2000 Series

Precision Multi Product Calibrator

Operation Manual

Version 5.0
December 2004

www.transmille.com

IMPORTANT NOTICE

THIS CALIBRATOR WILL REQUIRE AN UNLOCK CODE AFTER THE EVALUATION PERIOD HAS EXPIRED.

(60 Days after invoice date)

AFTER THE EVALUATION PERIOD HAS EXPIRED THE OPERATION OF THE CALIBRATOR IS LOCKED AND THE DISPLAY SHOWS A NUMBER WHICH MUST BE QUOTED TO TRANSMILLE TO RECEIVE THE UNLOCK CODE

THE UNLOCK CODE IS AVAILALBLE FROM TRANSMILLE ONLY AFTER PAYMENT HAS BEEN RECEIVED.

(This code is only entered once in the life of the instrument.)

Please contact Transmille or use the form in the back of the manual to obtain the code.

Transmille Ltd.
Staplehurst , Kent.
Tel: 44 (0)1580 890700 : Fax 44 (0)1580 890711
email:- sales@transmille.com

DECLARATION OF CONFORMITY CE

Manufacturer's Name: **Transmille Ltd.**
Manufacturer's Address: **Unit 4, Select Business Centre**
Lodge Road
Staplehurst
TN12 0QW

Declares, that the product

Product Name: **Multi-product Calibrator**
Model Number: **2050 / 2041A / 2006A**
Product Options: **This declaration covers all options of the above product(s)**

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/73EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly

Conforms with the following product standards:

EMC

Standard	**Limit**
IEC616326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998 EN55011:1991	
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995	***Group 1Class A***
IEC 61000-4-3:1995 / EN 61000-4-3:1995	***4kV CD, 8kV AD***
IEC 61000-4-4:1995 / EN 61000-4-4:1995	***3 V/m, 80-1000 MHz***
IEC 61000-4-5:1995 / EN 61000-4-5:1995	***0.5kV signal lines, 1kV power lines***
IEC 61000-4-6:1996 / EN 61000-4-6:1996	***0.5kV line-line, 1kV line-ground***
IEC 61000-4-11:1994 / EN 61000-4-11:1994	***3V, 0.15-80 MHz I cycle, 100%***
	Dips: 30% 10ms; 60% 100ms
	Interrupt > 95%@5000ms

SAFETY
IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995

12/12/2001

Revision No: 1.1 **Managing Director**
Date :12/12/2001

TABLE OF CONTENTS

2000 SERIES CALIBRATOR INTRODUCTION

The 2000 series of calibrators offer the smallest and by far the most portable multi-product multi - function calibrator in the world. The 2000 series calibrator provides a fully functioned precision programmable calibration source.

MAIN FEATURES

- **AC/DC Volts to 1020V**
- **AC/DC Current to 20 Amps**
- **AC/DC Current to 1000 Amps with 50 Turn Clamp coil Adapter**
- **2 and 4 Wire Resistance to 1 GOhms**
- **Capacitance**
- **Inductance**
- **Logic Level Frequency**
- **Mark Space Ratio**
- **PT100 resistance Simulation**

- **Thermocouple Simulation**
- **Power (Internal Option)**
- **600MHz Oscilloscope Calibration (Internal Option)**
- **RS232 Serial Interface ▪ GPIB (IEEE488) Interface Option**

> PLUS AN EXTENDABLE RANGE OF ADAPTORS ACCESSED USING THE FEATURE CONNECTOR.

ACCURACY AND FUNCTIONALITY

The 2000 Series calibrators are available in 3 accuracy grades including the 2006A basic DC accuracy of 5ppm, the 2041A of 25ppm and the 2050 of 50ppm. The appearance of these units is the same however the model is indicated on the Rear panel and shown on the display at switch on. The calibrators are also available as reduced function e.g. DC volts only etc.

TRUE MULTIPRODUCT CALIBRATION FROM ONE INSTRUMENT

Designed to provide an accurate cost effective portable instrument for the calibration of multimeters, clamp meters, frequency meters, temperature meters, capacitance meters. Internal retro fit options allow the calibration of power meters, oscilloscopes to 600MHz, inductance and LCR meters.

Designed for on use in the laboratory or portable on site calibration.
The 2000 series calibrator is equally suitable for use in the standards laboratory or for on site calibration work. The fast warm up time combined with the small case and low weight also make the 2000 series calibrator idea for on site calibration. The serial interface allows direct connection to a portable PC.

RETRO FITTABLE OPTIONS
ALLOWS EXTRA FUNCTIONS TO BE ADDED AS REQUIRED.

Several internal retro fit options including oscilloscope, power , inductance and PRT allow the user to select the most cost effective solution for the calibration work required at the time with the ability to add extra functions as required. External options for the calibration of clamp meters, high accuracy thermocouple simulation with auto CJC built into the TC connector, optical tachometers etc are also available controlled via the front panel feature connector

Serial Line RS232 Interface available as standard.

All functions and outputs of the series 2000 calibrator are fully programmable over the RS232 interface fitted as standard. The use of the RS232 interface saves the cost of fitting IEEE cards to the PC, and also allows easy connection to portable PC's, reducing the set up time for on site calibration.

Output Connection

The output terminal configuration is designed to match most DMM's input connection, e.g. volts/ohms, low current and high current. Eliminating the need for lead changing during calibration. All outputs are isolated when not in use, an led indicator showing the active output pair.

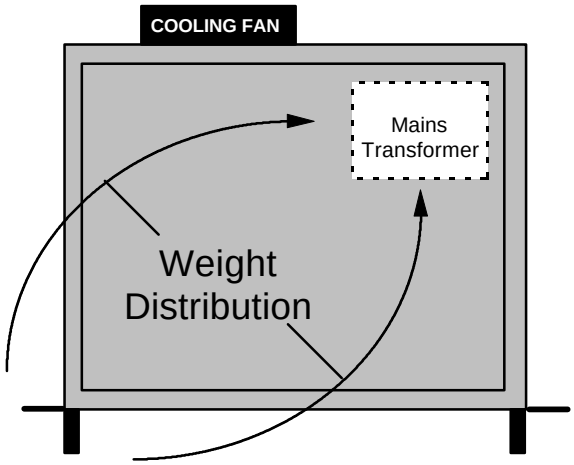
Preparing the calibrator for use.

Initial Inspection.

After shipment the calibrator should be inspected for any signs of external damage. Should external damage be found contact the carrier immediately. Do not connect a damaged instrument to the line power as this may result in internal damage. Please keep the original box which can be used when returning the calibrator for service and recalibration.

Lifting and carrying the calibrator

The calibrator weights 12kgs with most of the weight at the rear right hand corner. The calibrator can be carried easily by one person in any position by either holding the front handles or by supporting from underneath (note : observe all normal practices for health and safety when carrying). A custom carry case with shoulder strap is available if the calibrator is to be regularly transported - see options list. The calibrator should always be placed down on a firm flat surface on its base feet. Standing the calibrator down on its back may cause damage to the fan. Avoid knocking or banging the calibrator and always place down smoothly.



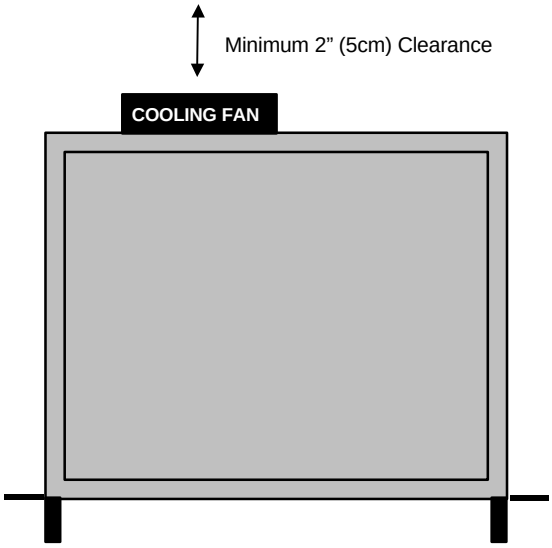
Warning

DO NOT DROP THE CALIBRATOR as this may cause internal damage.

Positioning the Calibrator.

See diagram

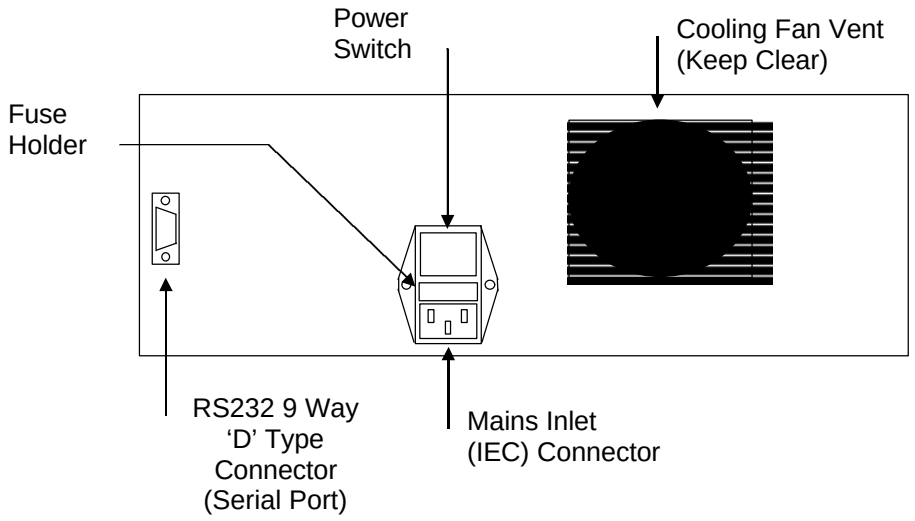
The calibrator can be used free standing on a bench or mounted in a standard 19” rack enclosure. The calibrator can be operated at any angle, the two front feet have tilt legs for bench operation. For all installations care must be taken not to cover the ventilation slots underneath or block the fan. A 2” (5cm) space behind the instrument is also required for line and interface connections.



Rear Panel Connections and controls

See diagram

Connections on the rear panel are for Line Power via a 3 Pin IEC connector incorporating the Line fuse and on-off switch, Note the mains inlet is filtered. A 9Pin Serial interface connector for the computer interface, this is optically isolated from the calibrators output. On some models a third connector for the 10kV Extension amplifier is also present.



Setting and checking the Line Voltage.

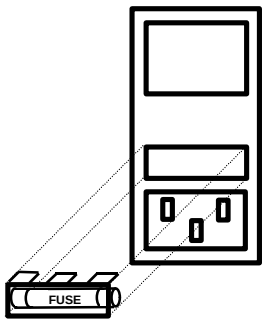
Warning

The line power cord must have an earth conductor to avoid risk of shock. This instrument must be correctly earthed.

The calibrator has been designed to work from either 100-120 Volt line supply or 200 - 240 Volt line supply. Check Supply voltage as marked on the rear panel before connecting to power line. Connecting the calibrator to the wrong supply will cause internal damage to the instrument. To Change the line voltage it is necessary to remove the rear panel and rewire the transformer. The calibrator will have been shipped wired for 110V operation for USA or 240V for Europe.

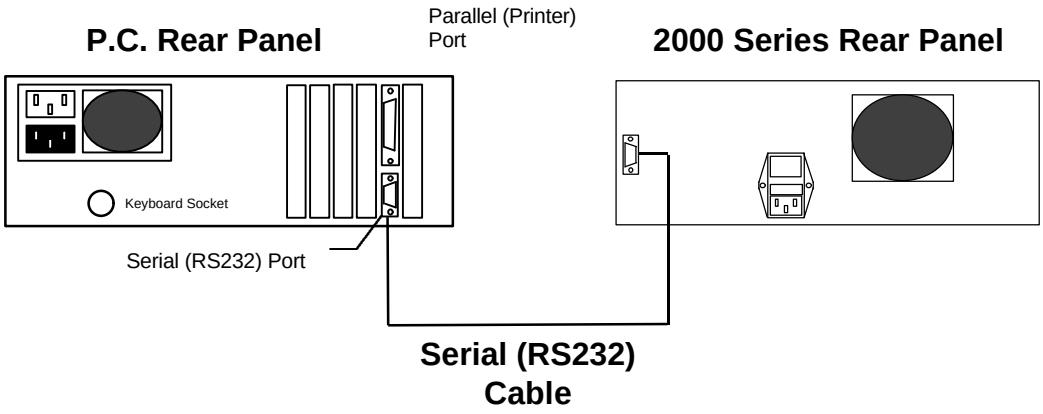
Power Line Inlet Fuse and rating

The Power line inlet fuse is located directly above the power inlet. The correct fuse for is.3.15A Anti-surge for 230Volt operation and 5Amps Anti surge for 110Volt Operation



Connecting to a computer

If required, a standard serial 9 pin cable may be used to connect the calibrator to a Comm port on a PC. A Null modem cable is not needed.



Powering up the calibrator

After connecting line power, the calibrator can be switched on with the line power switch above the mains inlet socket on the rear panel.

The fan will start and the front panel display will illuminate indicating power. The display will show a firmware version number and after a short delay, during which time the processor performs a self test of the instrument, the display will show an output of `0.0000mV D.C.` Allow the calibrator to warm up for 30 minutes to obtain full accuracy, the fast start feature of the calibrator will give approx. 90% of full specifications within 10 minutes. The calibrator has been designed to be powered up continuously, automatically switching to a standby mode after a pre-set period of time from the last command. In standby mode the display back light will turn off.

The control program can now be started on the computer, the program will establish communication with the calibrator at which time the calibrator will download the values of the internal standards.

Output Connections

***Warning* - Risk of shock.**

High voltages may be present on the output sockets.

Output sockets are all 4mm safety type, the voltage pairs contacts are low thermal gold plated for minimum thermal EMF.

The 2000 series calibrators outputs have been designed to allow most multimeters to be calibrated without changing ranges. There are 3 separate pairs of outputs :

1) Voltage, Resistance, Capacitance, frequency & Inductance
2) Current and 4 Wire Resistance
3) High 20A Current.

When an output terminal pair is not active they are completely open circuit and isolated from the other outputs. As only one pair is active at a time on (except on 4 wire ohms) they may be combined together if required to match the meters input arrangement.

One example common configuration of a multimeter's inputs is a single common Low with a voltage, current and high current input. To match this to the calibrator, simply connect the 3 low outputs of the calibrator together and connect the voltage, current & high current outputs to the appropriate meters input . Note that when outputting ohms, the calibrator will use the voltage output terminals.

A second example is where the meter has separate voltage and current inputs, often using four wire ohms on both pairs. In this case simply connect the voltage and current outputs to the meter's inputs, the calibrator will use both the voltage and current pair on four wire ohms.

It is recommended that the voltage and low current leads be high quality screened cable with gold plated 4mm plugs fitted. The cable must be able to withstand 1020 volts AC and have an insulation resistance greater than 1Teraohm to avoid introducing any shunting effect on the high resistance ranges.
Poor quality test leads will introduce noise, thermal emf and leakage errors on low voltage & current ranges and also unstable readings on resistance and capacitance outputs (see measurement techniques). Special test leads are available from Transmille, see accessories.

Warning

Under no circumstances should any voltage be connected to the calibrator outputs

The low output can be connected to line earth or allowed to float as selected - see operation section of this manual.. It is recommended that the low is earthed which will help to reduce noise on high ohms and low current. If allowed to float with respect to line earth the low must remain within 50 volts of line earth. Outputs are opto isolated from the RS232 interface

Output Overloads

If the calibrator is unable to drive the load then the output will be turned off and the calibrator returned to standby mode. The message STBY ! will be displayed on the front panel. The output will be automatically reset on setting the output again.

Operation

SAFETY WARNINGS

WARNING :

The information in this section is intended only for qualified personnel. The user must at all times be adequately protected from electric shock. Qualified personnel must ensure that operators of the equipment are adequately insulated from connection points.

WARNING :

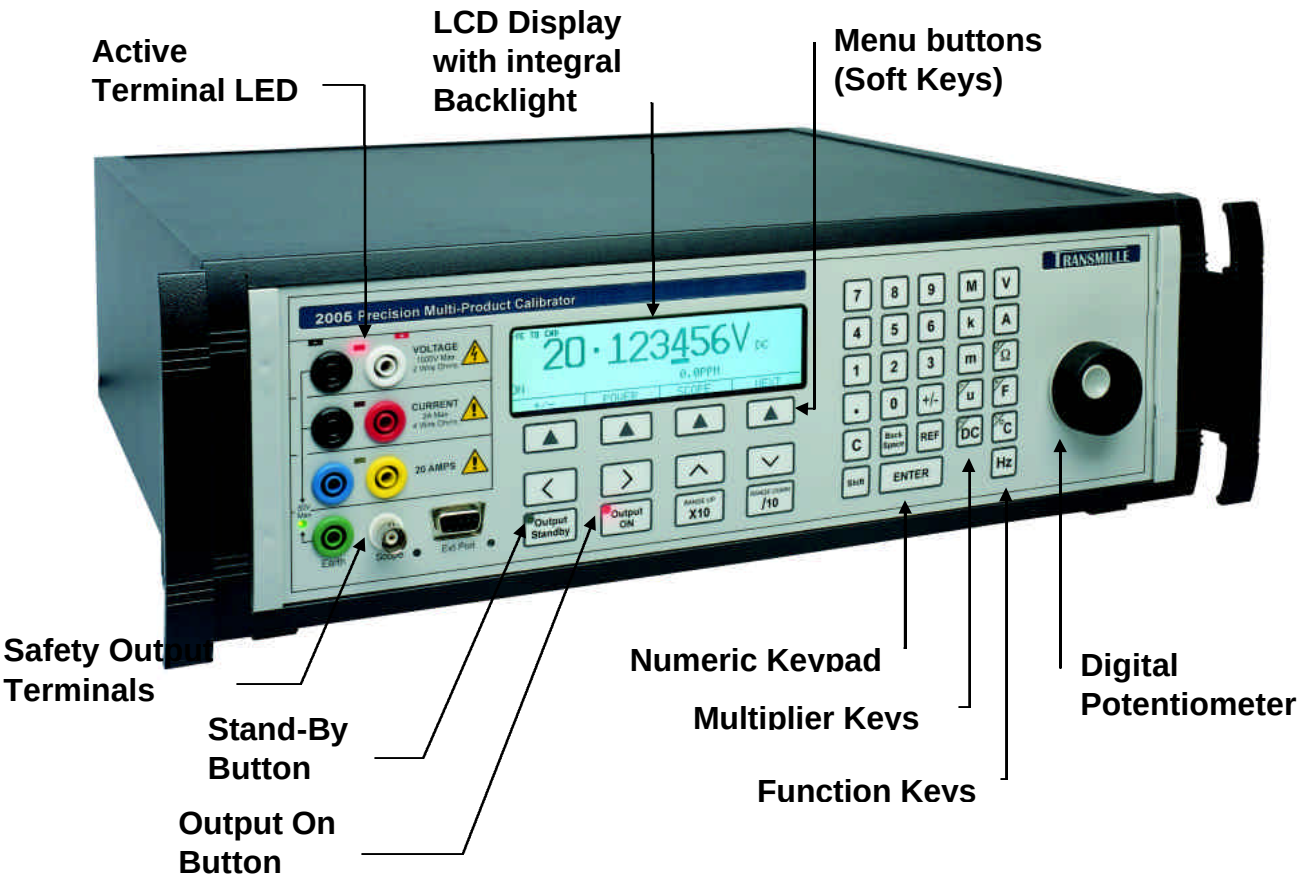
This instrument is capable of generating both DC and AC high voltages.

A soft carry-case and a hard transit case are available for regular transportation of the calibrator.

Introduction to Operation

All functions of the 2000 Series Calibrator can be controlled from the front panel. or controlled remotely by a computer over the interface. The front panel controls are ‘locked out’, but local control may be resumed by selecting a soft key - it must be remembered that this action may disrupt the computer program.

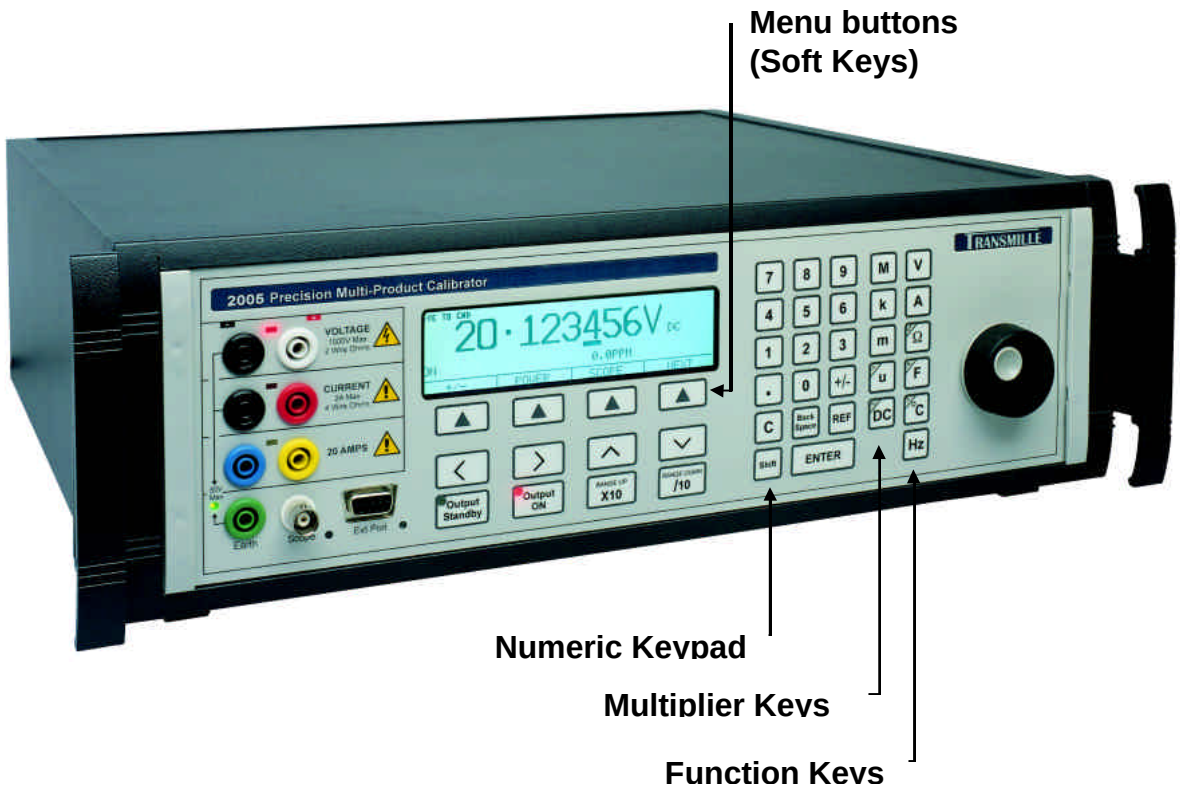
Front Panel Controls and Indicators



Front panel Keyboard

The front panel of the 2000 Series Calibrator utilises a high quality membrane switch panel with tactile feel buttons and integral display window. The front panel is therefore sealed against the ingress of moisture and dirt enabling the calibrator to be used in working environments without risk of dirt causing early failure of the operating buttons. The front panel can easily be wiped clean with a soft cloth. Care should be taken not scratch the display window. All graphics are 'under printed' so that they will not wear off with use.

IMPORTANT NOTE
The front panel key buttons are for use with fingers only - do not press the key with hard or sharp objects e.g. Ball-point pens, pencils, screwdrivers etc. Repeated actions like this will almost certainly cause the keyboard to fail. (This will not be covered under warranty). Care should also be taken when transporting the instrument, do not place test leads on top of the panel which may get squashed into the display area or keys which can also cause damage.



The Keyboard is divided into section to allow rapid operation.

The Numeric section

Allows values to be entered

A multiplier section to select either

Mega (M), Kilo (K), milli (m), micro(u) or nano (n)

Functions keys for

Volts (V), Amps(A), Ohms, Farads(F), Celsius(C), & Frequency(Hz)

Range up and range down keys

Allow the output to be multiplied/divided by 10.

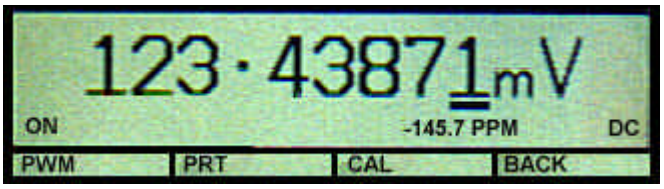
Left / right arrow keys

To select the digit to be controlled by the rotary control.

Output on / Standby keys

Allow the calibrators output to be disconnected from the terminals. Led indicators are incorporated in these switches to clearly show the output status.

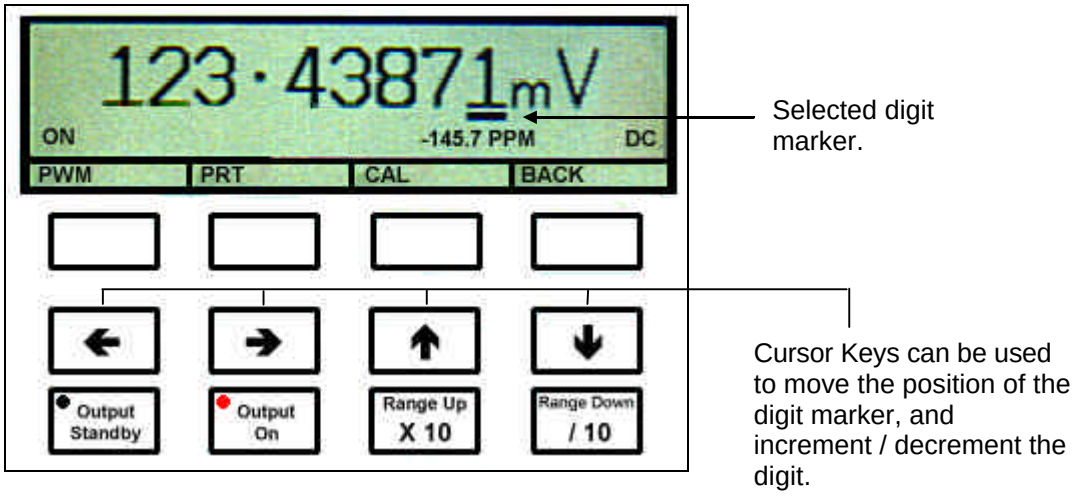
Graphic LCD Display

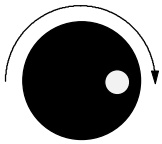


A back lit graphic LCD display shows the present output, instrument status, % or ppm change from the entered value, and also the new value being entered. The bottom line of the display is used to assign the function of the four 'soft (menu) keys' immediately under the display. The display utilises a back light which automatically turns off if no activity takes place. The back light turns on as soon as a key is pressed or a command is received.

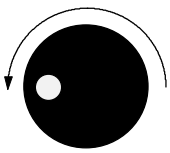
Digital Rotary Control

A digital potentiometer allows ‘highlighted numbers’ on the display to be incremented (turning clockwise) or decrement (turning anti-clockwise). As an output is changed the deviation from the original value entered on the keyboard is shown in either % or ppm.





