster than using only the nominal value and will require mathematical calculation each time to calculate the % error.

Null Operation

Due to the extreme sensitivity of the electronic null detector it is important to ensure that it is correctly zeroed before attempting accurate measurements.

Zero setting procedure:

a) Set function switch to ZERO.
b) Set RANGE switch to required position.
c) Sensitivity (SENS) to maximum (fully clockwise).
d) Adjust ZERO control for zero reading on null meter.

Measuring procedure:

a) Set function switch to MEASURE.
b) Set output polarity switch to NORM.
c) Set sensitivity (SENS) to minimum (fully counterclockwise).
d) Connect unknown voltage to output terminals (in the same polarity).
e) Adjust output digits and sensitivity for a null balance as required.

6. Calibration

Calibrating the Unit

The unit can be calibrated with a high accuracy DMM with DC voltage, current and resistance ranges with a specification better than that of the unit's.

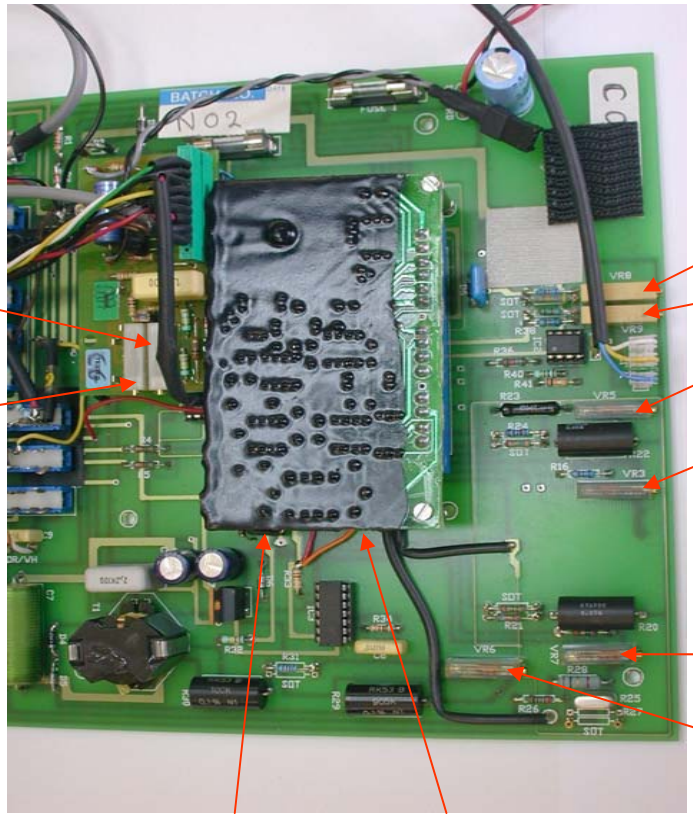
Calibration is best carried out on fully charged batteries without the mains supply connected to ensure that no mains supply interference has any effect on the readings.

It is recommended that a full calibration run is done prior to attempting to adjust any of the 1018's internal calibration adjustment trimmers.

A complete set of results will indicate the calibration status of the unit and determine whether or not re-adjustment is necessary. If the results are significantly different from those shown on the sample certificate this may indicate a fault which must be rectified before re-adjustment is attempted.

Re-adjustment of the 1018's calibration trimmers:
Access to the trimmers requires the top cover of the case to be removed and the rear panel to be moved away from the rear of the unit. This allows access to the trimmers - see picture below. Remove the top cover as follows,

Remove the three case fixing screws. These are located in recessed holes in the bottom of the case. Note that the recessed holes are covered with push fit rubber feet which must be removed to give access to the fixing screws. Once the screws have been removed place the 1018 on a flat surface, the top section of the cover can then be eased off and the rear panel/power supply can be moved back to allow access to the calibration trimmers which are shown on the diagram below. Please note that the main reference module and null amplifier module are not shown in this diagram - there are two trimmers on each.



Calibration sequence

A high performance DMM is required for the calibration. Time Electronics' 5075 or equivalent is suitable.

Source Function Calibration:

Select 'source' on the Function switch
Select 'off' on the Deviation switch
Set all Deviation digit switches to zero

1V range zero:
Select 999.999mV range.
Set output digit switch 000000
Connect the precision DMM to the 1018 output using low thermal leads.
Select a suitable range on the DMM and measure the signal.
The allowed error is 23uV.
It is recommended that it be set to less than 5uV using the zero trimmer on the module

1V range full scale:
Set output digit switch to 999999
Select suitable range on DMM.
Allowed error is 73uV
Adjust gain trimmer on the module for < 10uV

10V range zero:
Select 9.99999V range
Set digit switch to 000000
Allowed error is 200uV
There is no adjustment for this setting

10V range full scale:
Set digit switch to 999999
Allowed error is 700uV
Adjust 10V FS trimmer for 50uV or less

100V range zero:
Select the 99.9999V range
Set digit switch to 000000
Allowed error is 4mV
There is no adjustment for this setting

100V range full scale:
Set digit switch to 999999
Allowed error is 14mV
Adjust the 100V FS trimmer for 1 mV or less

100mV range zero
Select 99.999mV range
Set digit switch to 000000
Allowed error is 7uV
There is no adjustment for this setting

100mV range full scale:
Set digit switch to 999999
Allowed error is 7uV
Adjust the 100mV trimmer for 2uV ot less

10mV range zero:
Select the 9.99999mV range
Set digit switch to 000000
Allowed error is 3.5uV
There is no adjustment for this setting

10mV range full scale:
Set digit switch to 999999
Allowed error is 5.5uV
There is no adjustment for this setting

100mA range zero:
Select the 99.9999mA range
Set digit switch to 000000
Allowed error is 4uA
There is no adjustment for this setting

100mA range full scale:
Set digit switch to 999999
Allowed error is 24uA
Adjust 100mA trimmer for 5uA or less

Deviation:
Select 9.99999V range
Set digit switch to 999999
Select ‘pos’ deviation
Adjust DEV + trimmer for <1% error on the deviation
Select ‘neg’ deviation
Adjust DEV - trimmer for <1% error on the deviation

This completes the Source Function calibration.

Measure function:

There is no calibration required for this section of the 1018. However, if required the balance of the null voltage zero can be adjusted using a trimmer located on the null module. A current balance trimmer is also located on the null module. It is unlikely that either of these trimmers will need adjustment.

The null indicator meter has a mechanical zero adjust lever located on the rear bottom of the meter.

8. Guarantee & Service Facilities

The unit is guaranteed for a period of one year from its delivery to the purchaser.

We maintain a comprehensive after sales service and the instrument can, if necessary, be returned to us (or our authorised dealer) for servicing. The type and serial number of the instrument should always be quoted in all correspondence, together with the details of any fault found and the service required.

Equipment returned to us for servicing must be adequately packed, preferably in the box supplied, and shipped with transportation charges prepaid.
WE CAN NOT ACCEPT RESPONSIBILITY FOR ANY INSTRUMENT ARRIVING DAMAGED.

Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee period has expired, the repair will be put in hand without delay and charged unless other instructions are received.

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