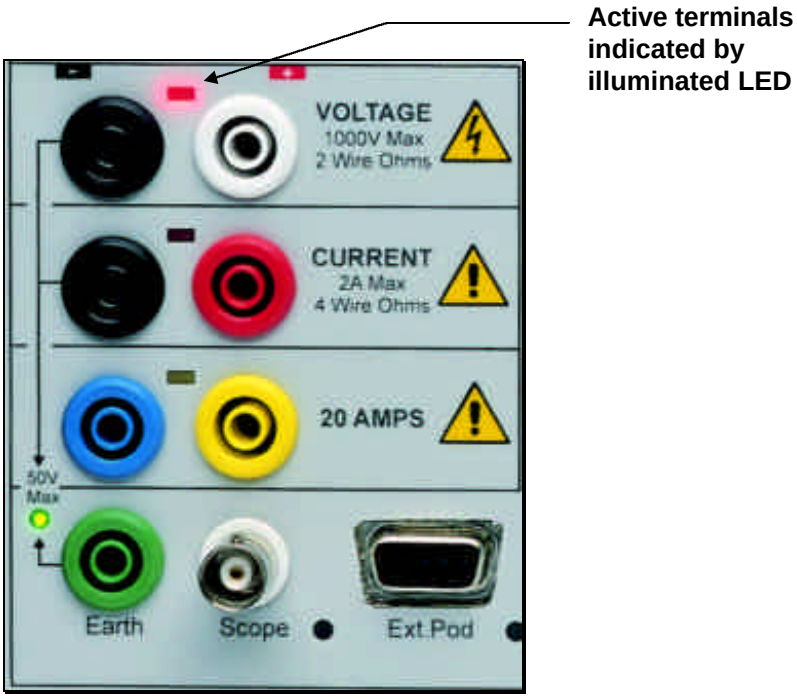
Clockwise Rotation (Increment Digit)



Anti-Clockwise Rotation (Decrement Digit)

Terminal status LED's

LED's above the terminals indicate which pair is active. When terminals are not active they are electrically isolated from each other, this enables terminals to be linked together if required.



Voltage Output Terminal Pair (Black & White)

WARNING Dangerous voltage may be present on these terminals.

Low thermal 4mm safety terminals

Used for all voltage outputs up to 1020V, for 2 wire/4 wire resistance, and inductance (optional).

Note the low 'black' terminal can be internally switched to line earth by a soft key function. When floating, the maximum voltage on this terminal with respect to ground should not exceed 50 Volts peak.

Current Output Terminals (Black & Red)

4mm safety terminals for all current outputs up to 2 Amps, capacitance, TTL frequency and for sense connection for 4 wire ohms.

Note the low 'black' terminal can be internally switched to line earth by a soft key function. When floating, the maximum voltage on this terminal with respect to ground should not exceed 50 Volts peak

20 Amps Output Terminals (Blue and Yellow)

4mm Safety terminals used for all currents above 2 Amps.

Earth Terminal (Green)

Connected directly to line earth and case.
Incorporates green LED indication of Negative to earth (grounded or floating) selection

Scope BNC Connector Output

Isolated BNC Output for oscilloscope calibration

Incorporates green LED indication if BNC is the active terminal.

WARNING

Dangerous voltage up to 400Volts may be present on this output

9 Pin Feature Connector.

Used for connection to external pods used for extending calibration capability, e.g. Thermocouple simulation etc.

Feature connector 9 Way 'D' type connector (Female)

Incorporates green LED indication if feature connector is active.

Setting a Voltage or Current Output

To set an output follow the example below to which will set 12.345mA note that the value will appear in the display as it is entered, use ‘backspace’ and clear ’C’ to edit an incorrect entry.

1) Key in the required value, e.g. ‘12.345’
2) Followed by the multiplier, e.g. ‘m’
3) Followed by the function ‘A’. Then press ‘Enter’

The display will now change to show the new value. The value entered will now be output by the calibrator on the appropriate terminals, except when a high voltage or current is entered. In this case, the calibrator will automatically go into standby mode. To output the voltage, press the ‘Output On’ key. This safety feature stops the accidental selection of high voltage or current. Once on a range, any new output within that range can be set without the calibrator returning to standby.

Adjusting the set output using the rotary control

After the output has been set, any digit of the output display can be incremented or decremented using either the digital control or the up down arrow keys. The digit selected is indicated by the cursor and can be selected using the left/right arrow keys.

Automatic Display of % or ppm Error and Ref. Key

When the output value is changed by the methods above, the display will show the change in ppm or % from the original reference value entered from the keyboard. If needed, the reference value can be reset to the present value on the display by the REF key.

This feature is ideal for displaying the error in a meter under test by adjusting the output from the calibrator to make the meter read the nominal.

Selecting AC and Setting a Frequency.

To set the calibrator to either AC volts or Current follow the example below which sets 1234Hz. Note that the value will appear in the display as it is entered, use ‘backspace’ and clear ’C’ to edit an incorrect entry.

1) Key in the required frequency, e.g. ‘1234’
2) Followed by the multiplier if required
(Note : frequency must be entered as Hz)
3) Followed by the function ‘Hz’
4) Then ‘Enter’

The display will show the frequency in the bottom right hand corner of the display. For safety, AC/DC changes will set the output to zero.

Returning the calibrator to DC

The output can be returned to DC by following the sequence below:

1: Press ‘DC’ Key

2: Enter.

The display will show DC in the bottom right hand corner of the display. For safety, AC/DC changes will set the output to zero.

Setting 2 Wire Resistance Output.

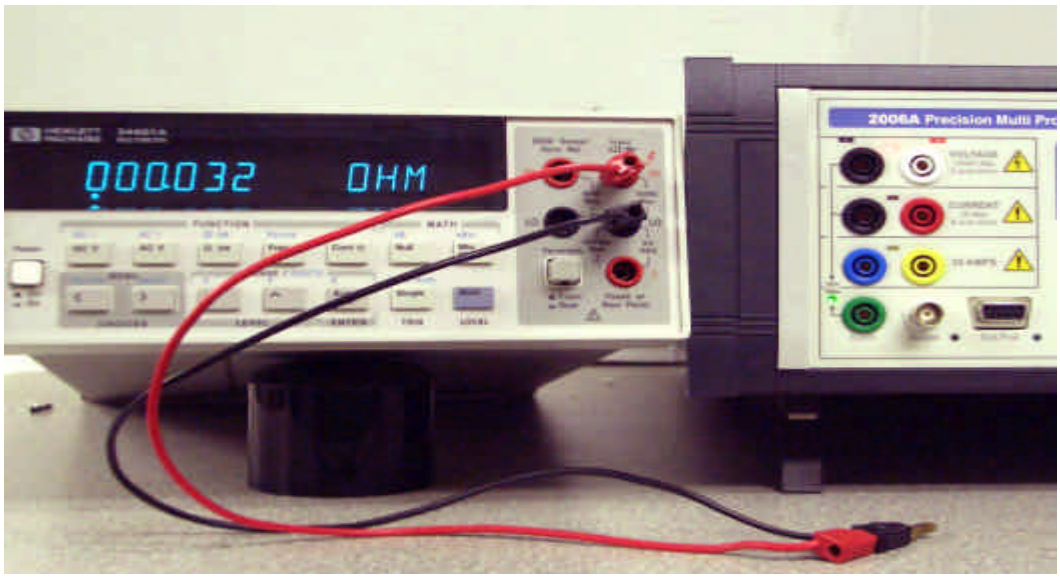
Note : The calibrator uses standard resistors of fixed decade values. The nearest available resistance to the entered value will be automatically selected. The example below selects 100kOhm in 2 wire mode.

1) Key in the required value, e.g. ‘100’
2) Followed by the multiplier if required e.g. ‘k’
3) Followed by the function ‘Ohms’
4) Then ‘Enter’ and ‘Output ON’

The resistance displayed will be the calibrated value held in the non volatile calibration memory for that standard. Note the values are different for two and four wire ohms.

Nulling DMM

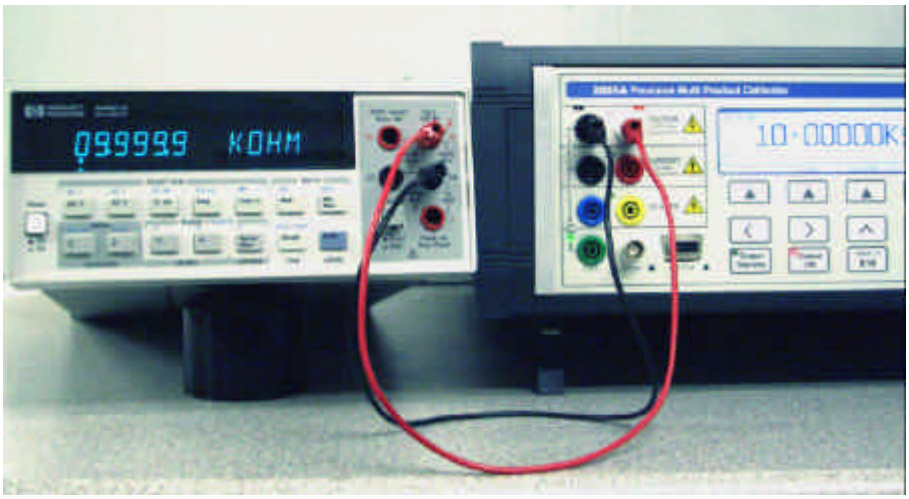
The calibrated values displayed for 2 wire ohms is the value present at the terminals. Therefore the measuring instrument should be zeroed (Nulled) with the leads shorted before connection to the calibrator.



2 wire ohms NULL connection

2 wire ohms operation

Two wire ohms is output on the voltage terminals as indicated by the terminal LED's.



2 wire ohms operation

Setting 4 Wire Resistance Output.

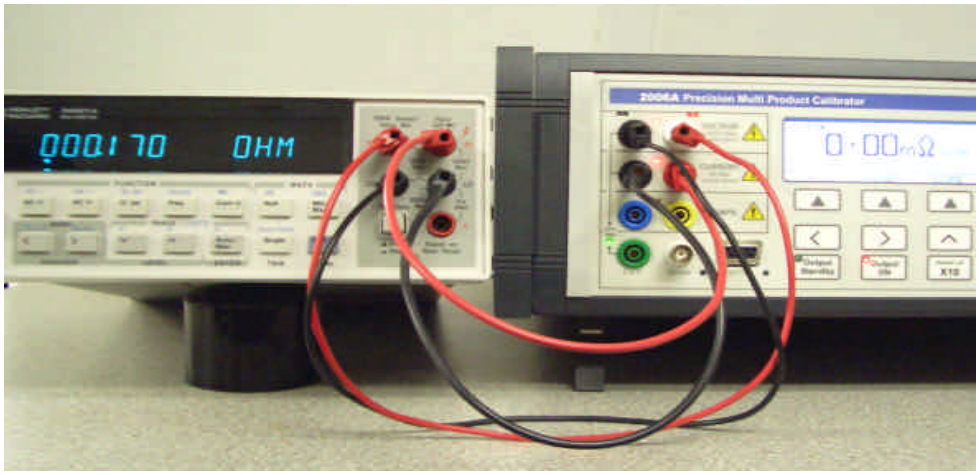
Note : The calibrator uses standard resistors of fixed decade values. The nearest available resistance to the entered value will be automatically selected. The example below selects 100milliOhms in 4 wire mode.

1) Key in the required value, e.g. ‘100’
2) Followed by the multiplier if required e.g. ‘m’
3) Press ‘Shift’ Key
4) Followed by the function ‘Ohms’
5) Then ‘Enter’ followed by ‘Output ON’

The resistance displayed will be the calibrated value held in the non volatile calibration memory for that standard. Note the values are different for two and four wire ohms. Four wire ohms is indicated on the terminal LED’s. by both the voltage and current terminal LEDs illuminating.

Nulling DMM

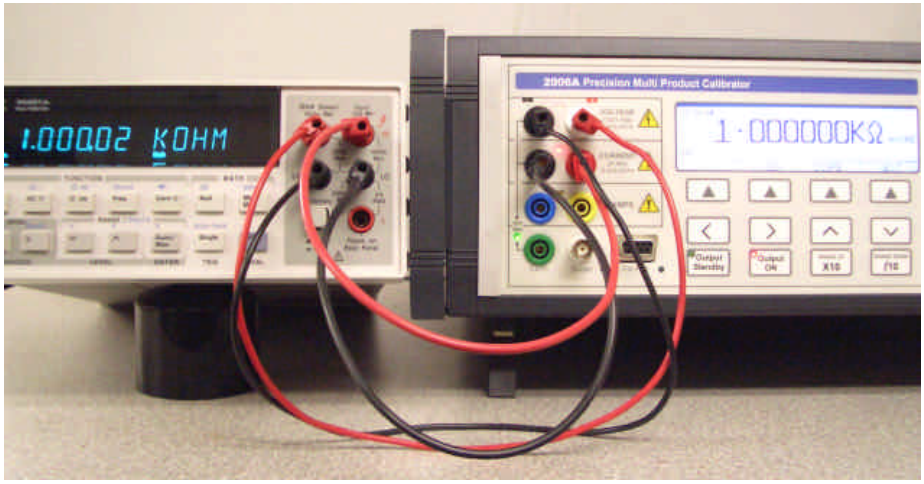
The calibrated values displayed for 4 wire ohms are the values referenced to the calibrator’s zero position. Therefore, the measuring instrument should be zeroed (Nulled) with all 4 leads (top leads sense, lower leads current) connected to the calibrator with the zero ohms selected. See diagram below.



4 wire ohms NULL connection

4 wire ohms operation

Four wire ohms is output on the voltage and current terminals as indicated by the terminal LED's. Connect the 'sense' from the DMM to the voltage output on the calibrator, and connect the 'current' from the DMM to the calibrator current terminals.



4 wire ohms connection

Setting Capacitance Output.

Note : The calibrator uses standard capacitors of fixed values. The nearest available capacitance to the entered value will be automatically selected. The example below selects 100nF.

1) Key in the required value, e.g. ‘100’
2) Followed by the multiplier if required e.g. ‘n’
3) Followed by the function ‘F’
4) Then ‘Enter’

Capacitance is output from the current terminals as indicated by the LED.
The capacitance displayed will be the calibrated value held in the non volatile calibration memory for that standard.. Note this is the value measured with a 1kHz sine wave on a LCR bridge. When measuring capacitance, Cs (series) should be selected for values up to and including 1uF and Cp (parallel) for values above.

Setting Inductance Output (Option)

Note : The calibrator uses standard inductors of fixed values. The nearest available inductance to the entered value will be automatically selected. The example below selects 10mH.

1) Key in the required value, e.g. ‘10’
2) Followed by the multiplier if required e.g. ‘m’
3) Press ‘Shift’
4) Followed by the function ‘H’
5) Then ‘Enter’

The inductance displayed will be the calibrated value held in the non volatile calibration memory for that standard.

Setting Thermocouple Output (Option).

Note : This option uses the feature connector and the thermocouple adapter unit with auto cold junction compensation (CJC). To use, first select ‘THERM’ from the soft key menu, then :

1) Key in the required temperature, e.g. ‘145.3’
2) Followed by the function °C
3) Then ‘Enter’

Use the soft keys to select thermocouple type and either auto or manual cold junction. Note that the output is only updated when a new temperature is entered.

Special Functions Available using the ‘soft’ keys

The ‘soft’ keys are positioned directly under the display and the function of these keys will change depending on the function of the calibrator. To enable scrolling down through menus ‘Next’ will take you down one level and ‘Back’ return you up one level. The functions available in these menus is detailed in the following paragraphs.

Connecting Output Negative to line earth or floating

The soft key ‘-VE GND’ in the menu switches the output from floating or connecting the negative side to Earth/ground. The ‘on’ condition is shown at the top left of the display ‘-ve Ground’ and also by the front panel LED. We recommend that the default condition of output earthed is used as this reduces noise and pick up on the output and also reduces the risk of damage to the calibrator by mis-connection.

Selecting front panel control

After the calibrator has been controlled from the interface, the front panel controls are disabled. To regain front panel control use the ‘Local’ soft key

Setting TTL Logic Frequency Output.

Note The calibrator uses a precision TCXO and divider chain for this output with exact values available only.

1) Select ‘FREQ O/P’ using the soft Keys.
2) Use up down arrow keys or the rotary control to select the required frequency.

NOTE: It is also possible from the frequency screen to select the internal / External reference if option fitted.

Setting a Mark space Ratio.

The Calibrator can produce an accurate mark space ratio output at approx. 1.23kHz at 20%, 40%, 60% and 80% intervals. These may be selected using the keyboard or the digital rotary control.

1. Select ‘PWM’ From the soft menu
2. Use up down arrow keys or the rotary control to select the required Mark Space ratio.

Selecting PT100 Resistance Output (Option)

Note : The calibrator uses standard resistors of fixed values. The nearest available temperature to the entered value will be automatically selected.

1) Select 'PRT' From the soft menu's
2) Use up down arrow keys or the rotary control to select the required temperature.

Selecting Power Calibration Output (Option)

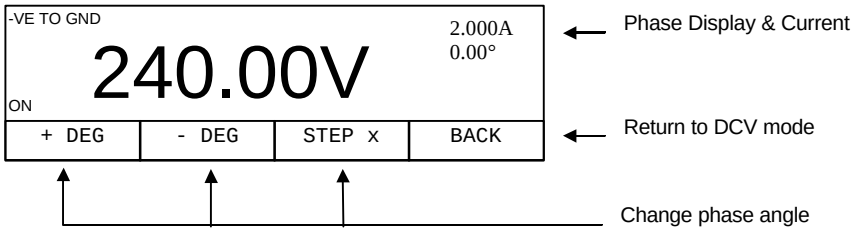
The Calibrator can simulate power by simultaneously outputting AC voltage and AC current with a phase relationship.

To configure power calibration mode :

1) Select 'POWER' function from the soft menu's
2) Enter a voltage by keying in a number followed by V, then press ENTER
3) Enter a current in amps by keying in the value, followed by A

Note : *When entering a current, pressing ENTER after the value is not required*.

4) Change phase as required by using the softkeys as shown below : Step x changes step size



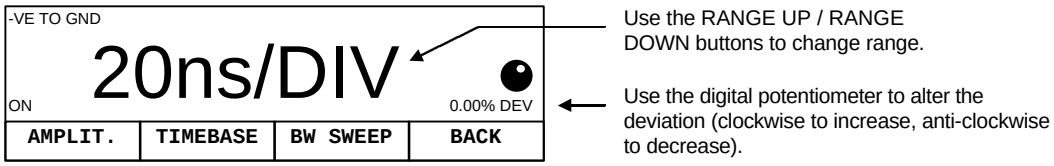
Selecting Oscilloscope Calibration Output (Option)

The Calibrator can provide Amplitude, Timebase and Bandwidth outputs for calibration of oscilloscopes.

To configure oscilloscope calibration mode :

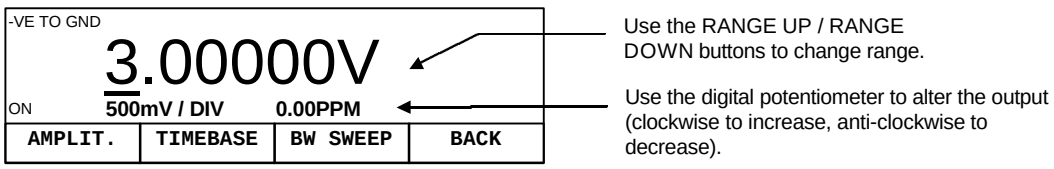
1) Select SCOPE function from the soft menu's
2) Calibrator will select TIMEBASE mode.
   Use the RANGE UP or RANGE DOWN buttons to change range
   (eg. From 20ns/DIV, pressing range up will up range to the 50ns/DIV range)

   To alter the deviation, use the up / down arrow buttons or use the digital potentiometer.



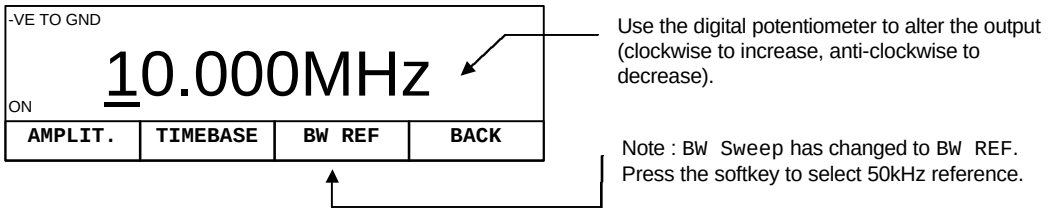
3. For AMPLITUDE output, select the AMPLIT. Mode using the softkey.
   To select a digit, use the left/right arrow buttons.
   Use the RANGE UP or RANGE DOWN buttons to change range
   (eg. From 500mV/DIV, pressing range up will up range to the 1V/DIV range)

   To change the output, use the up / down arrow buttons or use the digital potentiometer.



4. For BW SWEEP output, select the BW SWEEP. Mode using the softkey.
   To select a digit, use the left/right arrow buttons.
   To change the output, use the up / down arrow buttons or use the digital potentiometer.

   In BW Sweep Mode, the BW Sweep softkey menu item changes to BW REF.
   This allows selection of the 50kHz bandwidth reference.



Warning and output Overload indications.

The self test function of the 2000 series calibrator also continuously monitors the output of the calibrator of overload or fault conditions.
In the event of the calibrator not being able to drive the load, it will automatically trip into standby and the display will show ‘STBY !’. The ‘standby’ condition is caused by the required drive current being too high on a voltage range or the compliance voltage too high on a current range. The output can be restored by pressing ‘output on’ key after the load has been corrected.

High Voltage Timeout.

As an additional safety feature, the calibrator will automatically return to standby if left on the 200V or 1kV ranges after a set time period. This is 20 minutes for DC and AC frequencies of less than 5kHz or 3 minutes for frequencies of 5kHz and greater.

20 Amp Temperature Cut-out

The Calibrator is only intermittently rated for high current outputs. The output amplifier operating temperature is monitored by the micro controller which will shut down the output if required. The time before shut down occurs will vary depending on the set output current and the load. (See extended specifications). After cut-out, the calibrator will be set to standby with a warning message shown on the display (STBY ! !). It is safe to reselect the output at any time as the micro controller will automatically protect the output amplifier from damage.

Interface Types

Connection to the 2000 Series calibrators is achieved by the following interfaces :

■ RS232

9 Way ‘D’ type female connection

■ USB (optional)

USB connection using COM to USB conversion via a dedicated adapter

RS232 Interface

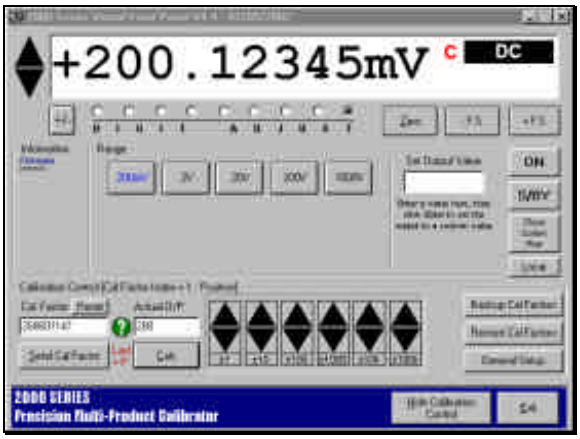
The calibrator can be fully controlled and calibrated via the bi-directional RS232 interface. The interface uses the standard 9 pin PC connector and a standard serial lead. The interface is fully optically isolated from the rest of the calibrator circuitry. Baud rate is fixed at 9600 baud, no parity and one stop bit which allows a complete output command to be sent in less than 20ms. The calibrator can send to the computer information about the output status, calibration factors, value of internal standards together with other information. The internal processor decodes the commands and returns control codes to verify the correct operation of that command.

The calibrator can be sent individual commands directly from the Windows HYPER Terminal program, any basic or high level program, the virtual front panel program (if ordered), or from the ProCal Calibration System

Configuring the COM port

To allow communication from PC based programs, these programs must be configured to the following settings :

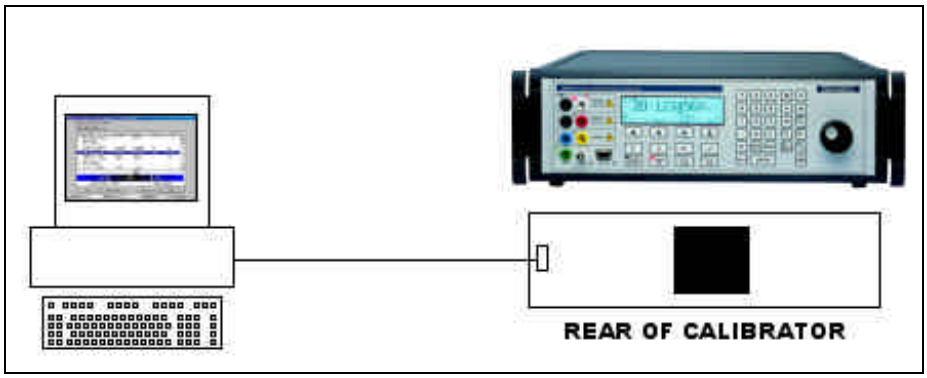
BAUD RATE : 9600
PARITY : NONE
DATA BITS : 8
STOP BITS : 1



The 2000 series Virtual Front Panel software (optional) from Transmille comes pre-configured with these settings, however if you are using another program these settings will need to be verified before proceeding to control the 2000 Series calibrators.

The RS232 connection is made using a straight-through type cable - this is supplied as standard with any 2000 Series calibrator.

DO NOT TRY TO USE A NULL MODEM TYPE CABLE AS THIS HAS PINS 2 & 3 REVERSED AND WILL NOT WORK.



Connect the RS232 Interface from the 9 Way ‘D’ type connector on the rear of the PC to the 9 Way ‘D’ type connector on the 2000 Series calibrator.

USB Interface (optional)

Universal Serial Bus

By using an RS232 to USB converter, the 2000 Series calibrators can be connected to the host PC via the USB port. This option will be provided as an additional compact unit and software driver.

The RS232 to USB converter will simulate a normal COM port (the next available free COM port number, usually COM3) - this is especially useful for newer type Laptop/Notebooks, where the traditional RS232 COM port has been replaced by one or more USB ports.

Connect the USB Interface from the USB type connector on the rear of the PC to the 9 Way ‘D’ type connector on the 2000 Series calibrator via the RS232 to USB converter.

Remote Programming

WARNING

The 2000 series calibrators can produce high voltages up to 1020V and must be programmed with due caution to prevent dangerous voltages from being output without warning to the operator.

Any programs should be extensively tested to maintain safe operation and include safeguard's such as error catchment and handling to ensure that any commands sent to the calibrator perform as expected and any that do not are safely handled to ensure user safety.

Within the 2000 series command language, response codes are included to determine the operational state of the calibrator. These response codes can also be used to determine whether a command was received correctly and in ensuring safe operation of the calibrator.

Programming Commands Overview

The 2000 series is controlled by a set of simple high level commands which can be used either individually or as part of a command sequence to setup the 2000 Series calibrator to required state.

The commands can be joined together using the / (forward slash) character.
The required terminator for the commands to be detected by the calibrator is a carriage return (ASCII character 13) and should be the last character sent on a command line

For Example :

Command1/Command2 <CR>

Where each command is represented as Commandx
(x being the command number)

and the carriage return (ASCII character 13) is represented by <CR>

RESPONSE CODES

The 2000 Series calibrators will respond to any command with a fixed code beginning with an star (*) - the codes are listed below

Response Code	Description
*0	OK
*1	ERROR IN COMMAND LINE
*2	ERROR IN RANGE COMMAND
*3	ERROR IN FREQUENCY COMMAND
*4	ERROR IN O/P COMMAND
*5	ERROR IN CAL FACTOR SENT
*6	ERROR IN CAL FACTOR COMPARE
*7	COMMAND OUT OF RANGE (A1,A2 ETC) OR PASSWORD NOT SET
*8	10A/HV TIMEOUT or OVER TEMPERATURE
*9	OUTPUT ERROR

DC Voltage Commands

Function	Range	Command
DC Voltage	200mV	R1
	2V	R2
	20V	R3
	200V	R4
	1000V	R5

Standby Mode	
Standby ON	S1
Standby OFF	S0

Output	
Set Output	O (not zero)

The DC voltage section consists of a set of range commands which are used in conjunction with the standby and output command. To enable a DC Voltage to be set and an output assigned, the following command sequence should be used :

<RANGE>/<OUTPUT>/<STANDBY CONDITION><CR>

For example, to get 2V DC with the output switched on, the command is :

R2/O2/S0<CR>

R2 = 2V Range (as detailed in the table above)

O2 = 2V Output

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

150mV DC R1/O150/S0<CR> (sets 150mV output on the 200mV range)

22V DC R3/O22/S0<CR> (sets 22V output on the 200V range)

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

AC Voltage Commands

Function	Range	Command
AC Voltage	200mV	R12
	2V	R13
	20V	R14
	200V	R15
	1000V	R16

Standby Mode	
Standby ON	S1
Standby OFF	S0

Output	
Set Output	O (not zero)

AC Frequency	
Fxxxxx	E.G. 10kHz = F10000

The AC voltage section consists of a set of range commands which are used in conjunction with the standby and output command. To enable an AC Voltage to be set and an output assigned, the following command sequence should be used :

<RANGE>/<OUTPUT>/<FREQUENCY>/<STANDBY CONDITION><CR>

For example, to get 2V @ 200Hz AC with the output switched on, the command is :

R2/O2/F200/S0<CR>

R2 = 2V Range (as detailed in the table above)

O2 = 2V Output

F200 = 200Hz Frequency

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

135mV @ 10kHz AC R1/O135/F10000/S0<CR>
(sets 135mV @ 10kHz output on the 200mV range)

255V @ 15kHz AC R3/O255/F15000/S0<CR>
(sets 255V @ 15kHz output on the 1000V range)

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

DC Current Commands

Function	Range	Command
DC Current	200uA	R6
	2mA	R7
	20mA	R8
	200mA	R9
	2A	R10
	20A	R11

Standby Mode	
Standby ON	S1
Standby OFF	S0

Output	
Set Output	O (not zero)

The DC current section consists of a set of range commands which are used in conjunction with the standby and output command. To enable a DC current to be set and an output assigned, the following command sequence should be used :

<RANGE>/<OUTPUT>/<STANDBY CONDITION><CR>

For example, to get 20mA DC with the output switched on, the command is :

R8/O20/S0<CR>

R8 = 20mA Range (as detailed in the table above)

O2 = 20mA Output

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

25mA DC R9/O25/S0<CR> (sets 25mA output on the 200mA range)

12A DC R11/O12/S0<CR> (sets 12A output on the 20A range)

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

AC Current Commands

Function	Range	Command
AC Current	200uA	R17
	2mA	R18
	20mA	R19
	200mA	R20
	2A	R21
	20A	R22

Standby Mode	
Standby ON	S1
Standby OFF	S0

Output	
Set Output	O (not zero)

AC Frequency	
Fxxxxx	E.G. 10kHz = F10000

The AC current section consists of a set of range commands which are used in conjunction with the standby and output command. To enable a AC current to be set and an output assigned, the following command sequence should be used :

<RANGE>/<OUTPUT>/<FREQUENCY>/<STANDBY CONDITION><CR>

For example, to get 20mA @ 1kHz AC with the output switched on, the command is:

R19/O20/F1000/S0<CR>

R19 = 20mA Range (as detailed in the table above)

O2 = 20mA Output

F1000 = 1kHz Frequency

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

25mA @ 1.5kHz AC **R20/O25/F1500/S0<CR>**
(sets 25mA @ 1.5kHz output on the 200mA range)

12A AC @ 300Hz **R22/O12/F300/S0<CR>**
(sets 12A @ 300Hz output on the 20A range)

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Resistance Commands

Function	Range	Command
Resistance	0 Ohms	R23
	0.1 Ohms	R24
	1 Ohms	R25
	10 Ohms	R26
	100 Ohms	R27
	1 kOhm	R28
	10 kOhms	R29
	100 kOhms	R30
	1 MOhms	R31
	10 MOhms	R32
	100 MOhms	R33
	1G Ohms	R65

Standby Mode	
Standby ON	S1
Standby OFF	S0

2 / 4 Wire Resistance	
2 Wire	I0
4 Wire	I1

The resistance section consists of a set of range commands which are used in conjunction with the 2 or 4 Wire mode and standby commands. To enable a DC resistance to be set, the following command sequence should be used :

<RANGE>/<2 OR 4 WIRE MODE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the resistance ranges are fixed ranges at decade points.

For example, to set the 1kOhm range 2-Wire output with the output switched on, the command is :

R28/I0/S0<CR>

R28 = 1KOhm Range (as detailed in the table above)

I0 = 2 Wire mode

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

1kOhm 4-Wire	**R28/I1/S0<CR>**
10Mohm 2-Wire	**R32/I0/S0<CR>**

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Capacitance Commands

Function	Range	Command
Capacitance	1nF	R34
	10nF	R35
	20nF	R36
	50nF	R37
	100nF	R38
	1uF	R39
	10uF	R40
	100uF	R41

Standby Mode	
Standby ON	S1
Standby OFF	S0

The capacitance section consists of a set of range commands which are used in conjunction with the standby command. To enable a capacitance to be set, the following command sequence should be used :

<RANGE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the capacitance ranges are fixed ranges at decade points.

For example, to set the 10nF output with the output switched on, the command is :

R35/S0<CR>

R28 = 10nF Range (as detailed in the table above)

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

50nF **R37/S0<CR>**

100uF **R41/S0<CR>**

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

TTL Frequency Commands (Option)

Function	Mode Activation Command	
TTL Frequency	R58	
	Range	Command
	1Hz	H0
	10Hz	H1
	100Hz	H2
	1kHz	H3
	10kHz	H4
	20kHz	H5
	50kHz	H6
	100kHz	H7
	1MHz	H8
	10MHz	H9

Standby Mode	
Standby ON	S1
Standby OFF	S0

The TTL frequency section consists of a mode activation command followed by a set of range commands which are used in conjunction with the standby command. To enable a TTL frequency to be set, the following command sequence should be used :

<MODE>/<RANGE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the TTL frequency are fixed outputs

For example, to set the 10kHz output with the output switched on, the command is :

R58/H4/S0<CR>

R58 = TTL Frequency Mode Activation (as detailed in the table above)

H4 = 10kHz output (as detailed in the table above)

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

1Hz R58/H0/S0<CR>

100kHz R58/H7/S0<CR>

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Pulse Width Modulation Commands (Option)

Function	Mode Activation Command	
Pulse Width Modulation	R59	
	Range	Command
	10%	H0
	20%	H1
	30%	H2
	40%	H3
	50%	H4
	60%	H5
	70%	H6
	80%	H7
	90%	H8

Standby Mode	
Standby ON	S1
Standby OFF	S0

The pulse width modulation section consists of a mode activation command followed by a set of range commands which are used in conjunction with the standby command. To enable a pulse width modulation to be set, the following command sequence should be used :

<MODE>/<RANGE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the pulse width modulation is configured for fixed outputs

For example, to set the 10% output with the output switched on, the command is :

R59/H0/S0<CR>

R59 = Pulse width modulation Mode Activation (as detailed in the table above)

H0 = 10% output (as detailed in the table above)

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

40% **R59/H3/S0<CR>**

60% **R59/H5/S0<CR>**

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Inductance Commands (Option)

Function	Range	Command
Inductance	1mH	R42
	10mH	R43
	19mH	R44
	29mH	R45
	50mH	R46
	100mH	R47
	1H	R48
	10H	R49

Standby Mode	
Standby ON	S1
Standby OFF	S0

The inductance section consists of a set of range commands which are used in conjunction with the standby command. To enable a inductance to be set, the following command sequence should be used :

<RANGE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the inductance ranges are fixed ranges at decade points.

For example, to set the 29mH output with the output switched on, the command is :

R45/S0<CR>

R45 = 29mH Range (as detailed in the table above)

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

10mH **R43/S0<CR>**

1H **R48/S0<CR>**

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

PRT Commands (Option)

Function	Range	Command
PRT Value	-100°C	R50
	0°C	R51
	30°C	R52
	60°C	R53
	100°C	R54
	200°C	R55
	300°C	R56
	400°C	R57

Standby Mode	
Standby ON	S1
Standby OFF	S0

The PRT section consists of a set of range commands which are used in conjunction with the standby command. To enable a PRT value to be set, the following command sequence should be used :

<RANGE>/<STANDBY CONDITION><CR>

The use of the output (O) command is not necessary as the PRT ranges are fixed output ranges.

For example, to set the 60°C output with the output switched on, the command is :

R53/S0<CR>

R53 = 60°C Range (as detailed in the table above)

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

200°C R55/S0<CR>

400°C R57/S0<CR>

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Thermocouple Simulation Commands (Option)

This function requires the use of the optional Thermocouple simulation adapter. This is used in conjunction with the feature connector on the 2000 Series to provide the thermocouple simulation.

Function	Mode Activation Command
Thermocouple Simulation	R60

Range	Command	Temperature Span
Type K	L1	-140°C to 1340°C
Type J	L2	-180°C to 750°C
Type T	L3	-250°C to 400°C
Type R	L4	-50°C to 1700°C
Type S	L5	-50°C to 1700°C
Type E	L6	0°C to 800°C
Type N	L7	-270°C to 1300°C
Type B	L8	0°C to 1820°C

Cold Junction	
Manual Cold Junction	K0
Auto Cold Junction	K1

Output	
Set Output	O (not zero)

Standby Mode	
Standby ON	S1
Standby OFF	S0

The thermocouple simulation function consists of the following commands :

- **Thermocouple simulation mode activation**
- **Thermocouple cold junction type**
- **Thermocouple type command**
- **Thermocouple output value**
- **Standby mode command**

To enable thermocouple simulation to be set up, the following command sequence should be used :

<MODE>/<CJC TYPE>/<THERMO TYPE>/<TEMP VALUE>/
<STANDBY CONDITION><CR>

For example, to set the following configuration :

- **AUTOMATIC COLD JUNCTION COMPENSATION**
- **TYPE R**
- **250°C**
- **Output ON**

Send the following command sequence :

R60/K1/L4/O250/S0<CR>

R60 = Thermocouple simulation mode activation
K1 = Automatic cold junction compensation (as detailed in the table above)
L4 = Type R thermocouple
O250 = 250°C output
S0 = Standby OFF (i.e. output switched ON)
<CR> = Carriage Return (ASCII character 13)

Additional examples

Type K : Auto CJC : 500°C = R60/K1/L1/O500/S0<CR>

Type K : Auto CJC : 1500°C = R60/K1/L1/O1500/S0<CR>

Type E : Manual CJC : 400°C = R60/K0/L6/O400/S0<CR>

Type N : Auto CJC : -100°C = R60/K1/L7/O-100/S0<CR>

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Miscellaneous Commands

Earth Relay (Floating or Grounded negative terminals)

Earth Relay	
J0	Earth Relay On
J1	Earth Relay Off

The earth relay command allows the negative terminals to either floating or grounded, depending on the command set. This is also indicated in the display of the calibrator by the -VE symbol (top left).

To set the negative terminals to floating, the command is :

J1<CR>

To set the negative terminals to grounded, the command is :

J0<CR>

<CR> = Carriage Return (ASCII character 13)

Display Modes

Display Commands	
!	Reverse Display Mode
b0	Set Backlight timeout to 5s
b1	Set Backlight timeout to 20 mins
b2	Set Backlight timeout to 2 hours

Sending one of the above commands allow the display mode to be changed.

! = Toggles between White on Black display or Black on White display modes

)

Oscilloscope Calibration Commands (Option)

This function requires the oscilloscope calibration option to be installed in the 2000 series calibrator - the output will appear on the BNC connector indicated by the green LED.

Amplitude

Function	Mode Activation Command	
Amplitude Mode	A1	Amplitude Mode ON
	A0	Amplitude Mode OFF (returns to DCV mode)

Range	Command
5mV/DIV	H1
10mV/DIV	H2
20mV/DIV	H3
50mV/DIV	H4
100mV/DIV	H5
200mV/DIV	H6
500mV/DIV	H7
1V/DIV	H8
2V/DIV	H9
5V/DIV	H10
10V/DIV	H11
20V/DIV	H12
50V/DIV	H13

Amplitude Waveform	
Square Wave	G0
DC	G1

The Amplitude function consists of the following commands :

- **Amplitude mode activation**
- **Amplitude range**
- **Amplitude waveform**
- **Standby mode command**

To enable an amplitude range to be set up, the following command sequence should be used :

<MODE>/<RANGE>/<WAVEFORM>/<STANDBY CONDITION><CR>

For example, to set the following configuration :

- **1V/Div**
- **Square Wave**
- **Output ON**

Send the following command sequence :

A1/H8/G0/S0<CR>

A1 = Oscilloscope amplitude mode activation

H8 = 1V/Div amplitude range

G0 = Square wave

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

100mV/Div : Square Wave = A1/H5/G0/S0<CR>

10V/Div : DC = A1/H11/G1/S0<CR>

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Timebase

Function	Mode Activation Command
Timebase Mode	R61

Range	Command
5s/DIV	H0
2s/DIV	H1
1s/DIV	H2
500ms/DIV	H3
200ms/DIV	H4
100ms/DIV	H5
50ms/DIV	H6
20ms/DIV	H7
10ms/DIV	H8
5ms/DIV	H9
2ms/DIV	H10
1ms/DIV	H11
500us/DIV	H12
200us/DIV	H13
100us/DIV	H14
50us/DIV	H15
20us/DIV	H16
10us/DIV	H17
5us/DIV	H18
2us/DIV	H19
1us/DIV	H20
500ns/DIV	H21
200ns/DIV	H22
100ns/DIV	H23
50ns/DIV	H24
20ns/DIV	H25

The Timebase function consists of the following commands :

- **Timebase mode activation**
- **Timebase range**
- **Standby mode command**

To enable a timebase range to be set up, the following command sequence should be used :

<MODE>/<RANGE>/<STANDBY CONDITION><CR>

For example, to set the following configuration :

- **1ms/Div**
- **Output ON**

Send the following command sequence :

R61/H11/S0<CR>

R61 = Oscilloscope timebase mode activation

H11 = 1ms/Div timebase range

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

1us/Div = A1/H20/S0<CR>

50ns/Div = A1/H24/S0<CR>

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Bandwidth (Levelled) Sweep

Function	Mode Activation Command
BW Sweep Mode	R62

Output	
Set Output	O (not zero)

The bandwidth function consists of the following commands :

- **Bandwidth mode activation**
- **Output value (MHz)**
- **Standby mode command**

To enable a bandwidth to be set up, the following command sequence should be used :

<MODE>/<OUTPUT VALUE>/<STANDBY CONDITION><CR>

For example, to set 400MHz output with the output switched on, the command is :

R62/O400/S0<CR>

R62 = Oscilloscope Bandwidth mode activation

O400 = 400MHZ output

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional examples

50MHz = R62/O50/S0<CR>

600MHz = R62/O600/S0<CR>

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Bandwidth 50kHz Reference

Function	Mode Activation Command
BW Ref (50kHz)	R63

The bandwidth 50kHz reference function consists of the following commands:

- Bandwidth 50kHz mode activation
- Standby mode command

To select the 50kHz reference to be selected, the following command sequence should be used :

<MODE>/<STANDBY CONDITION><CR>

R63/S0<CR>

R63 = Oscilloscope Bandwidth 50kHz reference mode activation

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Power Calibration Commands (Option)

This function requires the power calibration option to be installed in the 2000 series calibrator - the output will appear on the voltage and low current terminals and be indicated by the combined illumination of the voltage and low current terminal LEDs.

UNDERSTANDING POWER

The equations below explain the relationship between Watts, Current, Voltage & Phase Angle.

Active Power :	**Watts = Voltage x Current x Cosine 'Phase angle'**
Apparent Power :	**VA = Volts x Current**
Power Factor :	**PF = Active Power / Apparent Power**
Phase Angle :	**F = Angle of AC Current shift from Voltage**

Function	Mode Activation Command	
Power Mode	B1	Power Mode ON
	B0	Power Mode OFF (returns to DCV mode)

Voltage Setup	
Voltage output (volts)	O (not zero)

Current Setup	
Current output (amps)	C

Phase Setup	
Phase setting (degrees)	M

The power function consists of the following commands :

- Power mode activation
- Voltage output setting
- Current output setting
- Phase relationship in degrees
- Standby mode command

To enable a power output to be set up, the following command sequence should be used :

<MODE>/<VOLTAGE>/<CURRENT>/<PHASE>/<STANDBY CONDITION><CR>

For example, to set the following configuration :

- **200V**
- **2A**
- **90° Phase**
- **Output ON**

Send the following command sequence :

B1/O200/C2/M90/S0<CR>

B1 = Power mode activation

O200 = 200V voltage output

C2 = 2A current output

M90 = 90° phase relationship

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

Additional example

B1/O500/C10/M180/S0<CR>

B1 = Power mode activation

O500 = 500V voltage output

C10 = 10A current output

M180 = 90° phase relationship

S0 = Standby OFF (i.e. output switched ON)

<CR> = Carriage Return (ASCII character 13)

If a command includes a value which cannot be set due to, for example, the value being higher than the range maximum, the calibrator will reject the command and stay set as it is (the calibrator will also beep to signify a rejected command)

The calibrator will respond to the commands sent with the response codes as detailed at the beginning of this section. These codes can be used to ensure that hazardous output conditions are clearly indicated to the operator and to maintain control of these outputs. This allows the calibrator to be returned to a safe state once the testing required has been completed (eg. Setting the calibrator back to standby once a test is complete and ensuring this has been successfully achieved and no hazardous outputs remain on the terminals).

This functionality is employed within the ProCal calibration software from Transmille to allow safe operation of the calibrator and to ensure the calibrator is returned to a safe state in between test points and at the completion of a test sequence.

Using the optional virtual front panel software from Transmille, additional functionality can be achieved from the power function including energy tests in kWh.

Technical Description

General

The series 2000 calibrators use the latest in reference, resistor and processor technology designed to minimise cost and size yet maximise performance. The micro processor controls and monitors all functions of the calibrator. Calibration constants are held in non volatile memory allowing the calibration to be performed without removing the covers. There are no internal adjustments required in normal service.

⚠ *Warning* risk of shock.

The line power cord must be disconnected before opening the instrument

The circuitry comprises of six printed circuit boards :

- Processor board
- Power supply and output switching board
- Main analogue amplifier and feedback board
- Reference and D/A board.
- Front Panel Display and keyboard control
- Mother PCB.

Construction

The calibrator is constructed in a 3U 19” case with fan cooling used for the high voltage and high current amplifiers. The calibrator is constructed is modular to allow easy of servicing. The rear panel assembly comprises of the mains inlet and transformer, 20 Amp power output amplifier and fan.

The main analogue PCB slides in from the rear in slots in the inside of the case and plugs into the mother board which is mounted just behind the front panel. The precision reference and D/A converter plugs into the analogue PCB.

The Power supply and switching PCB plugs in to the mother board just above the analogue PCB. The Processor board plugs into this PCB.

Internal Fuses.

In normal operation these fuses should never need to be replaced. Only under fault conditions will they require changing.

NOTE : To access these fuses it is necessary to dismantle the case which should only be carried out by an engineer. See removing top cover.

⚠ *Warning* risk of shock.

The line power cord must be disconnected before opening the instrument.

Internal fuses include :

F1 : ± 15V Supply A/S 5Amp 20mm

F2 : ± 15V Supply A/S 5Amp 20mm

F3 : ± 35V Supply A/S 1Amp 20mm

F4 : ± 35V Supply A/S 1Amp 20mm

Opening The Case

Warning risk of shock.

The line power cord must be disconnected before opening the instrument.

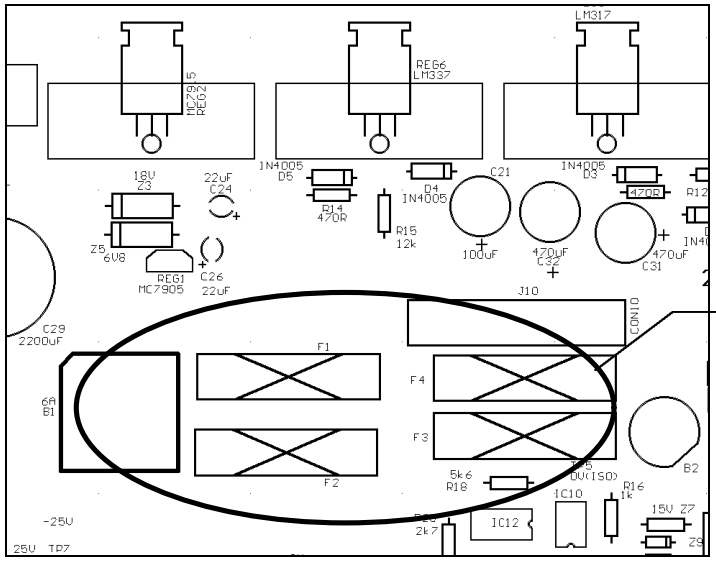
To gain access to the inside first remove the rear panel by removing 4 screw located at each corner of the rear panel. Then carefully draw the rear panel straight back away from the instrument. Note the back panel assemble is heavy with the weight of the mains transformer etc. There are cable assemblies running from the rear panel sub assemble to PCB inside, these cables can be unplugged if required.

Important : Great care must be taken not to spring apart the side of the instrument as this will allow the internal PCB to drop out of the guides in the sides.
It is suggested that steps are taken to ensure this does not occur.

Once the rear panel is removed the top or bottom cover can, if required, slide out allowing full access.

Access to Internal Fuses

After removing the rear panel and top panel (see above) the metal screening cover of the top PCB must be removed. The fuses will then be clearly visible (see layout diagram below).



Fuses F1 to F4

PCB Removal
(Not required for access to internal fuses)

The lower main analogue amplifier and feedback board can now be pulled back and removed, this board is held in place by the rear panel when the case is assembled. To remove the power supply and output switching board the front panel must first be removed to gain access to the locating bolt which must first be removed before the PCB can be withdrawn

Power supply and output switching board

On this board is the power supply for the calibrator which is a linear design having the inherent advantage of being low in noise. Supply voltages are ± 5 Volts, ±15 Volts, ±35 Volts and unregulated ±9 Volts at 20Amps.
The resistance, capacitance and inductance standard also on this PCB which are selected by high performance relays. The resistance outputs can be selected as 4 wire from the program if selected.

Processor Board

Plugs into the Power supply and output switching board and controls all functions within the calibrator with the exception of the high voltage safety cut-out. The processor board is a complete working board containing RAM, PROM, Clock, Cal Ram, I/O and RS232. The processor also applies all calibration factors held in RAM. Cal Factors are stored twice to prevent errors. The processor runs a self test to detect malfunction and overloads.

Warning

Removal of the processor board may corrupt the calibration factors stored.

Main analogue amplifier and feedback board

This board generates AC and DC voltages and currents which are derived from the D/A boards 0 to 10Volt reference. This reference voltage is compared against the output after it is scaled from either a precision resistive divider of switchable gain for voltage ranges or from a set of precision current shunts for the current ranges. The error signal is amplified to produce the output. To maximise stability there are no adjustment components in the attenuator circuits, all calibration uses correction calibration factors stored in the non-volatile memory of the processor.

AC outputs are produced using digital signal processing to produce an accurate stable low distortion sine wave. The amplitude of this waveform is controlled by the difference signal from the DC Reference from the D/A and the DC output from a high performance true RMS converter.

High Voltage Amplifier and Output

All outputs above 20 volts use this amplifier. A high power 150W IC amplifier running from 25 volt supplies with thermal and output overload protection output is switched into either a high frequency ferrite transformers or a LF iron laminate transformer depending on the frequency to produce all high voltage outputs. For DC outputs the signal is first chopped to provide an AC square wave at approx. 10kHz before being fed to the Power amp. The output from these transformers is rectified to produce a DC output or used directly for AC. A safety cut out circuit in the secondary windings of the transformers will disconnect the input to the amplifier in the event of excessive output current. This cut out is independent of processor control and once tripped will remain in an off state until reset by the processor. All high voltage switching is performed by relays. To maximise contact life relays are only operated when the amplifier is in standby.

Current Transconductance Amplifier

A low voltage high current amplifier is used for current outputs powered from the unregulated 9 volt 20 amp supply. A pair of high power transistors on the heat sink before the fan are the final output stage of this amplifier. The output from this stage is switched to either the low current output terminals or the 20 amp output terminals.

Output Currents Sensing & Shunts

Six high stability current shunts with low temperature coefficients from 4kOhms to 0.01ohm provide feedback for the current ranges. The lower values are switched using a four wire method for optimum accuracy, there is no provision for the adjustment of the value of the shunts, calibration is performed by the calibration factors. The 20Amp range shunt is mounted on the heat sink assembly on the rear panel.

Output from the shunts is fed to a low drift differential amplifier which is used to reference the current shunts output to system ground. Analogue switches set the transconductance amplifier to standby when range changing and when on voltage ranges. This prevents high current spikes being produced during range changing.

Calibration Tutorial

Getting the best out of the calibrator.

The 2000 series are very accurate calibrators producing a very wide range of output signals. To make the best possible use of the range of outputs and to eliminate errors this section details some common sources of errors and offers some techniques to reduce them.

Thermally generated EMF voltage errors.

At every connection in a measuring system different metals come into contact with each other, each junction forms a thermocouple. The voltages generated at these junctions are called thermoelectric voltages and are dependent on the type of metals in contact and the difference in temperature.

This effect, of course, is used to measure temperature with thermocouples, however this effect will cause large errors in low voltage measurements, as thermocouple voltages for some metals can be in the millivolt region. Copper is best but many standard test plugs are made from nickel plated brass and should not be used.

Gold plated copper plugs are available for low level work. If the test lead has been in use on a high current range this will have made the plug warm, which will also increase the error.

Power line and low frequency Pick up and noise

These effects are most noticeable when using high resistance (100kohms and above) and low current. All constant current sources have a very high output impedance which will pick up noise just like the high value resistance . To reduce pickup, use screened leads and try earthing the low side of the calibrator output.

For high value resistance it is essential that the cables insulation resistance will not effect the accuracy. Most PVC cables will only have insulation resistance of around 10GΩ, this will give a error of 1% on the 100mohm output.

Low AC Current is particularly difficult as the capacitance of screened leads will shunt some of the current away.

Calibration and Maintenance

WARNING

The information in this section is intended only for qualified personnel. The user must at all times be adequately protected from electric shock.

General

The 2000 series calibrators maintenance requirements are listed below. Please note that the calibrator does not require any regular internal servicing or adjustment.

1) Electrical Safety Checks on Line power lead and case

2) Cleaning of the Fan

3) Cleaning the external case

4) Calibration and operation verifications

Electrical Safety Tests

These can be carried out as frequently as required. Earth bond and insulation can be tested as a class 1 standard. Flash testing is not recommended due to the possibility of damage to internal components. .

Cleaning of the Fan

WARNING : Risk of Shock

Ensure calibrator is disconnected from line power before proceeding.

1) Remove the press fit fan guard by using a wedge if required.
2) Clean Fan with Brush and a vacuum cleaner
3) Refit Fan Guard

Cleaning the external case

Use a damp cloth with a mild water based cleaner for the outside case and front panel. Do not use alcohol based cleaners or solvents and do not spill or allow liquid to enter the case.

CALIBRATION

To adjust the 2000 Series calibrator the calibrator needs to be connected to a computer via the RS232 Serial interface. Calibration constants stored within the calibrator can then be adjusted using the 2000 Series Virtual Front Panel software. To prevent unauthorised use of this software, a password is required before access is granted. Adjustment can be completed without disassembly of the calibrator.

WARNING : Risk of Shock

The calibrator cannot be adjusted from the front panel.

Each function e.g. DC voltage, AC Current, Resistance etc. has several ranges. Each range has one or more calibration constants. See table below.

The 2000 Series Font Panel allows any calibration constant to be adjusted independently of any other, therefore it is possible to adjust a single range without needing to adjust any other points.
Altering the calibration constants directly changes the calibrators output. Adjusting the calibrator simply involves changing the constant until the output reads correctly.

DC Voltage	**:**	**Zero : + Full Scale : - Full Scale**
AC Voltage	**:**	**Zero : Full Scale @ 206Hz : Frequency Response**
DC Current	**:**	**Zero : + Full Scale : - Full Scale**
AC Current	**:**	**Zero : Full Scale @ 206Hz : Frequency Response**
Resistance	**:**	**2 Wire & 4 Wire value for each resistance**
Capacitance	**:**	**Value for each Capacitor**
Inductance	**:**	**Value for each Inductor**

Linearity is inherent within the design of the D to A in the calibrator and does not require adjustment.

EQUIPMENT REQUIRED

- **Precision 8 ½ Digital Multimeter.**

E.g. Hewlett Packard HP3458A or Wavetek 1281.

- **Capacitance / Inductance bridge.**

E.g. Wayne Kerr B905.

- **Frequency counter.**
- **Shunt resistors for measurement of 2A and 20A.**
- **Low thermal test leads with 4mm plug terminations.**
- **Shrouded test leads suitable for 1000V AC measurements.**
- **1m BNC to BNC cable with 2off BNC to 4mm adapters.**
- **Computer with RS232 interface running Transmille virtual front panel program.**
- **RS232 cable.**

ADJUSTMENT OVERVIEW

1) Install virtual front panel software.

2) Connect 20xx to computer RS232 port

3) Allow all equipment to stabilise for at least 4 hours.

4) Run virtual front panel program.

5) Select range & output to be adjusted using the virtual front panel program.

6) Enter calibration control mode. (Password required).

7) Press 'Start' to enable adjustment. A 'C' will appear on the calibrator display.

8) Adjust calibration constant until the output of the calibrator is correct. The constants for each range must be adjusted in the correct sequence. See following pages for details.

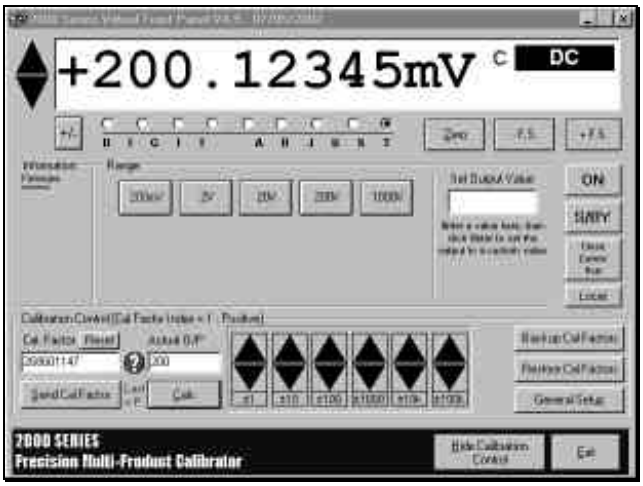
9) Press the store button to save the constant

(Changing range will also store the constant.)

10) Press the 'abort' button to abandon calibration of the range being adjusted.

11) Select next range to be adjusted.

12) Close calibration control panel and exit virtual front panel program



Comprehensive details of the calibration sequence is contained in the 2000 Series Service Manual.

Guarantee and service

Transmille Ltd. guarantees this instrument to be free from defects under normal use and service for a period of 3 years from purchase. This guarantee applies only to the original purchaser and does not cover fuses, or any instrument which, in Transmille's opinion, has been modified, misused or subjected to abnormal handling or operating conditions.

Transmille's obligation under this guarantee is limited to replacement or repair of an instrument which is returned to Transmille within the warranty period. If Transmille determines that the fault has been caused by the purchaser, Transmille will contact the purchaser before proceeding with any repair.

To obtain repair under this guarantee the purchaser must send the instrument in its original packaging (carriage prepaid) and a description of the fault to Transmille at the address shown below. The instrument will be repaired at the factory and returned to the purchaser, carriage prepaid.

Note :
TRANSMILLE ASSUMES NO RESPONSIBILITY FOR DAMAGE IN TRANSIT

THIS GUARANTEE IS THE PURCHASER'S SOLE AND EXCLUSIVE GUARANTEE AND IS IN LEIU OF ANY OTHER GUARANTEE, EXPRESSED OR IMPLIED. TRANSMILLE SHALL NOT BE LIABLE FOR ANY INCIDENTAL, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OR LOSS.

Transmille Ltd.
Unit 4, Select Business Centre
Lodge Road
Staplehurst
Kent
TN12 0QW
United Kingdom

Tel : +44 0 1580 890700
Fax : +44 0 1580 890711

EMail : sales@transmille.com
Web : www.transmille.com

Transmille Ltd.
Unit 4, Select Business Centre
Lodge Road
Staplehurst
Kent.
TN12 0QW
United Kingdom.

Tel : +44 0 1580 890700
Fax : +44 0 1580 890711

Email : sales@transmille.com
Web : www.transmille.com

2000 Series Fax Back Form

Your 2000 Series Multi-Product Calibrator is fitted with a *security system* which requires a *security code* to be entered to allow continued operation of the unit beyond the 65 Day evaluation period.

Please complete the following details :

Company Name : _____

Contact Name : _____

Address : _____

_____

_____

_____

Country : _____

Tel. : _____

Fax : _____

Instrument Model : **2000 Series Multi-Product Calibrator**

Serial Number : _____

Please Fax This Form To : +44 (0) 1580 890700

On receipt of this fax Transmille will, on receipt of payment for the calibrator, send details of the security code with details on how to enter this code.

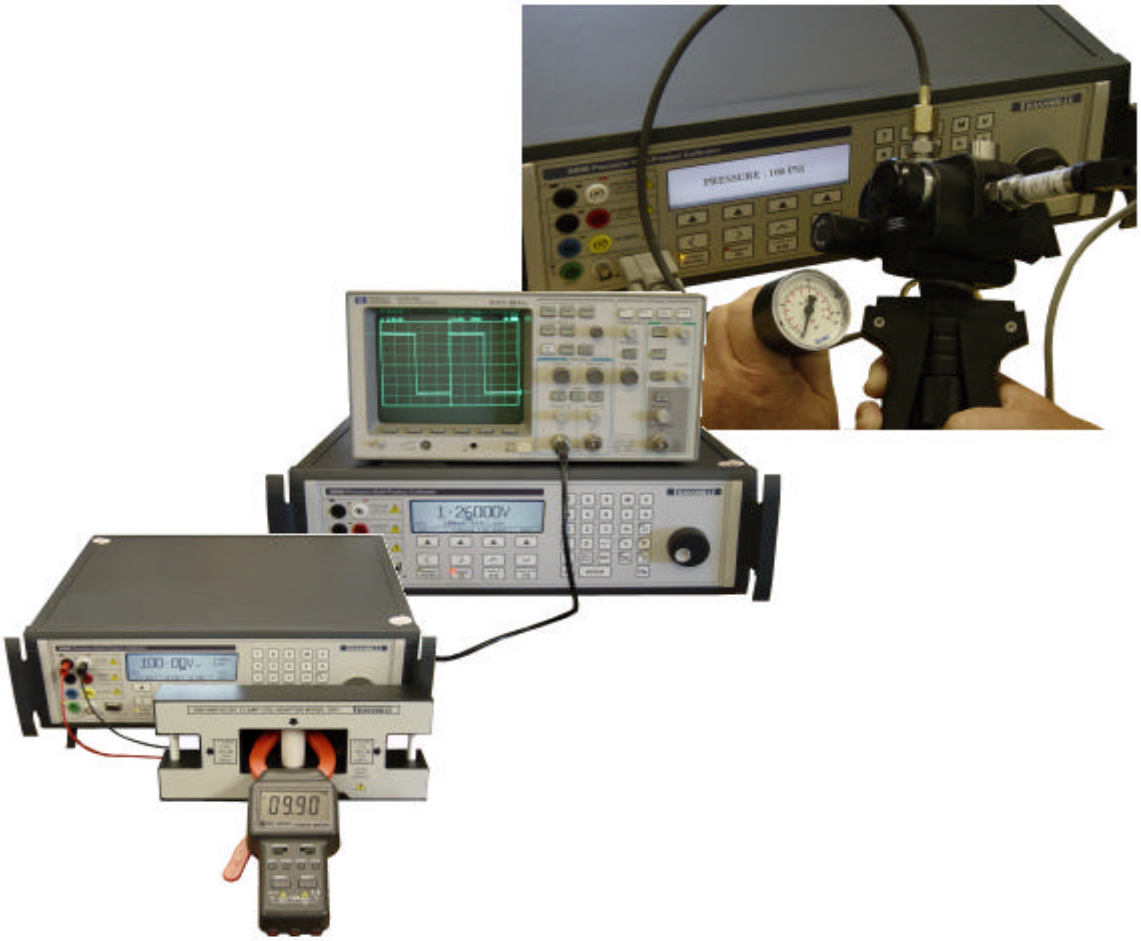
2000 Series

Precision Multi Product Calibrator

Operation Manual
Appendix A

2006A MULTI-PRODUCT CALIBRATOR

5ppm LABORATORY STANDARD



EXTENDED SPECIFICATIONS

TRANSMILLE LTD., UNIT 4 SELECT BUSINESS CENTRE, LODGE ROAD, STAPLEHURST, KENT. TN12 0QW. UK.
www.transmille.com : sales@transmille.com : Tel : +44 (0) 1580 890700 : Fax : +44 (0) 1580 890711

DECLARATION OF CONFORMITY CE

Manufacturer's Name: **Transmille Ltd.**
Manufacturer's Address: **Unit 4, Select Business Centre**
Lodge Road
Staplehurst
TN12 0QW

Declares, that the product

Product Name: **Multi-product Calibrator**
Model Number: **2050 / 2041A / 2006A**
Product Options: **This declaration covers all options of the above product(s)**

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/73EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly

Conforms with the following product standards:

EMC

Standard	**Limit**
IEC616326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998 EN55011:1991	
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995 Group 1Class A	
IEC 61000-4-3:1995 / EN 61000-4-3:1995	***4kV CD, 8kV AD***
IEC 61000-4-4:1995 / EN 61000-4-4:1995	***3 V/m, 80-1000 MHz***
IEC 61000-4-5:1995 / EN 61000-4-5:1995	***0.5kV signal lines, 1kV power lines***
IEC 61000-4-6:1996 / EN 61000-4-6:1996	***0.5kV line-line, 1kV line-ground***
IEC 61000-4-11:1994 / EN 61000-4-11:1994	***3V, 0.15-80 MHz I cycle, 100%***
	Dips: 30% 10ms; 60% 100ms
	Interrupt > 95%@5000ms

SAFETY

IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995

12/12/2001

Revision No: 1.1
Date :12/12/2001

Managing Director

2006A General Specifications

TRANSMILLE
Solutions In Calibration

Warm Up Time	Double the time since last used up to 20 minutes maximum	
Standard Interfaces	RS232	
Optional Interfaces	GPIB (IEEE-488) : USB (Universal Serial Bus)	
Temperature Performance	Storage : -5°C to +60°C Operation : 0°C to +50°C	
Relative Humidity	Operation : <80% to 30°C, <70% to 40°C, <40% to 50°C Storage : <95%, non-condensing	
Altitude	Operation : 3000m (10,000ft) Maximum Transit : 12000m (40,000ft) Maximum	
EMC & Safety	The calibrator line input plug must be earthed See D.O.C for full details	
Line Power	Line Voltage Selectable : 110V / 230V Line Frequency : 50Hz to 60Hz Line Voltage Variation : -6% +10%	
Power Consumption	28 Watts (Standby)	200 Watts (Maximum)
Low Analogue Isolation	100V	
Connections	Voltage / 2 Wire Resistance Low Current (<=2A) High current (>2A) Earth Connection Oscilloscope Functions Feature (Ext. Pod) RS232 Interface	1x Black : 1x White 4mm Safety sockets 1x Black : 1x Red 4mm Safety sockets 1x Blue : 1x Yellow 4mm Safety sockets 1x Green 4mm Safety Socket 1x BNC terminal 1x Female 'D' type socket 1x Female 'D' type socket
RS232 Settings	Baud Rate Parity Data Bits Stop Bits	9600 None 8 1
Display Information	Type Viewing Area Resolution Backlight Type Brightness	Backlit Black on white film STN type 124.3mm * 34mm 256 * 94 dots Cold fluorescent lamp 70 to 90 cd/m^2
Indicators	Voltage / Current / High Current Negative to ground Oscilloscope Feature Connector (Ext. Pod)	Red LED (between terminals) Green LED (left of Earth terminal) Green LED (right of BNC Connector) Green LED (right of 'D' type connector)
Keyboard	Membrane type with tactile feedback	
Fuses	Mains Inlet	3A A/S (240 Volt) 5A A/S (110 Volt operation)
Isolation	Outputs are opto-isolated from mains earth and the RS-232 interface Maximum common mode voltage between earth and the low terminals 30 Volts ac/dc.	
	Calibrator in Shipping Box Calibrator in Soft Carry Case Calibrator in Hard Transit case	58cm x 56cm x 37cm : 15kgs 49cm x 50cm x 19cm : 13.5kgs 55cm x 56cm x 26cm : 22kgs
Warranty Period	3 Years (Parts & Labour)	
Recommended Service Interval	1 Year	
Supplied Connections	1x Serial Interface Connection	
Optional Lead Set Kit	1x Voltage connection leadset 1x Low Current connection leadset 1x High current connection leadset 1x AC connection leadset	
Mounting Kit (optional)	3U rack mount kit	
Case Colour	Matt Dark Grey (RAL7016)	

Due to continuous development specifications may be subject to change.

2006A DC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications

Range	Resolution	Max. Burden Current[1]	Output Resistance	Overload Protection
0-202mV	10nV	1mA[2]	50 Ohms	20 V
0.2-2.02V	100nV	50mA	0.2 Ohms	150V
2-20.2V	1uV	50mA	0.2 Ohms	150V
20-202V	10uV	10mA[3]	0.5 Ohms	1200V
200-1020V	100uV	10mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications

Range	24 Hour Stability		Noise[4]	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
	ppm Set	Rng	1Hz to 10Hz	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng
0-202mV	2	+ 1	60nV	6.4	+ 2	7.2	+ 2	8	+ 2	11.2	+ 2.8
0.2-2.02V	2	+ 1	280nV	5.6	+ 2	6.3	+ 2	7	+ 2	9.8	+ 2.8
2-20.2V	2	+ 1	2.5uV	4	+ 2	4.5	+ 2	5	+ 2	7	+ 2.8
20-202V	3.5	+ 1	50.7uV	4.8	+ 2	5.4	+ 2	6	+ 2	8.4	+ 2.8
200-1020V	5	+ 2	280uV	6.4	+ 4	7.2	+ 4	8	+ 4	11.2	+ 5.6

All specifications allow 2uV for lead and thermal emf effects

Notes

Note 1 : Current limited by self resetting thermal fuse. Shown as max. current for 10 seconds/continuous operating current

Note 2 : Limited by 50 Ohm output impedance

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

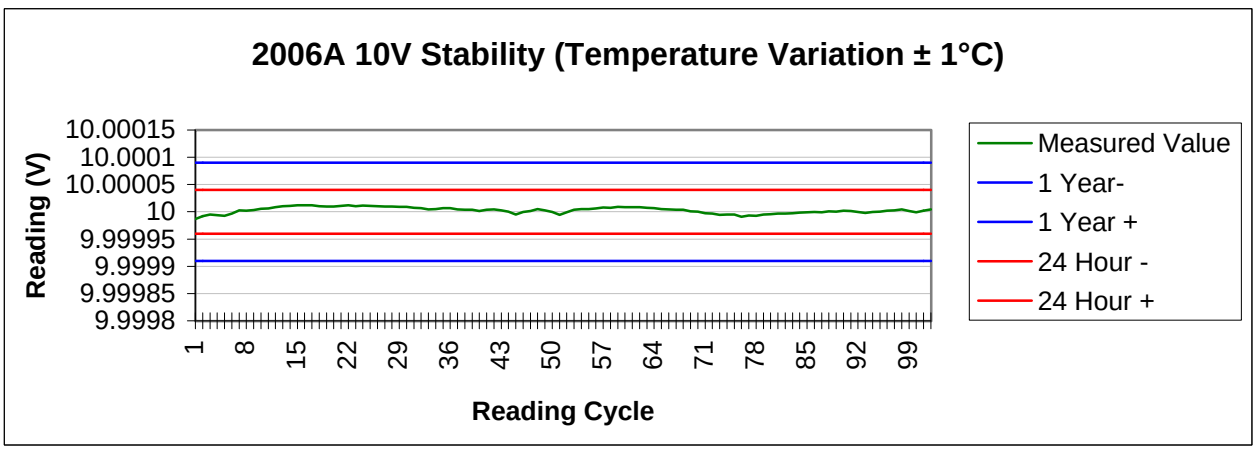
Note 4 : Typical RMS noise figures at 50% of full scale.

High Voltage Safety

High voltage output is ramped to allow instruments to auto range
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage
Standby is automatically selected for high voltage (>20V) after 5 minutes on the same setting
High voltage (> 20V) output is indicated to user through an audible warning beep
An external high voltage output/standby control switch is available as an option

2 Wire output / Remote sensing not available
Isolation : Floating or grounded selection available as standard
Maximum floating voltage : 100V

Specifications apply between 18°C and 25°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.
Due to continuous development specifications may be subject to change.



2006A DC Current Specifications

General Specifications

Range	Resolution	Max. Inductive Load	Compliance Voltage	Overload Protection
0-202uA	10pA	10mH	4.2 Volts	150V
0.2-2.02mA	100pA	10mH	4.2 Volts	150V
2-20.2mA	1nA	10mH	4.2 Volts	150V
20-202mA	10nA	10mH	4.2 Volts	150V
0.2-2.02A	100nA	10mH	4.2 Volts	150V
2-20.2A	1uA	10mH	3.9 Volts	150V

Accuracy Relative to Calibration Standards Specifications

Range	Noise [1]	90 day Rel			180 Day Rel			1 year Rel			2 year Rel		
	0.1-1Hz	ppm set		Rng	ppm set		Rng	ppm set		Rng	ppm set		Rng
0-202uA	180pA	36	+	10	40.5	+	10	45	+	10	63	+	14
0.2-2.02mA	500pA	28	+	5	31.5	+	5	35	+	5	49	+	7
2-20.2mA	4nA	16	+	3	18	+	3	20	+	3	28	+	4.2
20-202mA	40nA	20	+	4	22.5	+	4	25	+	4	35	+	5.6
0.2-2.02A	1uA	68	+	12	76.5	+	12	85	+	12	119	+	16.8
2-20.2A	20uA	136	+	20	153	+	20	170	+	20	238	+	28

All specifications +/- 4nA.

Power & temperature sensor on 20A range - microprocessor monitors & protects from overheating
Duty Cycle into 0 Ohms = 90 seconds ON, 5 minutes OFF[2]

Notes

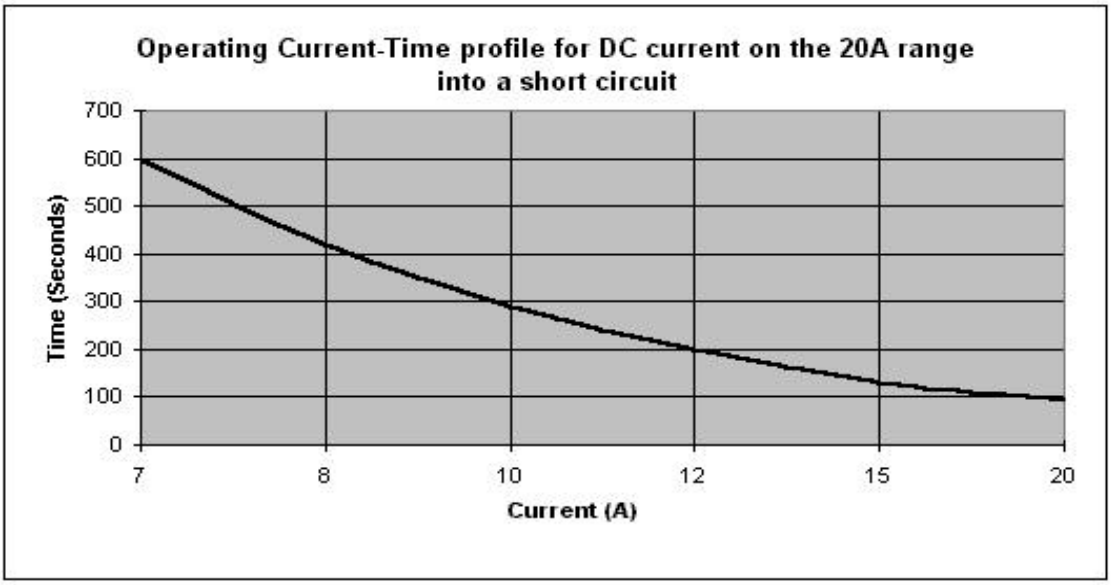
Note 1 : Typical RMS noise figures at 50% of full scale.

Note 2 : Higher resistance loads allow a longer ON period

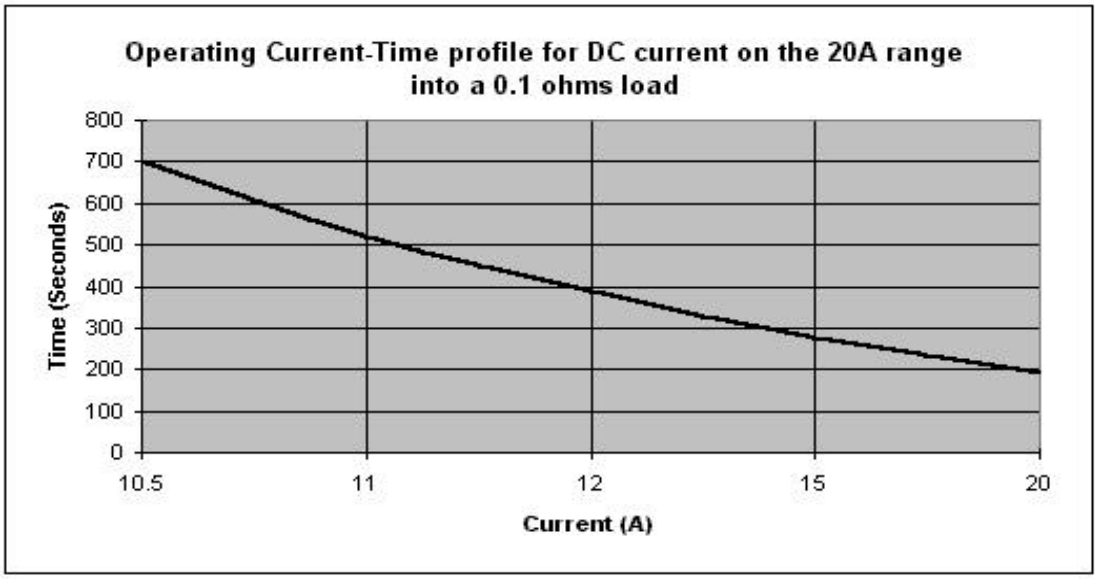
Specifications apply between 18°C and 25°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Graph 1* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 2* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2006A AC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications

Range	Frequency	Resolution	Max. Burden Current[1]	Output Resistance	Overload Protection
0-202mV	10Hz to 30Hz	100nV	1mA[2]	50 Ohms	20 V
	30Hz to 1kHz	100nV	1mA[2]	50 Ohms	20 V
	1kHz to 10kHz	100nV	1mA[2]	50 Ohms	20 V
	10kHz to 60kHz	100nV	1mA[2]	50 Ohms	20 V
0.2-2.02V	10Hz to 30Hz	1uV	50mA	0.2Ohms	1200V
	30Hz to 1kHz	1uV	50mA	0.2 Ohms	1200V
	1kHz to 20kHz	1uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	1uV	50mA	0.2 Ohms	1200V
2-20.2V	10Hz to 30Hz	10uV	50mA	0.2 Ohms	1200V
	30Hz to 1kHz	10uV	50mA	0.2 Ohms	1200V
	1kHz to 20kHz	10uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	10uV	50mA	0.2 Ohms	1200V
20-202V	30Hz to 1kHz	100uV	10mA[3]	0.5 Ohms	1200V
	1kHz to 10kHz	100uV	5mA[3]	0.5 Ohms	1200V
	10kHz to 40kHz	100uV	2mA[3]	0.5 Ohms	1200V
200-1020V	30Hz to 1kHz	1mV	10mA[3]	0.7 Ohms	1200V
	1kHz to 10kHz	1mV	2mA[3]	0.7 Ohms	1200V
	10kHz to 40kHz	1mV	2mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			ppm set	Rng	ppm set	Rng	ppm set	Rng	ppm set	Rng
0-202mV	10Hz to 30Hz	1Hz	640 +	100	720 +	100	800 +	100	1120 +	140
	30Hz to 1kHz	1Hz	96 +	80	108 +	80	120 +	80	168 +	112
	1kHz to 10kHz	1Hz	160 +	80	180 +	80	200 +	80	280 +	112
	10kHz to 60kHz	1Hz	280 +	100	315 +	100	350 +	100	490 +	140
0.2-2.02V	10Hz to 30Hz	1Hz	520 +	80	585 +	80	650 +	80	910 +	112
	30Hz to 1kHz	1Hz	80 +	50	90 +	50	100 +	50	140 +	70
	1kHz to 20kHz	1Hz	168 +	80	189 +	80	210 +	80	294 +	112
	20kHz to 100kHz	1Hz	480 +	190	540 +	190	600 +	190	840 +	266
2-20.2V	10Hz to 30Hz	1Hz	400 +	80	450 +	80	500 +	80	700 +	112
	30Hz to 1kHz	1Hz	80 +	50	90 +	50	100 +	50	140 +	70
	1kHz to 20kHz	1Hz	168 +	80	189 +	80	210 +	80	294 +	112
	20kHz to 100kHz	1Hz	480 +	190	540 +	190	600 +	190	840 +	266
20-202V	30Hz to 1kHz	1Hz	80 +	60	90 +	60	100 +	60	140 +	84
	1kHz to 10kHz	1Hz	160 +	80	180 +	80	200 +	80	280 +	112
	10kHz to 40kHz	1Hz	240 +	150	270 +	150	300 +	150	420 +	210
200-1020V	30Hz to 1kHz	1Hz	80 +	100	90 +	100	100 +	100	140 +	140
	1kHz to 10kHz	1Hz	160 +	120	180 +	120	200 +	120	280 +	168
	10kHz to 40kHz	1Hz	280 +	250	315 +	250	350 +	250	490 +	350

All specifications +/- 20uV. All specifications apply from 10% of full scale.

Notes

Note 1 : Current limited by self resetting thermal fuse. Shown as max. current for 10 seconds/continuous operating current

Note 2 : Limited by 50 Ohm output impedance

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

2 Wire output / Remote sensing not available Maximum floating voltage : 100V Isolation : Floating or grounded selection available as standard

Specifications apply between 18°C and 25°C. Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

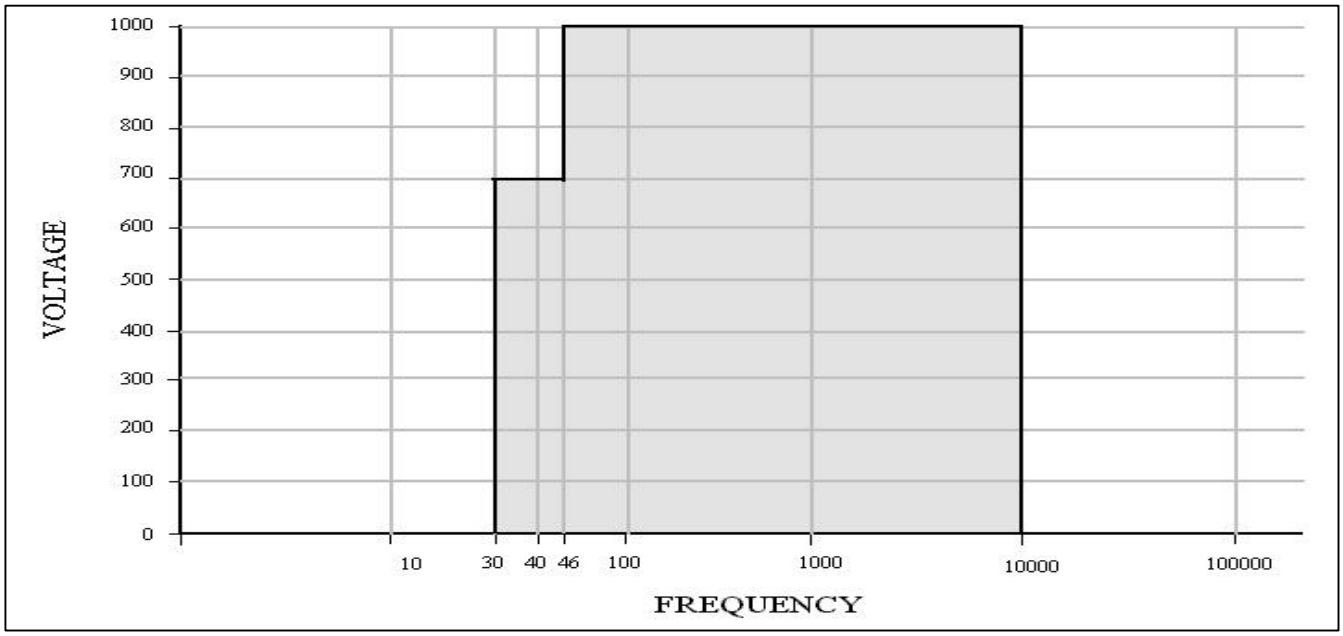
2006A AC Voltage Specifications

High Voltage Safety
High voltage output is ramped to allow instruments under test to auto-range.
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage.
Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting for frequencies up 5kHz or 3 mins for frequencies above 5kHz. See graph 4.
High voltage (> 20V) output is indicated to user through an audible warning beep.
An external high voltage output/standby control switch is available as an option.

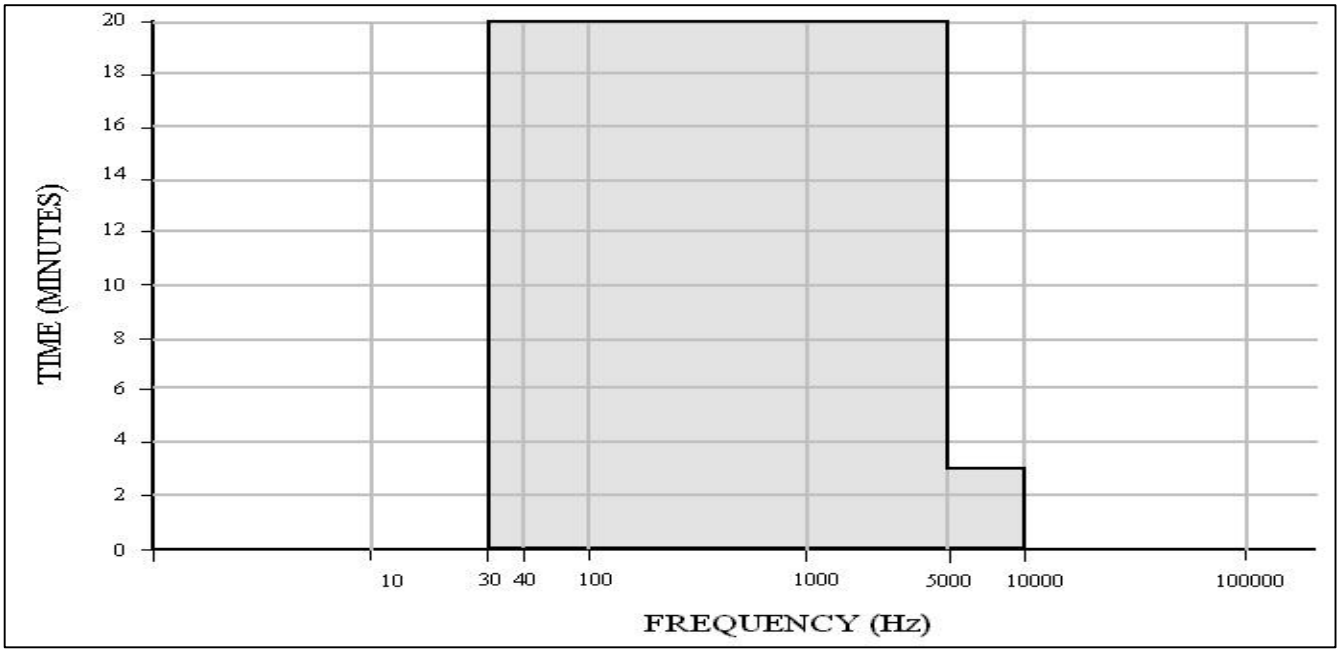
Worked Accuracy Calibration of 1V output at 5kHz on the 2V range at 20°C using 180 day spec.

189ppm Set (Output setting on calibrator = 1V)	189ppm of 1V =	189uV
80ppm Rng (Full scale of range selected = 2V)	80ppm of 2V =	160uV
Zero or floor allowance		20uV
Total accuracy of calibrator only =		± 369uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 3 : Volt-Hertz profile for 1000V AC range



Graph 4 : Time-Hertz profile for voltages above 20V

2006A AC Current Specifications

General Specifications

Range	Frequency	Resolution	Maximum Burden Voltage	Overload Protection	Inductive Load
20-202uA	10Hz to 10kHz	1nA	3 Volts	150V	5mH
0.2-2.02mA	10Hz to 10kHz	10nA	3 Volts	150V	5mH
2-20.2mA	10Hz to 10kHz	100nA	3 Volts	150V	5mH
20-202mA	10Hz to 5kHz	1uA	3 Volts	150V	5mH
0.2-2.02A	10Hz to 2kHz	10uA	3 Volts	150V	5mH
2-20.2A	30Hz to 1kHz	100uA	2.8 Volts	150V	0.8mH

All specifications +/- 650nA. All specifications apply from 10% of full scale.

Settling Time: For 50% change in output: Less than 3 second from standby to within spec

Inductive Loads: Up to 1H may be connected without additional protection.

High current output is limited to a maximum of 2 Mins.

Accuracy Relative to Calibration Standards Specifications

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
20-202uA	10Hz to 30Hz	1Hz	0.14	+ 0.08	0.16	+ 0.08	0.18	+ 0.08	0.25	+ 0.11
	30Hz to 1kHz	1Hz	0.06	+ 0.05	0.06	+ 0.05	0.07	+ 0.05	0.10	+ 0.07
	1kHz to 10kHz	1Hz	0.56	+ 0.08	0.63	+ 0.08	0.70	+ 0.08	0.98	+ 0.11
0.2-2.02mA	10Hz to 30Hz	1Hz	0.14	+ 0.08	0.16	+ 0.08	0.18	+ 0.08	0.25	+ 0.11
	30Hz to 1kHz	1Hz	0.06	+ 0.02	0.06	+ 0.02	0.07	+ 0.02	0.10	+ 0.03
	1kHz to 10kHz	1Hz	0.40	+ 0.05	0.45	+ 0.05	0.50	+ 0.05	0.70	+ 0.07
2mA-20.2mA	10Hz to 30Hz	1Hz	0.14	+ 0.08	0.16	+ 0.08	0.18	+ 0.08	0.25	+ 0.11
	30Hz to 1kHz	1Hz	0.02	+ 0.01	0.03	+ 0.01	0.03	+ 0.01	0.04	+ 0.01
	1kHz to 10kHz	1Hz	0.24	+ 0.05	0.27	+ 0.05	0.30	+ 0.05	0.42	+ 0.07
20-202mA	10Hz to 30Hz	1Hz	0.14	+ 0.08	0.16	+ 0.08	0.18	+ 0.08	0.25	+ 0.11
	30Hz to 1kHz	1Hz	0.02	+ 0.01	0.03	+ 0.01	0.03	+ 0.01	0.04	+ 0.01
	1kHz to 5kHz	1Hz	0.24	+ 0.05	0.27	+ 0.05	0.30	+ 0.05	0.42	+ 0.07
200-2.02A	10Hz to 30Hz	1Hz	0.14	+ 0.08	0.16	0.08	0.18	+ 0.08	0.25	+ 0.11
	30Hz to 1kHz	1Hz	0.02	+ 0.01	0.03	0.01	0.03	+ 0.01	0.04	+ 0.01
	1kHz to 2kHz	1Hz	0.40	+ 0.1	0.45	0.1	0.50	+ 0.1	0.70	+ 0.14
2-20.2A	30Hz to 500Hz	1Hz	0.06	+ 0.01	0.07	+ 0.01	0.08	+ 0.01	0.11	+ 0.01
	500Hz to 1kHz	1Hz	0.16	+ 0.05	0.18	+ 0.05	0.20	+ 0.05	0.28	+ 0.07

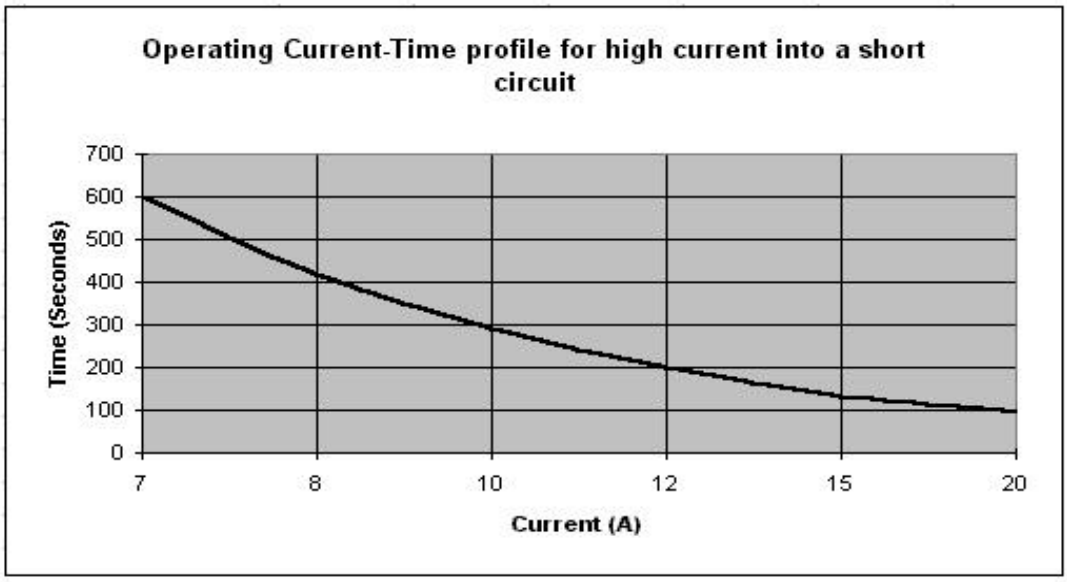
Power & temperature sensor on 20A range - microprocessor monitors & protects from overheating
Duty Cycle into 0 Ohms = 90 seconds ON, 5 minutes OFF[1]

Notes

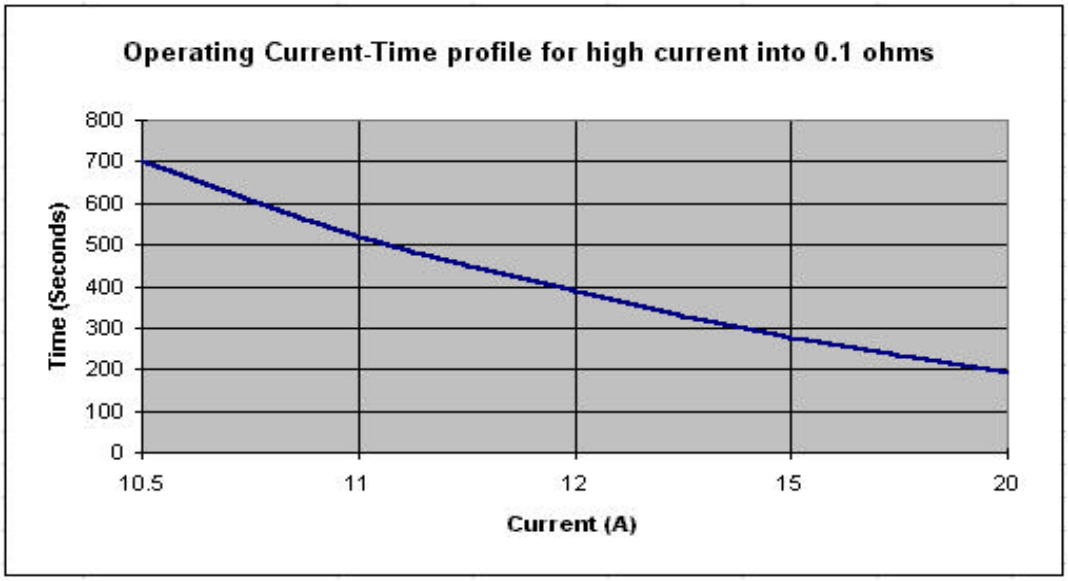
Note 1 : Higher resistance loads allow a longer ON period

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Graph 5* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 6* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2006A DC Resistance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard resistors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Current	Maximum Voltage
0Ω	0.5A	-
0.1Ω	0.5A	0.05 Volts
1Ω	0.3A	0.3 Volts
10Ω	200mA	2 Volts
100Ω	50mA	5 Volts
1kΩ	10mA	10 Volts
10kΩ	3mA	30 Volts
100kΩ	1mA	100 Volts
1MΩ*	0.1mA	100 Volts
10MΩ*	10uA	100 Volts
100MΩ*	1uA	100 Volts
1GΩ*	100nA	100 Volts

*** 2-Wire only**

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel ppm	180 Day Rel ppm	1 year Rel ppm	2 year Rel ppm
0Ω	-	-	-	-
0.1Ω	36	41	45	63
1Ω	28	32	35	49
10Ω	20	23	25	35
100Ω	12	14	15	21
1κΩ	6	7	8	11
10κΩ	6	7	8	11
100κΩ	8	9	10	14
1MΩ	20	23	25	35
10MΩ	76	86	95	133
100MΩ	312	351	390	546
1000MΩ	7600	8550	9500	13300

For 4-Wire connection allow 1mW on all resistance specifications.

For 2-Wire connection allow 40mW on all resistance specifications.

The 2 and 4 Wire value for each resistor is calibrated. The 2-Wire value is measured at the terminals

Specifications apply between 18°C and 25°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

2006A Capacitance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard capacitors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Voltage	D	R_s
1nF	50V	0.006	N/A
10nF	50V	0.006	N/A
20nF	50V	0.006	N/A
50nF	50V	0.006	N/A
100nF	50V	0.006	N/A
1uF	30V	0.002	N/A
10uF	20V	0.014	0.2Ω
100uF	10V	0.1	0.15Ω

Specifications apply at 1kHz. Allow 20pF for lead effects.
No appreciable variation is noticable in value above 1kHz.

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
1nF	0.16	0.18	0.2	0.28
10nF	0.16	0.18	0.2	0.28
20nF	0.16	0.18	0.2	0.28
50nF	0.16	0.18	0.2	0.28
100nF	0.2	0.225	0.25	0.35
1uF	0.32	0.36	0.4	0.56
10uF	0.48	0.54	0.6	0.84
100uF	0.64	0.72	0.8	1.12

Measurement methods
C_p up to 1uF
C_s from 1uF to 10uF

Capacitance is calibrated as value at the terminals
ie. displayed value incorporates capacitance of circuit up to and including the terminals

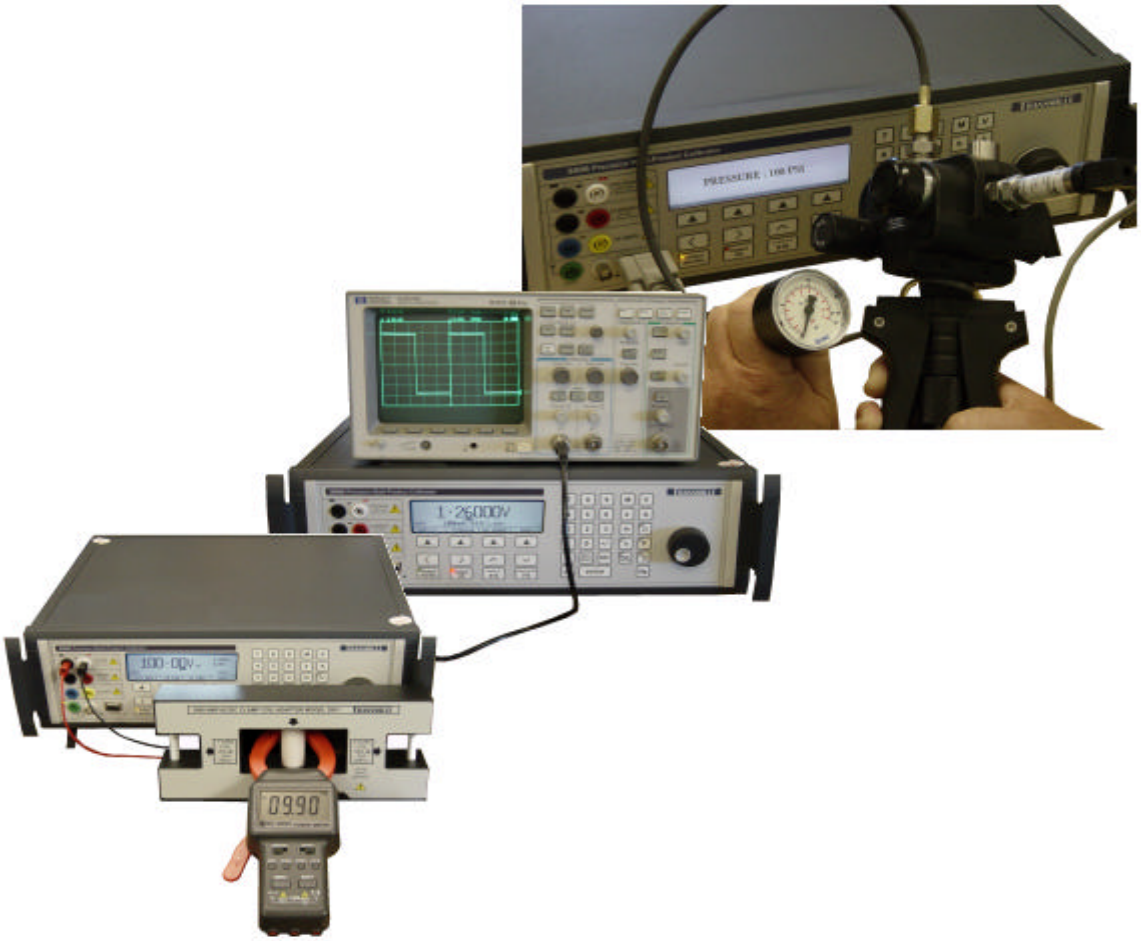
Specifications apply between 18°C and 25°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

2041A MULTI-PRODUCT CALIBRATOR

25ppm MULTI-PRODUCT CALIBRATOR



EXTENDED SPECIFICATIONS

TRANSMILLE LTD., UNIT 4, SELECT BUSINESS CENTRE, STAPLEHURST, KENT. TN12 0QW. UK.
www.transmille.com : sales@transmille.com : Tel : +44 (0) 1580 890700 : Fax : +44 (0) 1580 890711

2041A General Specifications

TRANSMILLE
Solutions In Calibration

Warm Up Time	Double the time since last used up to 20 minutes maximum	
Standard Interfaces	RS232	
Optional Interfaces	GPIB (IEEE-488) : USB (Universal Serial Bus)	
Temperature Performance	Storage : -5°C to +60°C Operation : 0°C to +50°C	
Relative Humidity	Operation : <80% to 30°C, <70% to 40°C, <40% to 50°C Storage : <95%, non-condensing	
Altitude	Operation : 3000m (10,000ft) Maximum Transit : 12000m (40,000ft) Maximum	
EMC & Safety	The calibrator line input plug must be earthed See D.O.C for full details	
Line Power	Line Voltage Selectable : 110V / 230V Line Frequency : 50Hz to 60Hz Line Voltage Variation : -6% +10%	
Power Consumption	28 Watts (Standby)	200 Watts (Maximum)
Low Analogue Isolation	100V	
Connections	Voltage / 2 Wire Resistance Low Current (<=2A) High current (>2A) Earth Connection Oscilloscope Functions Feature (Ext. Pod) RS232 Interface	1x Black : 1x White 4mm Safety sockets 1x Black : 1x Red 4mm Safety sockets 1x Blue : 1x Yellow 4mm Safety sockets 1x Green 4mm Safety Socket 1x BNC terminal 1x Female 'D' type socket 1x Female 'D' type socket
RS232 Settings	Baud Rate Parity Data Bits Stop Bits	9600 None 8 1
Display Information	Type Viewing Area Resolution Backlight Type Brightness	Backlit Black on white film STN type 124.3mm * 34mm 256 * 94 dots Cold fluorescent lamp 70 to 90 cd/m^2
Indicators	Voltage / Current / High Current Negative to ground Oscilloscope Feature Connector (Ext. Pod)	Red LED (between terminals) Green LED (left of Earth terminal) Green LED (right of BNC Connector) Green LED (right of 'D' type connector)
Keyboard	Membrane type with tactile feedback	
Fuses	Mains Inlet	3.15A A/S (240 Volt) 5A A/S (110 Volt operation)
Isolation	Outputs are opto-isolated from mains earth and the RS-232 interface Maximum common mode voltage between earth and the low terminals 30 Volts ac/dc.	
Dimensions & Weights	Calibrator Only Calibrator in Shipping Box Calibrator in Soft Carry Case Calibrator in Hard Transit case	14cm x 43cm x 46cm : 12.5kgs 58cm x 56cm x 37cm : 15kgs 49cm x 50cm x 19cm : 13.5kgs 55cm x 56cm x 26cm : 22kgs
Warranty Period	3 Years (Parts & Labour)	
Recommended Service Interval	1 Year	
Supplied Connections	1x Serial Interface Connection 1x Adaptor Connection Lead (if at least one adaptor ordered)	1x Mains Lead
Optional Lead Set Kit	1x Voltage connection leadset 1x Low Current connection leadset 1x High current connection leadset 1x AC connection leadset	
Mounting Kit (optional)	3U rack mount kit	
Case Colour	Matt Dark Grey (RAL7016)	

Due to continuous development specifications may be subject to change.

2041A DC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications [1]

Range	Resolution	Max. Burden Current	Output Resistance	Overload Protection
0-202mV	0.1uV	1mA[2]	50 Ohms	20 V
0.2-2.02V	1uV	50mA	0.2 Ohms	150V
2-20.2V	10uV	50mA	0.2 Ohms	150V
20-202V	100uV	10mA[3]	0.5 Ohms	1200V
200-1020V	1mV	10mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications [1]

Range	24 Hour Stability		Noise[4]	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
	ppm Set	Rng	1Hz to 10Hz	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng
0-202mV	2	+ 1	60nV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
0.2-2.02V	2	+ 1	280nV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
2-20.2V	2	+ 1	2.5uV	20	+ 3	22.5	+ 3	25	+ 3	35	+ 4.2
20-202V	3.5	+ 1	50.7uV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
200-1020V	5	+ 2	280uV	24	+ 6	27	+ 6	30	+ 6	42	+ 8.4

All specifications allow 3uV for lead and thermal emf effects [5]

Notes

Note 1 : Specifications apply up to 10% of maximum load current. Above this level, allowance must be made for output resistance.

Note 2 : Limited by 50 Ohm output impedance.

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard. For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

Note 4 : Typical RMS noise figures at 50% of full scale.

Note 5 : Zero or floor allowance.

High Voltage Safety

High voltage output is ramped to allow instrument under test to auto range.
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage.
Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting.
High voltage (> 20V) output is indicated to user through an audible warning beep.
An external high voltage output/standby control switch is available as an option.

2 Wire output / Remote sensing not available.
Isolation : Floating or grounded selection available as standard.
Maximum floating voltage : 100V
Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Worked Accuracy Calculation of 5V output on the 20V range at 20°C using 1 year specification

25ppm Set (Output setting on calibrator = 5V)	25ppm of 5V =	125uV
3ppm Rng (Full scale of range selected = 20V)	3ppm of 20V =	60uV
Zero or floor allowance		3uV
Total accuracy of calibrator only =		± 188uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.

2041A DC Current Specifications

General Specifications

Range	Resolution	Max. Inductive Load	Compliance Voltage	Overload Protection
0-202uA	100pA	10mH	4.2 Volts	150V
0.2-2.02mA	1nA	10mH	4.2 Volts	150V
2-20.2mA	10nA	10mH	4.2 Volts	150V
20-202mA	100nA	10mH	4.2 Volts	150V
0.2-2.02A	1uA	10mH	4.2 Volts	150V
2-20.2A	10uA	10mH	3.9 Volts	150V

Accuracy Relative to Calibration Standards Specifications [3]

Range	Noise [1]	90 day Rel			180 Day Rel			1 year Rel			2 year Rel		
	0.1-1Hz	%Set		%Rng	%Set		%Rng	%Set		%Rng	%Set		%Rng
0-202uA	180pA	0.008	+	0.008	0.009	+	0.008	0.01	+	0.008	0.014	+	0.0112
0.2-2.02mA	500pA	0.0064	+	0.002	0.0072	+	0.002	0.008	+	0.002	0.0112	+	0.0028
2-20.2mA	4nA	0.004	+	0.002	0.0045	+	0.002	0.005	+	0.002	0.007	+	0.0028
20-202mA	40nA	0.0064	+	0.002	0.0072	+	0.002	0.008	+	0.002	0.0112	+	0.0028
0.2-2.02A	1uA	0.012	+	0.002	0.0135	+	0.002	0.015	+	0.002	0.021	+	0.0028
2-20.2A [2]	20uA	0.032	+	0.002	0.036	+	0.002	0.04	+	0.002	0.056	+	0.0028

All specification +/- 4nA. [4]

Notes

Note 1 : Typical RMS noise figures at 50% of full scale.

Note 2 : Power & temperature sensor on 20A range - microprocessor monitors & protects from overheating. Higher resistance loads allow a longer ON period. See graphs 1 and 2 for details.

Note 3 : Specifications apply to loads of less than 10% of the maximum burden voltage.

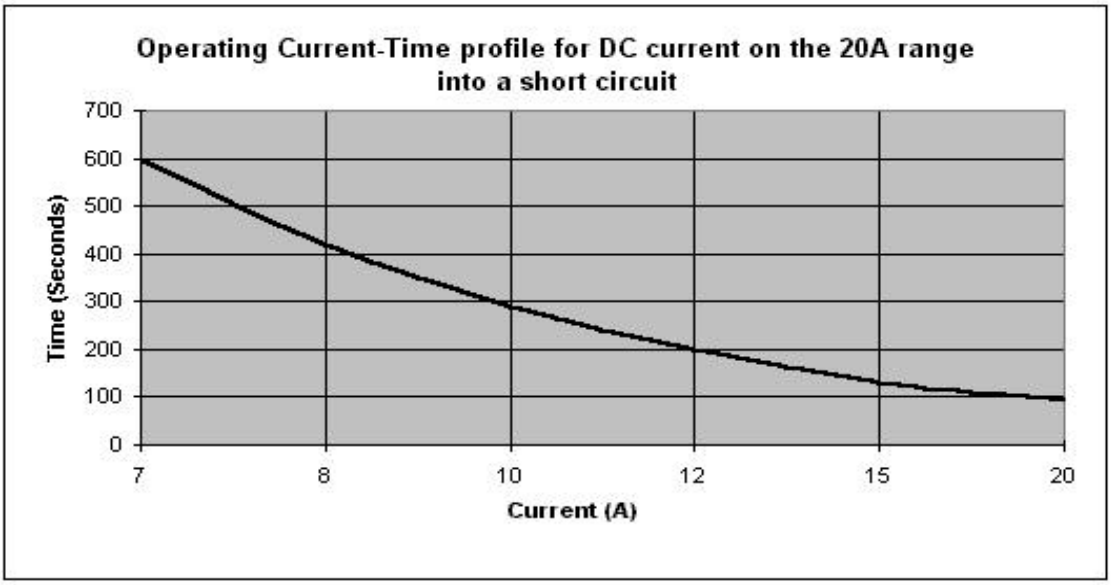
Note 4: Zero or floor allowance.

Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

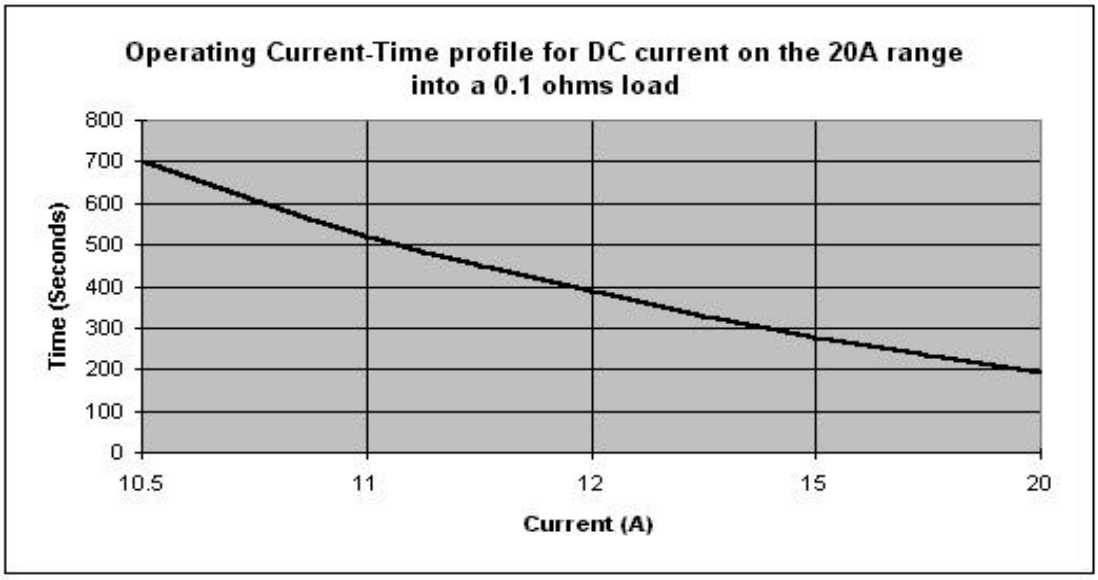
Worked Accuracy Calculation of 1.2mA output on the 2mA range at 20°C using 1 year spec.

0.008% Set (Output setting on calibrator = 1.2mA)	0.008% of 1.2mA =	96nA
0.002% Rng (Full scale of range selected = 2mA)	0.002% of 2mA =	40nA
Zero or floor allowance		4nA
Total accuracy of calibrator only =		± 140nA

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 1* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 2* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2041A AC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications

Range	Frequency	Resolution	Max. Burden Current	Output Resistance	Overload Protection
0-202mV	10Hz to 29Hz	1uV	1mA [1]	50 Ohms	20 V
	30Hz to 999Hz	1uV	1mA [1]	50 Ohms	20 V
	1kHz to 9.999kHz	1uV	1mA [1]	50 Ohms	20 V
	10kHz to 40kHz	1uV	1mA [1]	50 Ohms	20 V
0.2-2.02V	10Hz to 29Hz	10uV	50mA	0.2 Ohms	1200V
	30Hz to 999Hz	10uV	50mA	0.2 Ohms	1200V
	1Hz to 19.999kHz	10uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	10uV	50mA	0.2 Ohms	1200V
2-20.2V	10Hz to 29Hz	100uV	50mA	0.2 Ohms	1200V
	30Hz to 999Hz	100uV	50mA	0.2 Ohms	1200V
	1Hz to 19.999kHz	100uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	100uV	50mA	0.2 Ohms	1200V
20-202V	30Hz to 999Hz	1mV	10mA [2]	0.5 Ohms	1200V
	1kHz to 9.999kHz	1mV	5mA [2]	0.5 Ohms	1200V
	10kHz to 20kHz	1mV	2mA [2]	0.5 Ohms	1200V
200-1020V [3]	30Hz to 999Hz	10mV	10mA [2]	0.7 Ohms	1200V
	1kHz to 10kHz	10mV	2mA [2]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications [4]

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
0-202mV	10Hz to 29Hz	1Hz	0.16	+ 0.08	0.18	+ 0.08	0.2	+ 0.08	0.28	+ 0.112
	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.01	0.04	+ 0.01	0.056	+ 0.014
	1kHz to 9.999kHz	1Hz	0.048	+ 0.04	0.054	+ 0.04	0.06	+ 0.04	0.084	+ 0.056
	10kHz to 40kHz	1Hz	0.08	+ 0.07	0.09	+ 0.07	0.1	+ 0.07	0.14	+ 0.098
0.2-2.02V	10Hz to 29Hz	1Hz	0.112	+ 0.09	0.126	+ 0.09	0.14	+ 0.09	0.196	+ 0.126
	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.008	0.04	+ 0.008	0.056	+ 0.011
	1kHz to 19.999kHz	1Hz	0.072	+ 0.04	0.081	+ 0.04	0.09	+ 0.04	0.126	+ 0.056
	20kHz to 59.999kHz	1Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
	60kHz to 100kHz	2Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
2-20.2V	10Hz to 29Hz	1Hz	0.112	+ 0.09	0.126	+ 0.09	0.14	+ 0.09	0.196	+ 0.126
	30Hz to 999Hz	1Hz	0.024	+ 0.01	0.027	+ 0.008	0.03	+ 0.008	0.042	+ 0.011
	1kHz to 19.999kHz	1Hz	0.072	+ 0.04	0.081	+ 0.04	0.09	+ 0.04	0.126	+ 0.056
	20kHz to 59.999kHz	1Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
	60kHz to 100kHz	2Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
20-202V	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.01	0.04	+ 0.01	0.056	+ 0.014
	1kHz to 9.999kHz	1Hz	0.048	+ 0.04	0.054	+ 0.04	0.06	+ 0.04	0.084	+ 0.056
	10kHz to 20kHz	1Hz	0.08	+ 0.05	0.09	+ 0.05	0.1	+ 0.05	0.14	+ 0.070
200-1020V [3]	30Hz to 999Hz	1Hz	0.032	+ 0.02	0.036	+ 0.02	0.04	+ 0.02	0.056	+ 0.028
	1kHz to 10kHz	1Hz	0.12	+ 0.1	0.135	+ 0.1	0.15	+ 0.1	0.21	+ 0.140

All specifications ± 20uV. All specifications apply from 10% of full scale. [5]

Notes

Note 1: Current limited by 50 ohms output resistance.

Note 2 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

Note 3 : Frequency and voltage combinations are limited. See Volt-Hertz profile in Graph 3

Note 4 : Specifications apply up to 10% of maximum load current. Above this level, allowance must be made for output resistance.

Note 5 : Zero or floor allowance.

2 Wire output / Remote sensing not available. Maximum floating voltage : 100V.
Isolation : Floating or grounded selection available as standard.
Specifications apply between 17°C and 27°C. Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

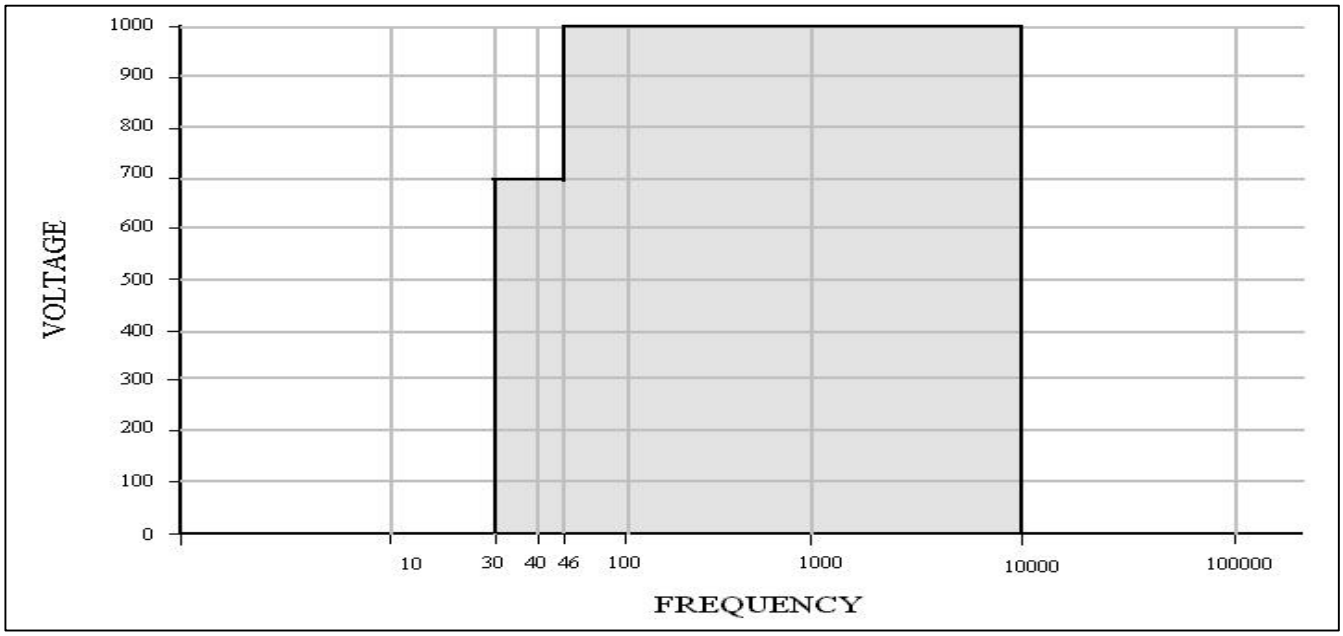
Due to continuous development specifications may be subject to change.

High Voltage Safety
High voltage output is ramped to allow instruments under test to auto-range.
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage.
Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting for frequencies up to 5kHz or 3 mins for frequencies above 5kHz. See graph 4.
High voltage (> 20V) output is indicated to user through an audible warning beep.
An external high voltage output/standby control switch is available as an option.

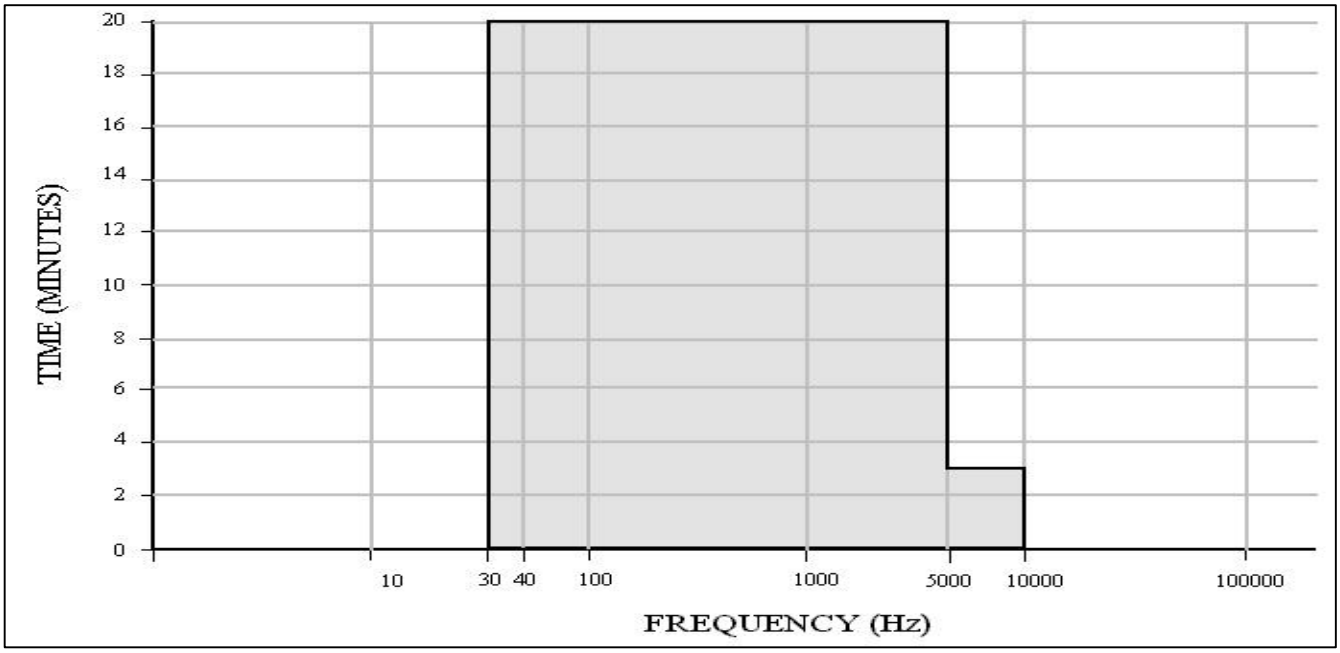
Worked Accuracy Calibration of 1V output at 5kHz on the 2V range at 20°C using 180 day spec.

0.081% Set (Output setting on calibrator = 1V)	0.081% of 1V =	810uV
0.04% Rng (Full scale of range selected = 2V)	0.04% of 2V =	800uV
Zero or floor allowance		20uV
Total accuracy of calibrator only =		± 1630uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 3 : Volt-Hertz profile for 1000V AC range



Graph 4 : Time-Hertz profile for voltages above 20V

General Specifications

Range	Frequency	Resolution	Maximum Burden Voltage	Overload Protection	Inductive Load
20-202uA	10Hz to 2kHz	1nA	3 Volts	150V	5mH
0.2-2.02mA	10Hz to 10kHz	10nA	3 Volts	150V	5mH
2-20.2mA	10Hz to 10kHz	100nA	3 Volts	150V	5mH
20-202mA	10Hz to 2kHz	1uA	3 Volts	150V	5mH
0.2-2.02A	30Hz to 2kHz	10uA	3 Volts	150V	5mH
2-20.2A	30Hz to 500Hz	100uA	2.8 Volts	150V	0.8mH

All specifications +/- 650nA. All specifications apply from 10% of full scale.

Settling Time: For 50% change in output: Less than 3 second from standby to within spec

Inductive Loads: Up to 1H may be connected without additional protection.

Accuracy Relative to Calibration Standards Specifications [2]

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
20-202uA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.02	0.081	0.02	0.09	0.02	0.126	0.028
	1kHz to 2kHz	1Hz	0.8	0.2	0.9	0.2	1	0.2	1.4	0.28
0.2-2.02mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 10kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
2mA-20.2mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 10kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
20-202mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 2kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
200-2.02A	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 2kHz	1Hz	0.56	0.2	0.63	0.2	0.7	0.2	0.98	0.28
2-20.2A[1]	30Hz to 500Hz	1Hz	0.08	0.01	0.09	0.01	0.1	0.01	0.14	0.014

Notes

Note 1 : Temperature sensor on 20A range - microprocessor monitors & protects from overheating.
Higher resistance loads allow a longer ON period. See graphs 5 and 6 for details.

Note 2 : Specifications apply to loads of less than 10% of the maximum burden voltage.

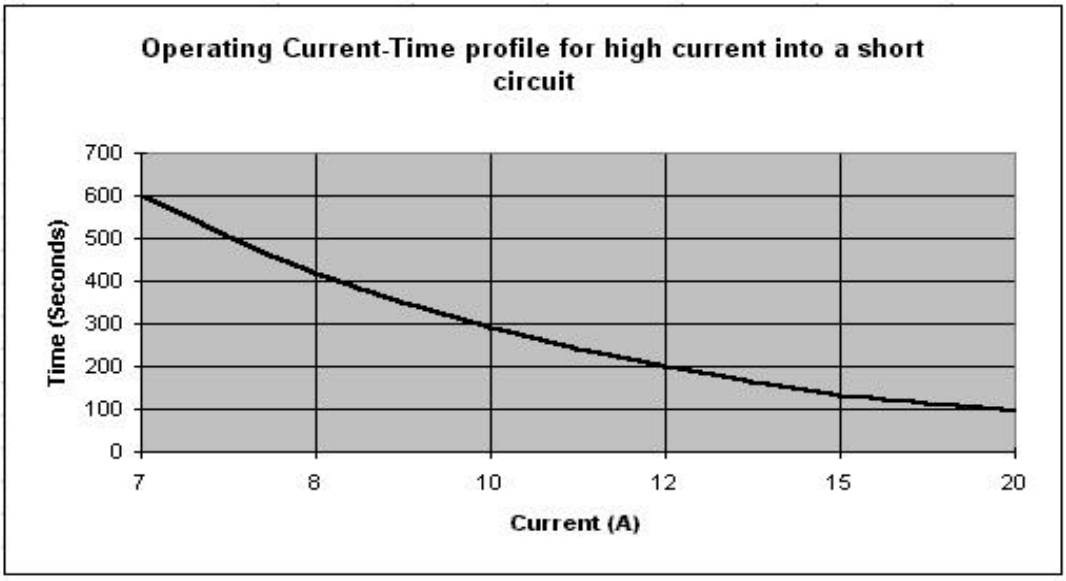
Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

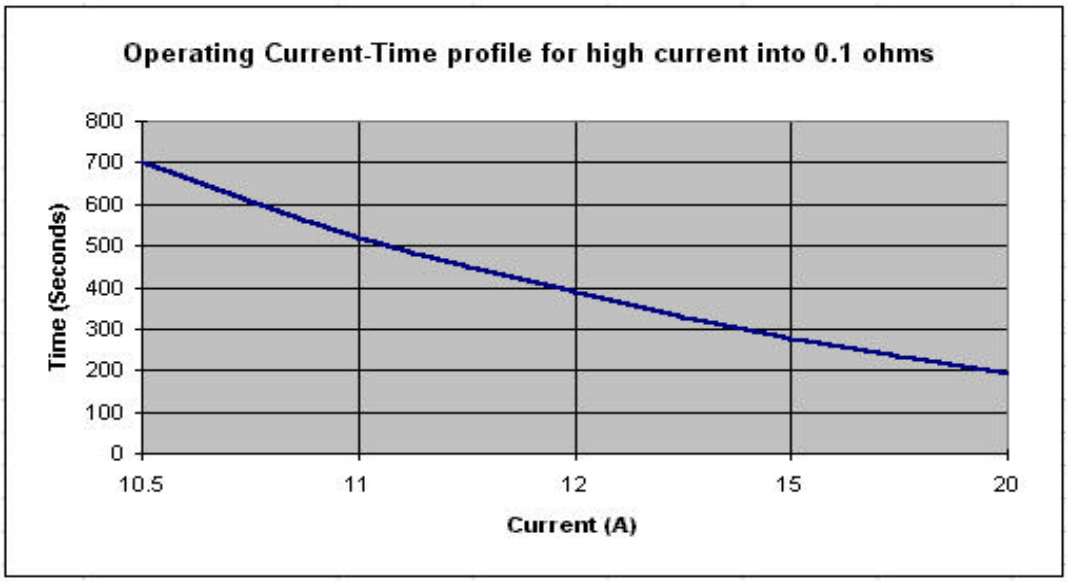
Worked Accuracy Calibration of 8mA output at 500Hz on the 20mA range at 20°C using 1 year spec.

0.09% Set (Output setting on calibrator = 8mA)	0.09% of 8mA =	7.2uA
0.01% Rng (Full scale of range selected = 20mA)	0.01% of 20mA =	2.0uA
Zero or floor allowance		0.65nA
Total accuracy of calibrator only =		± 9.85uA

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 5* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 6* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard resistors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Current	Maximum Voltage
0Ω	0.5A	-
0.1Ω	200mA	2 Volts
1Ω	200mA	2 Volts
10Ω	100mA	5 Volts
100Ω	50mA	5 Volts
1kΩ	10mA	10 Volts
10kΩ	3mA	30 Volts
100kΩ	1mA	100 Volts
1MΩ*	0.1mA	100 Volts
10MΩ*	10uA	100 Volts
100MΩ*	1uA	100 Volts
1GΩ*	100nA	100 Volts

*** 2-Wire only**

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
0Ω	-	-	-	-
0.1Ω	0.012	0.0135	0.015	0.021
1Ω	0.008	0.009	0.01	0.014
10Ω	0.008	0.009	0.01	0.014
100Ω	0.004	0.0045	0.005	0.007
1κΩ	0.0032	0.0036	0.004	0.0056
10κΩ	0.0032	0.0036	0.004	0.0056
100κΩ	0.0032	0.0036	0.004	0.0056
1MΩ	0.008	0.009	0.01	0.014
10MΩ	0.028	0.0315	0.035	0.049
100MΩ	0.24	0.27	0.3	0.42
1000MΩ	0.8	0.9	1	1.4

For 4-Wire connection allow 1mW on all resistance specifications.

For 2-Wire connection allow 40mW on all resistance specifications.

The 2 and 4 Wire value for each resistor is calibrated. The 2-Wire value is measured at the terminals The 4-Wire values are taken using the zero position to NULL the measuring system.

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Worked Examples

100 ohms 4-wire output at 31°C using 2 year specification.

0.007% of setting (100Ω)	7 mΩ
Zero allowance (4 wire connection)	1mΩ
Temp coefficient (31-27) X 0.18 X 0.005% X 100Ω	3.6mΩ
Total accuracy of calibrator only =	140nA

1k ohms 2-wire output at 25°C using 180 day specification.

0.0036% of setting (1kΩ)	36mΩ
Zero allowance (2 wire connection)	40mΩ
Total accuracy of calibrator only =	76mΩ

Absolute accuracy must also include the accuracy (uncertainty) of the origional calibration of the 2041A and the accuracy of the instrument used to verify its performance.

2041A Capacitance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard capacitors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Voltage	D	R_s
1nF	50V	0.006	N/A
10nF	50V	0.006	N/A
20nF	50V	0.006	N/A
50nF	50V	0.006	N/A
100nF	50V	0.006	N/A
1uF	30V	0.002	N/A
10uF	20V	0.014	0.2Ω
100uF	10V	0.1	0.15Ω

Specifications apply at 1kHz. Allow 20pF for lead effects.
No appreciable variation is noticable at frequencies above 1kHz.

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
1nF	0.2	0.225	0.25	0.35
10nF	0.2	0.225	0.25	0.35
20nF	0.2	0.225	0.25	0.35
50nF	0.2	0.225	0.25	0.35
100nF	0.2	0.225	0.25	0.35
1uF	0.32	0.36	0.4	0.56
10uF	0.48	0.54	0.6	0.84
100uF	0.64	0.72	0.8	1.12

Measurement methods
C_p up to 1uF
C_s from 10uF to 100uF

Capacitance is calibrated as value at the terminals
ie. displayed value incorporates capacitance of circuit up to and including the terminals

Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

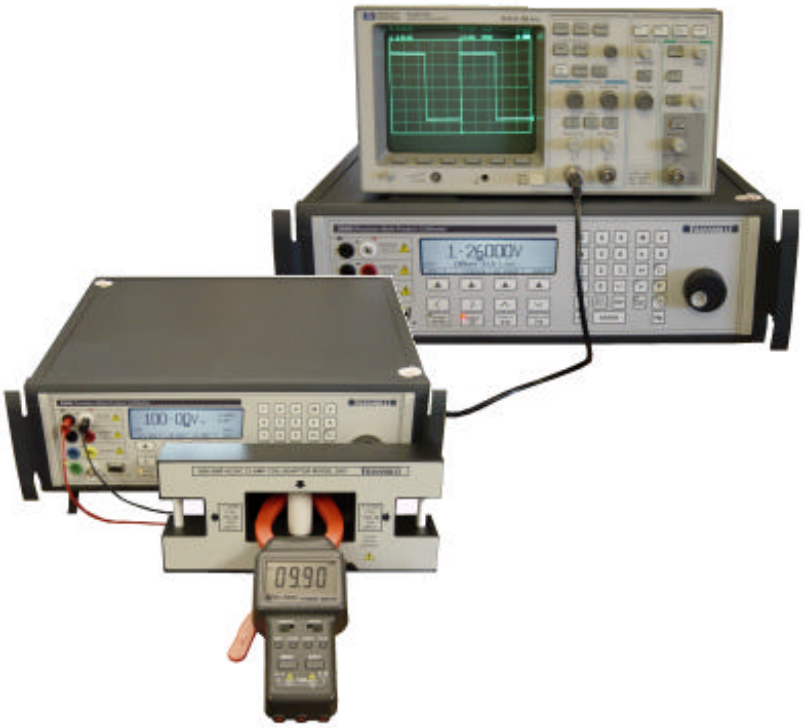
Worked Accuracy Calculation of 50nF output at 20°C using 90 day specification.

0.2% of setting (50nF) =	100pF
Zero or floor allowance (Lead effects) =	20pF
Total accuracy of calibrator only =	120pF

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.

2050 MULTI-PRODUCT CALIBRATOR

50ppm ENTRY LEVEL CALIBRATOR



EXTENDED SPECIFICATIONS

TRANSMILLE LTD., UNIT 4 SELECT BUSINESS CENTRE, LODGE ROAD, STAPLEHURST, KENT. TN12 0QW. UK.
www.transmille.com : sales@transmille.com : Tel : +44 (0) 1580 890700 : Fax : +44 (0) 1580 890711

DECLARATION OF CONFORMITY CE

Manufacturer's Name: **Transmille Ltd.**
Manufacturer's Address: **Unit 4, Select Business Centre**
Lodge Road
Staplehurst
TN12 0QW

Declares, that the product

Product Name: **Multi-product Calibrator**
Model Number: **2050 / 2041A / 2006A**
Product Options: **This declaration covers all options of the above product(s)**

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/73EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly

Conforms with the following product standards:

EMC

Standard	**Limit**
IEC616326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998 EN55011:1991	
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995 Group 1Class A	
IEC 61000-4-3:1995 / EN 61000-4-3:1995	***4kV CD, 8kV AD***
IEC 61000-4-4:1995 / EN 61000-4-4:1995	***3 V/m, 80-1000 MHz***
IEC 61000-4-5:1995 / EN 61000-4-5:1995	***0.5kV signal lines, 1kV power lines***
IEC 61000-4-6:1996 / EN 61000-4-6:1996	***0.5kV line-line, 1kV line-ground***
IEC 61000-4-11:1994 / EN 61000-4-11:1994	***3V, 0.15-80 MHz I cycle, 100%***
	Dips: 30% 10ms; 60% 100ms
	Interrupt > 95%@5000ms

SAFETY

IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995

12/12/2001

Revision No: 1.1
Date :12/12/2001

Managing Director

2050 General Specifications

TRANSMILLE
Solutions In Calibration

Warm Up Time	Double the time since last used up to 20 minutes maximum	
Standard Interfaces	RS232	
Optional Interfaces	USB (Universal Serial Bus)	
Temperature Performance	Storage : -5°C to +60°C Operation : 0°C to +50°C	
Relative Humidity	Operation : <80% to 30°C, <70% to 40°C, <40% to 50°C Storage : <95%, non-condensing	
Altitude	Operation : 3000m (10,000ft) Maximum Transit : 12000m (40,000ft) Maximum	
EMC & Safety	The calibrator line input plug must be earthed See D.O.C for full details	
Line Power	Line Voltage Selectable : 110V / 230V Line Frequency : 50Hz to 60Hz Line Voltage Variation : -6% +10%	
Power Consumption	28 Watts (Standby)	200 Watts (Maximum)
Low Analogue Isolation	100V	
Connections	Voltage / 2 Wire Resistance Low Current (<=2A) High current (>2A) Earth Connection Oscilloscope Functions Feature (Ext. Pod) RS232 Interface	1x Black : 1x White 4mm Safety sockets 1x Black : 1x Red 4mm Safety sockets 1x Blue : 1x Yellow 4mm Safety sockets 1x Green 4mm Safety Socket 1x BNC terminal 1x Female 'D' type socket 1x Female 'D' type socket
RS232 Settings	Baud Rate Parity Data Bits Stop Bits	9600 None 8 1
Display Information	Type Viewing Area Resolution Backlight Type Brightness	Backlit Black on white film STN type 124.3mm * 34mm 256 * 94 dots Cold fluorescent lamp 70 to 90 cd/m^2
Indicators	Voltage / Current / High Current Negative to ground Oscilloscope Feature Connector (Ext. Pod)	Red LED (between terminals) Green LED (left of Earth terminal) Green LED (right of BNC Connector) Green LED (right of 'D' type connector)
Keyboard	Membrane type with tactile feedback	
Fuses	Mains Inlet	3A A/S (240 Volt) 5A A/S (110 Volt operation)
Isolation	Outputs are opto-isolated from mains earth and the RS-232 interface Maximum common mode voltage between earth and the low terminals 30 Volts ac/dc.	
Dimensions & Weights	Calibrator Only Calibrator in Shipping Box Calibrator in Soft Carry Case Calibrator in Hard Transit case	14cm x 43cm x 46cm : 12.5kgs 58cm x 56cm x 37cm : 15kgs 49cm x 50cm x 19cm : 13.5kgs 55cm x 56cm x 26cm : 22kgs
Warranty Period	3 Years (Parts & Labour)	
Recommended Service Interval	1 Year	
Supplied Connections	1x Serial Interface Connection 1x Adaptor Connection Lead (if at least one adaptor ordered)	
Optional Lead Set Kit	1x Voltage connection leadset 1x Low Current connection leadset 1x High current connection leadset 1x AC connection leadset	
Mounting Kit (optional)	3U rack mount kit	
Case Colour	Matt Dark Grey (RAL7016)	

Due to continuous development specifications may be subject to change.

2050 DC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications

Range	Resolution	Max. Burden Current[1]	Output Resistance	Overload Protection
0-202mV	0.1uV	1mA[2]	50 Ohms	20 V
0.2-2.02V	1uV	50mA	0.2 Ohms	150V
2-20.2V	10uV	50mA	0.2 Ohms	150V
20-202V	100uV	10mA[3]	0.5 Ohms	1200V
200-1020V	1mV	10mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng
0-202mV	48	+ 5	54	+ 5	60	+ 5	84	+ 7
0.2-2.02V	48	+ 5	54	+ 5	60	+ 5	84	+ 7
2-20.2V	40	+ 4	45	+ 4	50	+ 4	70	+ 5.6
20-202V	56	+ 5	63	+ 5	70	+ 5	98	+ 7
200-1020V	56	+ 10	63	+ 10	70	+ 10	98	+ 14

All specifications allow 5uV for lead and thermal emf effects

Notes

Note 1 : Current limited by self resetting thermal fuse. Shown as max. current for 10 seconds/continuous operating current

Note 2 : Limited by 50 Ohm output impedance

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

Note 4 : Typical RMS noise figures at 50% of full scale.

High Voltage Safety

High voltage output is ramped to allow instruments to auto range
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage
Standby is automatically selected for high voltage (>20V) after 5 minutes on the same setting
High voltage (> 20V) output is indicated to user through an audible warning beep
An external high voltage output/standby control switch is available as an option

2 Wire output / Remote sensing not available
Isolation : Floating or grounded selection available as standard
Maximum floating voltage : 100V

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.
Due to continuous development specifications may be subject to change.

2050 DC Current Specifications

General Specifications

Range	Resolution	Max. Inductive Load	Compliance Voltage	Overload Protection
0-202uA	100pA	10mH	4.2 Volts	150V
0.2-2.02mA	1nA	10mH	4.2 Volts	150V
2-20.2mA	10nA	10mH	4.2 Volts	150V
20-202mA	100nA	10mH	4.2 Volts	150V
0.2-2.02A	1uA	10mH	4.2 Volts	150V
2-20.2A	10uA	10mH	3.9 Volts	150V

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel			180 Day Rel			1 year Rel			2 year Rel		
	%Set		%Rng	%Set		%Rng	%Set		%Rng	%Set		%Rng
0-202uA	0.012	+	0.010	0.014	+	0.010	0.015	+	0.010	0.021	+	0.014
0.2-2.02mA	0.010	+	0.005	0.011	+	0.005	0.012	+	0.005	0.017	+	0.007
2-20.2mA	0.010	+	0.005	0.011	+	0.005	0.012	+	0.005	0.017	+	0.007
20-202mA	0.120	+	0.005	0.135	+	0.005	0.150	+	0.005	0.210	+	0.007
0.2-2.02A	0.040	+	0.005	0.045	+	0.005	0.050	+	0.005	0.070	+	0.007
2-20.2A	0.064	+	0.008	0.072	+	0.008	0.080	+	0.008	0.112	+	0.011

All specification +/- 4nA.

Power & temperature sensor on 20A range - microprocessor monitors & protects from overheating
Duty Cycle into 0 Ohms = 90 seconds ON, 5 minutes OFF

Notes

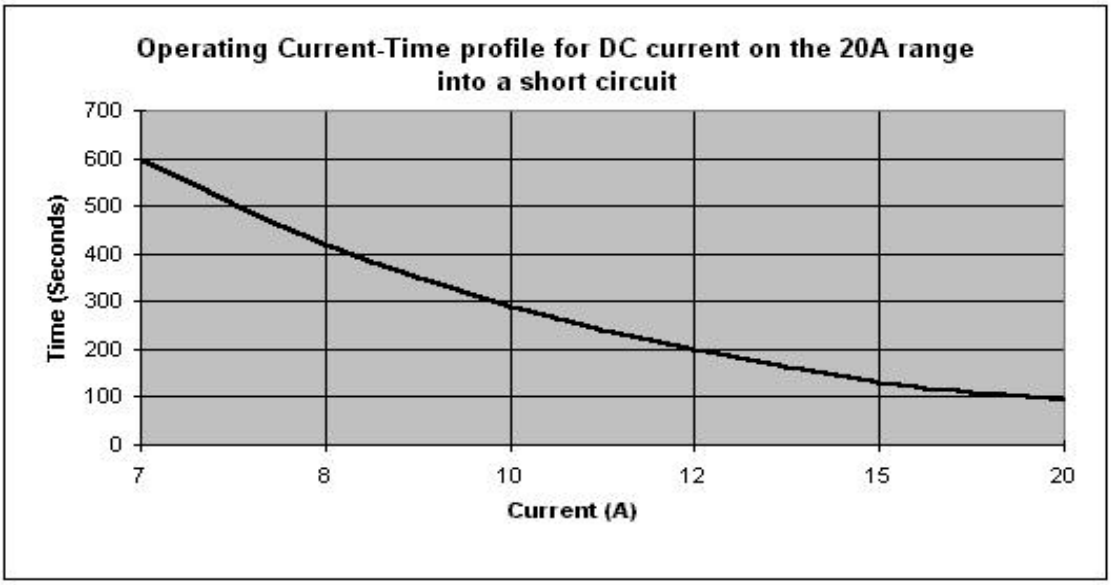
Note 1 : Typical RMS noise figures at 50% of full scale.

Note 2 : Higher resistance loads allow a longer ON period

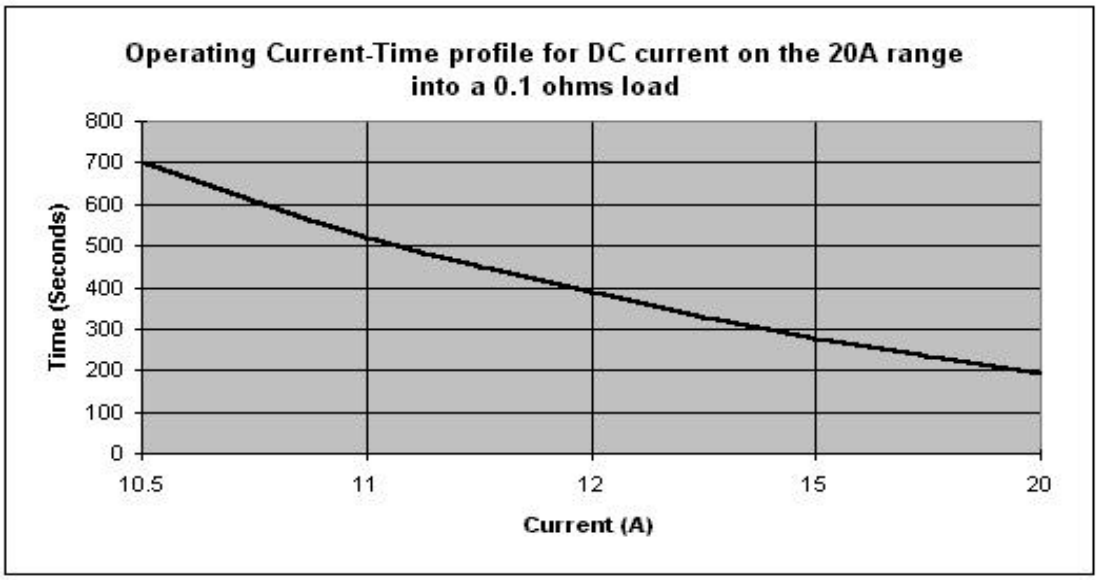
Specifications apply between 17°C and 30°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Graph 1* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 2* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2050 AC Voltage Specifications

TRANSMILLE
Solutions In Calibration

General Specifications

Range	Frequency	Resolution	Max. Burden Current[1]	Output Resistance	Overload Protection
0-202mV	40Hz to 1kHz	1uV	1mA[2]	50 Ohms	20 V
	1kHz to 10kHz	1uV	1mA[2]	50 Ohms	20 V
0.2-2.02V	40Hz to 1kHz	10uV	50mA	0.2Ohms	1200V
	1kHz to 10kHz	10uV	50mA	0.2 Ohms	1200V
2-20.2V	40Hz to 1kHz	100uV	50mA	0.2 Ohms	1200V
	1kHz to 10kHz	100uV	50mA	0.2 Ohms	1200V
20-202V	40Hz to 1kHz	1mV	10mA[3]	0.5 Ohms	1200V
	1kHz to 10kHz	1mV	5mA[3]	0.5 Ohms	1200V
200-1020V	40Hz to 1kHz	10mV	10mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
0-202mV	40Hz to 1kHz	1Hz	0.064	+ 0.02	0.072	+ 0.015	0.08	+ 0.015	0.112	+ 0.021
	1kHz to 10kHz	1Hz	0.080	+ 0.06	0.090	+ 0.06	0.10	+ 0.060	0.140	+ 0.084
0.2-2.02V	40Hz to 1kHz	1Hz	0.064	+ 0.01	0.072	+ 0.012	0.08	+ 0.012	0.112	+ 0.017
	1kHz to 10kHz	1Hz	0.080	+ 0.06	0.090	+ 0.06	0.10	+ 0.060	0.140	+ 0.084
2-20.2V	40Hz to 1kHz	1Hz	0.056	+ 0.01	0.063	+ 0.012	0.07	+ 0.012	0.098	+ 0.017
	1kHz to 10kHz	1Hz	0.080	+ 0.05	0.090	+ 0.05	0.10	+ 0.050	0.140	+ 0.070
20-202V	40Hz to 1kHz	1Hz	0.064	+ 0.02	0.072	+ 0.015	0.08	+ 0.015	0.112	+ 0.021
	1kHz to 10kHz	1Hz	0.080	+ 0.06	0.090	+ 0.06	0.10	+ 0.060	0.140	+ 0.084
200-1020V	40Hz to 1kHz	1Hz	0.064	+ 0.03	0.072	+ 0.03	0.08	+ 0.030	0.112	+ 0.042

All specifications ± 20uV. All AC specifications apply from 10% of full scale.

Notes

Note 1 : Current limited by self resetting thermal fuse. Shown as max. current for 10 seconds/continuous operating current

Note 2 : Limited by 50 Ohm output impedance

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

2 Wire output / Remote sensing not available

Maximum floating voltage : 100V

Isolation : Floating or grounded selection available as standard

Specifications apply between 17°C and 30°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

2050 AC Voltage Specifications

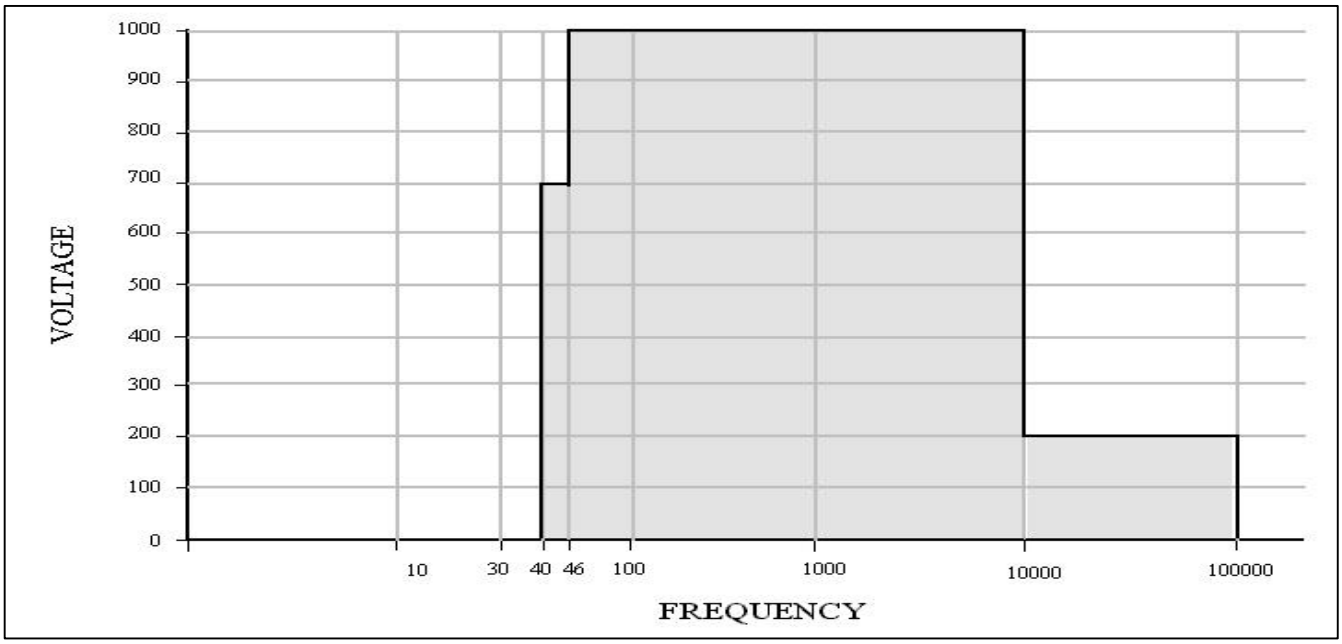
High Voltage Safety
High voltage output is ramped to allow instruments under test to auto-range.
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage.
Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting for frequencies

High voltage (> 20V) output is indicated to user through an audible warning beep.

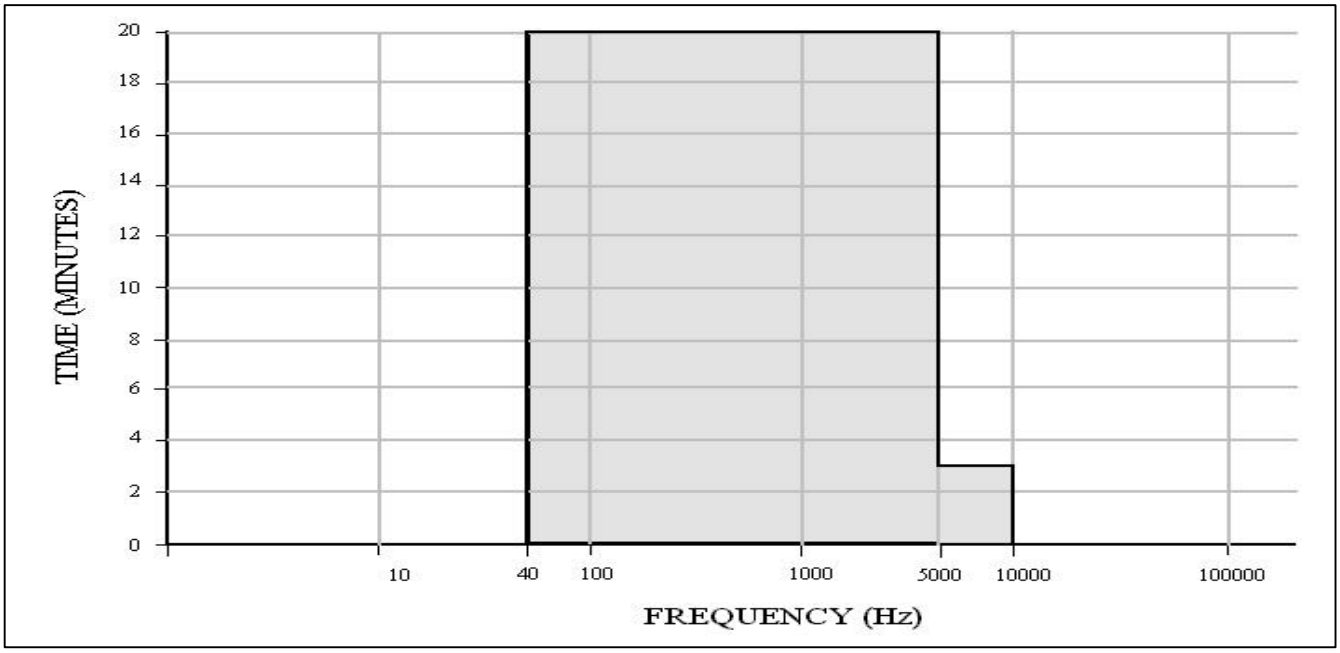
Worked Accuracy Calibration of 1V output at 5kHz on the 2V range at 20°C using 180 day spec.

0.09% Set (Output setting on calibrator = 1V)	0.09% of 1V =	900uV
0.06% Rng (Full scale of range selected = 2V)	0.06% of 2V =	1200uV
Zero or floor allowance		20uV
Total accuracy of calibrator only =		± 2120uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 3 : Volt-Hertz profile for 1000V AC range



Graph 4 : Time-Hertz profile for voltages above 20V

2050 AC Current Specifications

General Specifications

Range	Frequency	Resolution	Maximum Burden Voltage	Overload Protection	Inductive Load
20-202uA	40Hz to 500Hz	1nA	3 Volts	150V	5mH
0.2-2.02mA	40Hz to 500Hz	10nA	3 Volts	150V	5mH
2-20.2mA	40Hz to 500Hz	100nA	3 Volts	150V	5mH
20-202mA	40Hz to 500Hz	1uA	3 Volts	150V	5mH
0.2-2.02A	40Hz to 500Hz	10uA	3 Volts	150V	5mH
2-20.2A	40Hz to 500Hz	100uA	2.8 Volts	150V	0.8mH

All specifications +/- 650nA. All AC specifications apply from 10% of full scale.

Settling Time: For 50% change in output: Less than 3 second from standby to within spec

Inductive Loads: Up to 1H may be connected without additional protection.

High current output is limited to a maximum of 2 Mins.

Accuracy Relative to Calibration Standards Specifications

Range	Frequency	Frequency Resolution	90 day Rel			180 Day Rel			1 year Rel			2 year Rel		
			%Set		%Rng	%Set		%Rng	%Set		%Rng	%Set		%Rng
20-202uA	40Hz to 500Hz	1Hz	0.08	+	0.06	0.09	+	0.06	0.10	+	0.06	0.14	+	0.084
0.2-2.02mA	40Hz to 500Hz	1Hz	0.08	+	0.05	0.09	+	0.05	0.10	+	0.05	0.14	+	0.070
2mA-20.2mA	40Hz to 500Hz	1Hz	0.08	+	0.03	0.09	+	0.03	0.10	+	0.03	0.14	+	0.042
20-202mA	40Hz to 500Hz	1Hz	0.08	+	0.03	0.09	+	0.03	0.10	+	0.03	0.14	+	0.042
200-2.02A	40Hz to 500Hz	1Hz	0.12	+	0.05	0.135		0.05	0.15		0.05	0.21	+	0.070
2-20.2A	40Hz to 500Hz	1Hz	0.16	+	0.10	0.18	+	0.10	0.20	+	0.10	0.28	+	0.140

Power & temperature sensor on 20A range - microprocessor monitors & protects from overheating
Duty Cycle into 0 Ohms = 90 seconds ON, 5 minutes OFF[1]

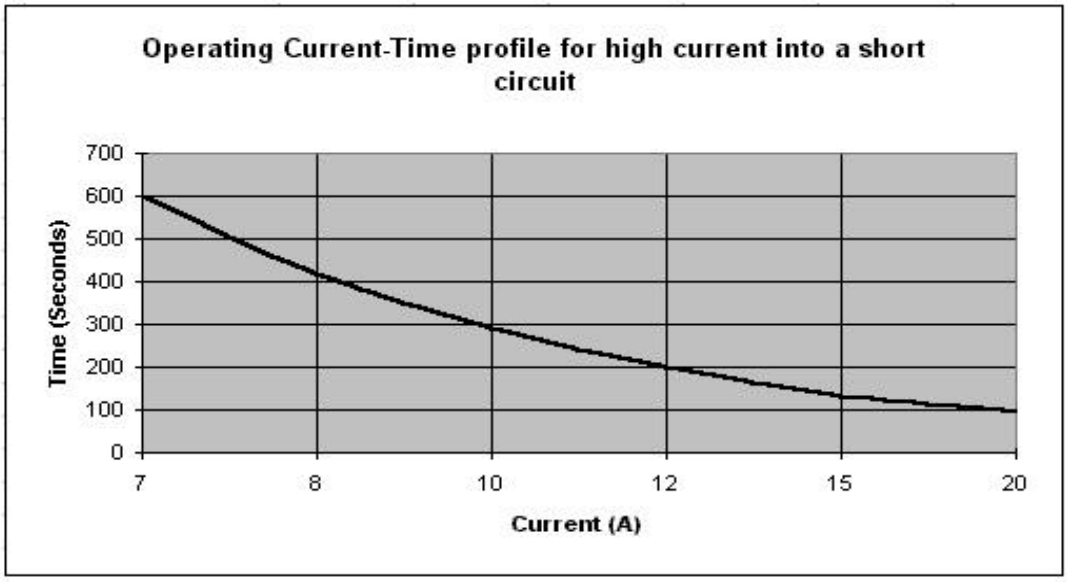
Notes

Note 1 : Higher resistance loads allow a longer ON period

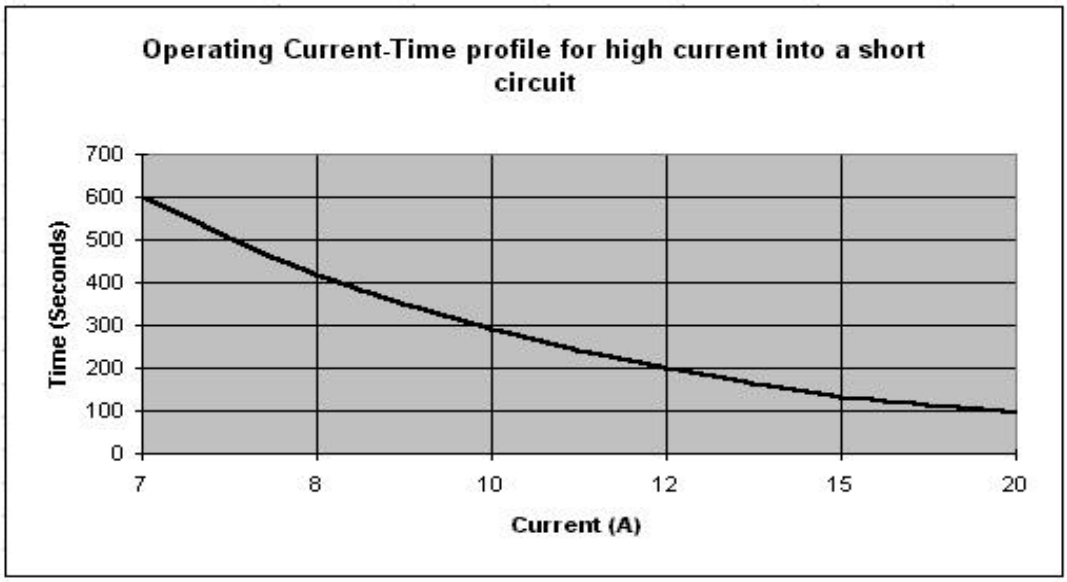
Specifications apply between 17°C and 30°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Graph 5* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 6* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2050 DC Resistance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard resistors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Current	Maximum Voltage
10Ω	100mA	5 Volts
100Ω	50mA	5 Volts
1kΩ	10mA	10 Volts
10kΩ	3mA	30 Volts
100kΩ	1mA	100 Volts
1MΩ	0.1mA	100 Volts
10MΩ	10uA	100 Volts

2050 provides 2 wire resistance for all values

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
10Ω	0.04	0.045	0.05	0.07
100Ω	0.0064	0.0072	0.008	0.0112
1κΩ	0.004	0.0045	0.005	0.007
10κΩ	0.004	0.0045	0.005	0.007
100κΩ	0.004	0.0045	0.005	0.007
1MΩ	0.008	0.009	0.01	0.014
10MΩ	0.04	0.045	0.05	0.07

Allow 40mW on all resistance specifications.

The 2-Wire value for each resistor is calibrated. The 2-Wire value is measured at the terminals

Specifications apply between 17°C and 30°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

2050 Capacitance Specifications

TRANSMILLE
Solutions In Calibration

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard capacitors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Voltage	D	R_s
10nF	50V	0.006	N/A
1uF	30V	0.002	N/A

Specifications apply at 1kHz. Allow 20pF for lead effects.
No appreciable variation is noticable in value above 1kHz.

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
10nF	0.2	0.225	0.25	0.35
1uF	0.32	0.36	0.4	0.56

Measurement methods
C_p up to 1uF

Capacitance is calibrated as value at the terminals
ie. displayed value incorporates capacitance of circuit up to and including the terminals

Specifications apply between 17°C and 30°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

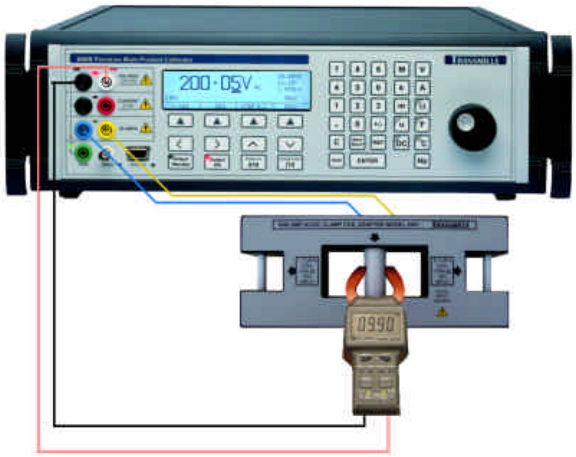
2000 Series

Precision Multi Product Calibrator

Operation Manual
Appendix B

Affordable AC Power Calibration PWR

- **Internal retro-fittable option**
- **10mW to 1MW Range**
- **10Hz to 400Hz frequency range**
- **0° to ± 180° adjustable phase relationship**
- **Accuracy : Power 0.1% • Phase 0.2°**



A complete solution for the accurate calibration of power (Watts) and VA ranges on power meters, power analysers & clamp meters, the power option for the 2000 series calibrators allows both an AC voltage and an AC current output to be generated simultaneously with an adjustable phase angle relationship.

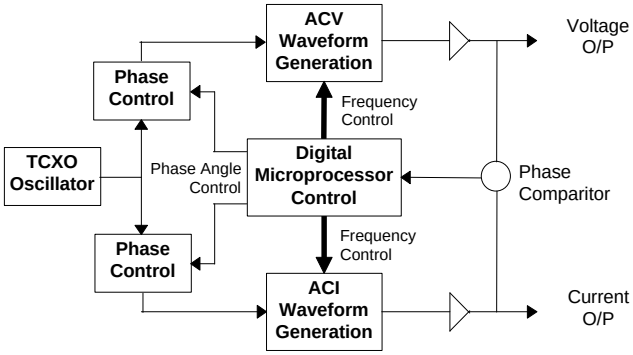
Any AC voltages up to 1000 Volts can be set using the normal AC output ranges and specification of the calibrator. Currents up to 20Amps with 2mA resolution are available from the 20Amp output of the calibrator without the need for an external amplifier.

The power function is extremely simply to use, simply select ‘Power’ from the soft key menu under the display, connect the Power meter to both the voltage and 20Amp output terminals, and enter the voltage, current, frequency and phase angle required.

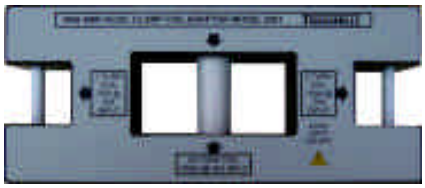
The phase angle can easily be changed leaving the voltage/current set using the soft menu keys.

Dynamic Digital Phase Control

The 2000 series calibrator dynamically controls the phase angle between the current and voltage waveforms eliminating errors caused by capacitive or inductive loading experienced when using clamp coils.



Extended the power range Using the 1 / 5 / 50 Clamp Coil Adapter



Combined with the optional clamp coil adapter the AC Power calibration option allows a current of 1000Amps to be simulated, and power to 1Megawatt (1000Amps x 1000Volts).

The equations below explain the relationship between Watts, Current, Voltage & Phase Angle.

Active Power : Watts = Voltage x Current x Cosine ‘Phase angle’
Apparent Power : VA = Volts x Current
Power Factor : PF = Active Power / Apparent Power
Phase Angle : F = Angle of AC Current shift from Voltage

Automating Power Meter Calibration Using ProCal Software

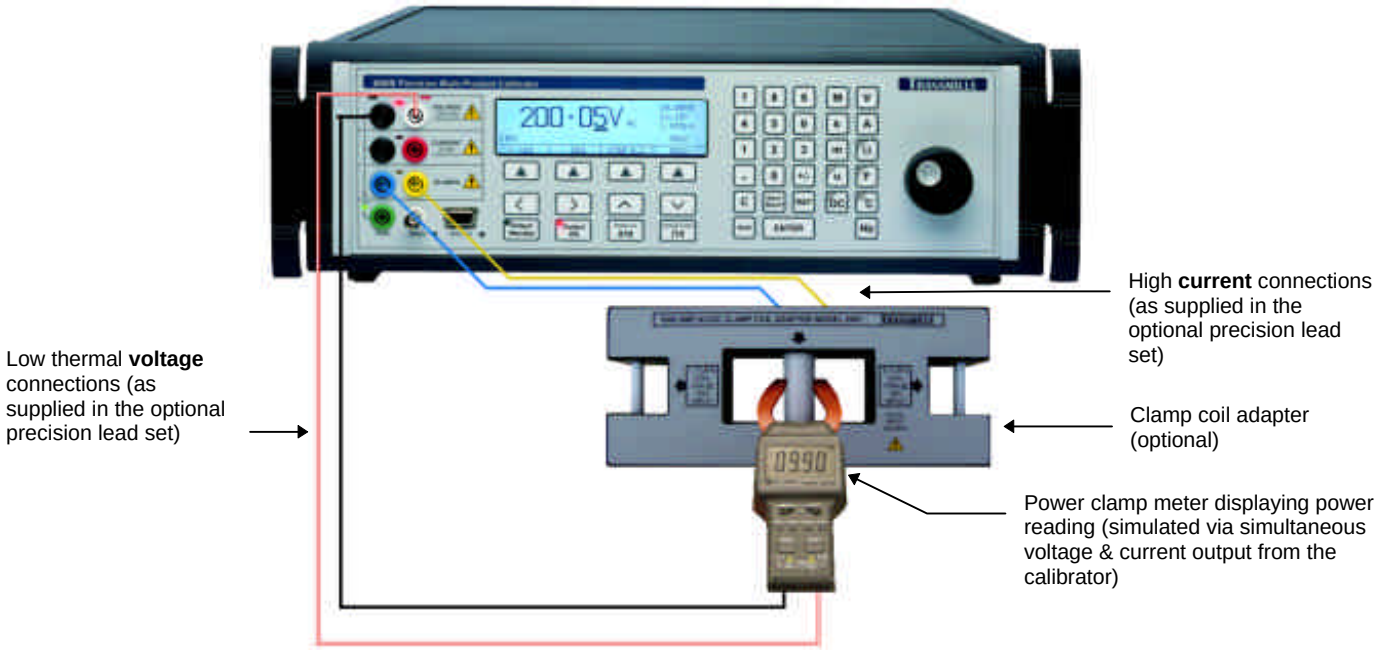
AC power calibration can be fully automated by using ProCal to control the 2000 Series calibrator using a PC. The 2000 Series calibrator is controlled via the RS232, removing the need for expensive interface cards. Alternatively, control can also be achieved via the GPIB interface option if required.

AC Power Calibration Option - Operation

The power option for the 2000 Series calibrators calibrator can simulate power by simultaneously outputting AC voltage and AC current with an adjustable phase relationship.

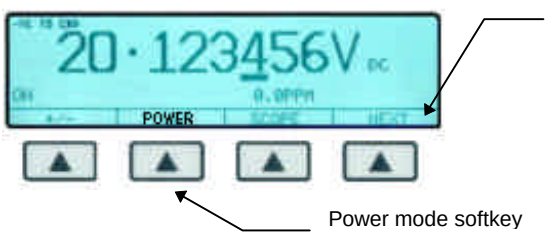
Connecting a UUT to the Calibrator

The UUT should be connected to the **voltage** and **current** terminals of the calibrator to allow AC power to be simulated. The example configuration below shows a *power clamp meter* with the calibrator's current terminals connected to the optional Transmille clamp coil adapter and the calibrator's voltage terminals connected to the power clamp meter voltage input terminals :



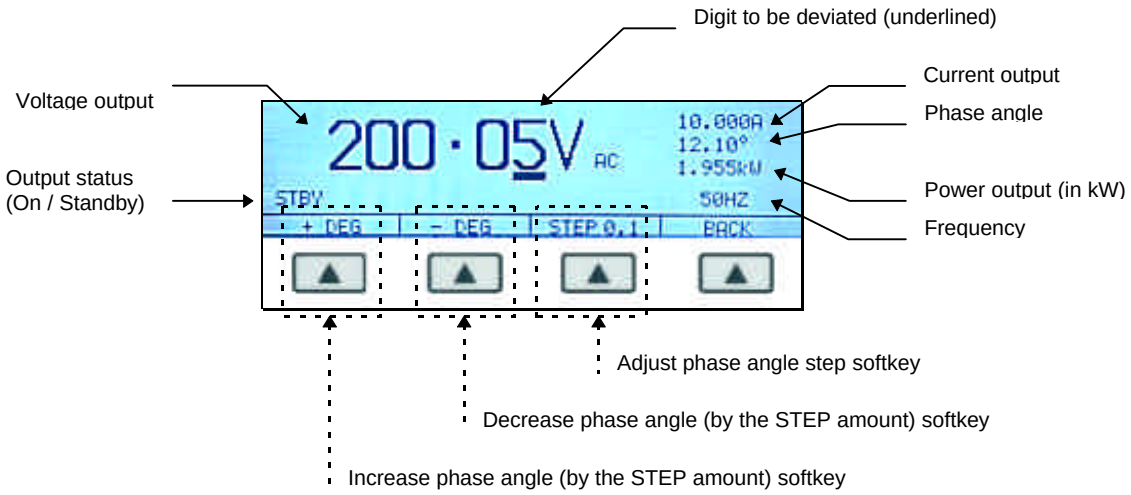
Starting the AC Power Calibration Option

To start the AC power calibration option, press the softkey below the menu item POWER



AC Power Calibration

The 2000 series calibrator can produce AC power output by simultaneously outputting an AC voltage at the **VOLTAGE** terminals and an AC current at the **HIGH CURRENT** terminals with a fully adjustable phase relationship.



1. Connect the UUT to the calibrator's voltage and high current terminals either directly or through the optional 1 / 5 / 50 clamp coil adapter.

2. Using the keypad enter the voltage, for example 200V :

[2] [0] [0] [V] [ENTER]

3. Using the key pad, enter the required current, for example 2A :

[2] [A]

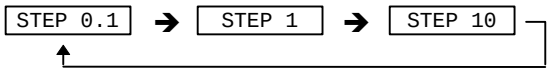
ⓘ Note : After entering the current it is **NOT** necessary to press the [ENTER] key.

Ensure the calibrator output is turned ON by pressing the [Output ON] key.

Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

4. Change the phase angle by using the menu items [+ DEG] and [- DEG] softkeys below the menu items shown.

The phase angle step size can be changed by stepping through the step size menu using the softkey below the menu item

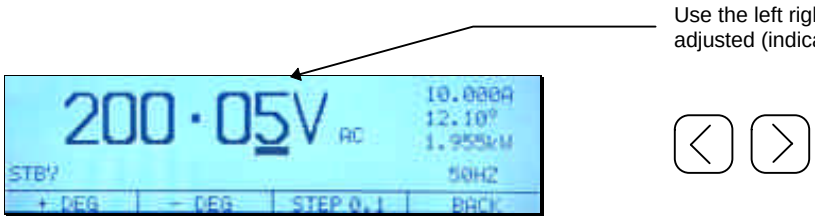


ⓘ Note : Available step sizes are 0.1, 1 & 10

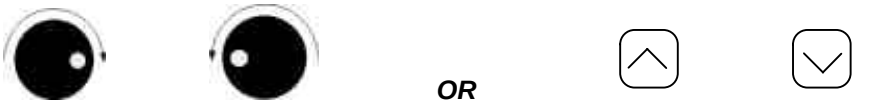
TIP
The value in kW is calculated and displayed on the right hand side of the display

5. To deviate the power output from the nominal value, use the deviation function to alter the voltage output which will allow the total power output simulated to be altered.

This is controlled by using the left and right arrow keys to select the digit to be increased or decreased



To increase or decrease the digit, simply use the up down keys on the calibrator's keyboard or use the digital potentiometer



Increment Decrement Increment Decrement

Note : The voltage, current and phase settings can be changed at any time by re-entering the value required

AC Power calibration times can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the power instrument's specifications.

2006A AC Power Option Specifications

General Specifications	
Voltage Range	0 to 1000V AC
Current Range	2 to 20A AC
Frequency Range	10 to 400Hz
Output Terminals	Voltage output from top (Black & White) terminals Current output from bottom 20A (Blue & Yellow) terminals Note : Indicator LEDs for both sets of terminals will illuminate to indicate AC Power mode

90 Day Accuracy Relative to Calibration standards (% Watts)

Current Range	Resolution	Voltage Range & Resolution			
		2V	2V to 20V	20V to 200V	200V to 1kV
		100uV	1mV	10mV	100mV
10A to 20A	2mA	0.11%	0.08%	0.06%	0.06%
5A to 10A	2mA	0.14%	0.1%	0.07%	0.08%
1A to 5A	2mA	0.22%	0.18%	0.18%	0.2%
Using High Accuracy 50 Turn Coil					
20A to 1000A	100mA	0.4%	0.35%	0.37%	0.38%

1 Year Accuracy Relative to Calibration standards (% Watts)

Current Range	Resolution	Voltage Range & Resolution			
		2V	2V to 20V	20V to 200V	200V to 1kV
		100uV	1mV	10mV	100mV
10A to 20A	2mA	0.14%	0.1%	0.07%	0.08%
5A to 10A	2mA	0.18%	0.12%	0.09%	0.1%
1A to 5A	2mA	0.28%	0.22%	0.22%	0.25%
Using High Accuracy 50 Turn Coil					
20A to 1000A	100mA	0.5%	0.44%	0.46%	0.48%

Frequency range 40Hz to 400Hz
Power Factor = 1

Phase Specifications

Phase Angle	Resolution	Life Accuracy	
		40Hz to 100Hz	100Hz to 400Hz
0° to 359.9°	0.1°	0.2°	0.8°

2000 Series calibrators **automatically correct for any errors in the phase** caused by inductive loading, for example when using the clamp coil adaptor.

High Voltage Safety

High voltage output is ramped to allow instruments to auto range
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage
Standby is automatically selected for high voltage (>20V) after 5 minutes on the same setting
High voltage (> 20V) output is indicated to user through an audible warning beep
An external high voltage output/standby control switch is available as an option

20A available as standard - external amplifier **not** required
Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

2041A AC Power Option Specifications

General Specifications	
Voltage Range	0 to 1000V AC
Current Range	2 to 20A AC
Frequency Range	10 to 400Hz
Output Terminals	Voltage output from top (Black & White) terminals Current output from bottom 20A (Blue & Yellow) terminals Note : Indicator LEDs for both sets of terminals will illuminate to indicate AC Power mode

90 Day Accuracy Relative to Calibration standards (% Watts)

Current Range	Resolution	Voltage Range & Resolution			
		2V	2V to 20V	20V to 200V	200V to 1kV
		100uV	1mV	10mV	100mV
10A to 20A	2mA	0.16%	0.11%	0.13%	0.14%
5A to 10A	2mA	0.16%	0.14%	0.16%	0.18%
1A to 5A	2mA	0.28%	0.24%	0.25%	0.28%
Using High Accuracy 50 Turn Coil					
20A to 1000A	100mA	0.48%	0.43%	0.45%	0.46%

1 Year Accuracy Relative to Calibration standards (% Watts)

Current Range	Resolution	Voltage Range & Resolution			
		2V	2V to 20V	20V to 200V	200V to 1kV
		100uV	1mV	10mV	100mV
10A to 20A	2mA	0.2%	0.14%	0.16%	0.18%
5A to 10A	2mA	0.2%	0.18%	0.2%	0.22%
1A to 5A	2mA	0.35%	0.3%	0.31%	0.35%
Using High Accuracy 50 Turn Coil					
20A to 1000A	100mA	0.6%	0.54%	0.56%	0.58%

Frequency range 40Hz to 400Hz
Power Factor = 1

Phase Specifications

Phase Angle	Resolution	Life Accuracy	
		40Hz to 100Hz	100Hz to 400Hz
0° to 359.9°	0.1°	0.2°	0.8°

2000 Series calibrators **automatically correct for any errors in the phase** caused by inductive loading, for example when using the clamp coil adaptor.

High Voltage Safety

High voltage output is ramped to allow instruments to auto range
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage
Standby is automatically selected for high voltage (>20V) after 5 minutes on the same setting
High voltage (> 20V) output is indicated to user through an audible warning beep
An external high voltage output/standby control switch is available as an option

20A available as standard - external amplifier **not** required
Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

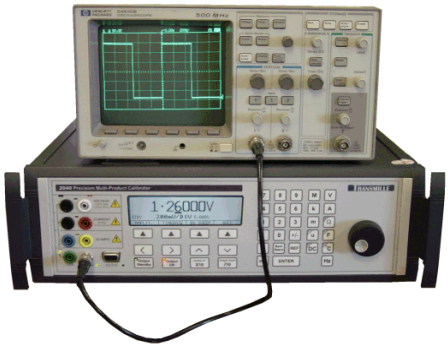
Due to continuous development specifications may be subject to change.

Oscilloscope Calibration Option

For the 2000 Series Calibrators

Cost Effective Oscilloscope Calibration Option SCP

- **Internal Retro-Fittable Option**
- **Economical scope calibration -** All the benefits at a fraction of the cost of a dedicated instrument
- **All outputs from one BNC**
- **Automate calibration using ProCal Calibration software**



Calibration module expands the capabilities of the 2000 Series calibrators to provide **Amplitude**, **Timebase** and **Bandwidth** calibration of oscilloscopes up to 600MHz. A fixed 50kHz reference is also incorporated. Output for all oscilloscope calibration module functions is through a single dedicated BNC connection with an associated 'active' indicator LED.

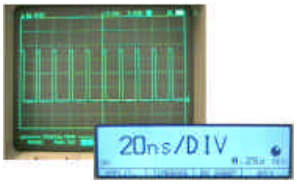
Amplitude

- **2mV/Div to 50V/Div**
- **1 - 2 - 5 Sequence**
- **10% Deviation**

Easily selected using the softkeys, the calibrator produces either a precision 1kHz square wave or a DC level covering the range from 2mV/Div to 50V/Div in a 1,2,5 sequence. Deviation up to 10% in 0.01% steps can be applied using the digital potentiometer. The calibrator's wide range output, giving up to 300V pk-pk, can be used to directly calibrate the ever increasing number of oscilloscopes with amplitude ranges up to 50V/Div placing it in a class leading position.

Timebase

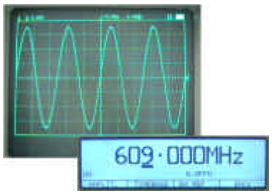
- **2ns/Div to 5s/Div**
- **1 - 2 - 5 Sequence**
- **10% Deviation**



The timebase function of the oscilloscope option provides outputs from 2ns/Div to 5s/Div in 1,2,5 Sequence. Deviation up to 10% in 0.01% steps can be applied using the digital potentiometer. To use, simply align the time marker with the graticule display and read the deviation from the % display on the calibrator. The comb waveform used below 100ns is ideal for triggering on both analogue and digital oscilloscopes alike. For faster timebase calibration, a sine wave is produced which makes viewing on bandwidth limited oscilloscopes easier. The timebase output can be used either directly or into a 50 Ohm input.

Levelled Sweep

- **5MHz to 620MHz**
- **50kHz Reference**
- **600mV pk-pk**



The levelled sweep output of the oscilloscope option provides a continuously variable sine wave from 5MHz to 620MHz. A 50kHz reference level waveform is also available to allow the oscilloscope controls to be set to give a 6 graticule height display.

Automated calibration Using ProCal

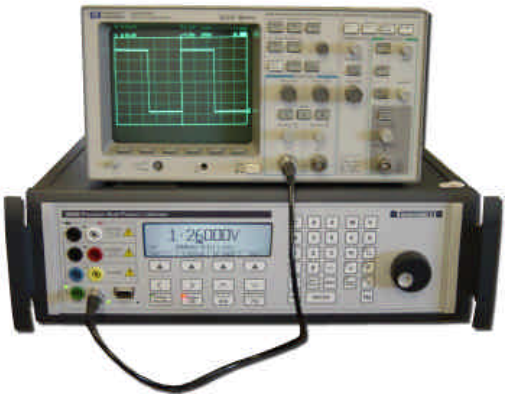
When used with ProCal, a calibration procedure automatically sets calibrator and guides the operator, recording the results and producing a printed certificate if required saving time and reducing skill levels while improving quality and efficiency.

Specifications

Amplitude : 2mV/Div to 50V/Div • 1-2-5 Sequence • 10% Dev.
Timebase : 2ns/Div to 5s/Div • 1-2-5 Sequence • 10% Dev.
Bandwidth : 5MHz to 620MHz • 50kHz Ref. •600mV pk-pk

See extended specifications for full details

Calibrating Oscilloscopes - Applications



Introduction

Oscilloscopes have always been an important measurement tool for the engineer. The design of oscilloscopes has evolved slowly from early instruments which were used to simply view a waveform, to oscilloscopes with calibrated ranges and graticules (grid) on the display to enable measurements to be made, up to the modern digital storage oscilloscope (DSO) which have many advanced measurement functions built in as standard.

The latest designs now use digital LCD displays instead of the tradition CRT (cathode ray tube) and are putting even more measurement power in the hands of the engineer in ever more portable instruments. The oscilloscope is still evolving, the latest step is the scope meter which combines the functions of an oscilloscope with those of the DMM in one instrument. Each evolutionary step has added to the measurement capability of the oscilloscope, making the calibration of these instruments even more important.

The large number of ranges, channels and functions of oscilloscopes can make the calibration process time consuming and hence expensive which has lead to, in some cases, the oscilloscope being marked 'DISPLAY USE ONLY' calibration not required - this limits the usage of an otherwise very power measurement tool. The solution is more efficient calibration which is provided by the 2000 series calibration option and ProCal software.

Oscilloscope Types

There are three basic types of oscilloscope in common usage which the calibration laboratory may need to calibrate.

1) *Simple oscilloscopes* - usually dual channel with direct display on CRT.

2) *Digital storage scope* (DSO) with readout

3) *Hand held* Scope meters

All types are available with different bandwidths, but the bulk of oscilloscopes have bandwidths less than 200MHz with very few having bandwidth above 600MHz.

The bandwidth rating is a measure of the oscilloscopes ability to display high frequency, and as a guide the higher the bandwidth the more features a scope will have.

All types of oscilloscopes require calibration of three main functions.

Vertical Deflection / Amplitude

- Typical ranges from 2mV/Div to 50V/Div

Ranges are normally in a 1,2,5 sequence, calibration is carried out using a 1kHz square wave positive going from ground, 6 graticules high. As it is impossible to read the error accurately from the scope display the calibrators output is slewed (Increased or Decreased) to align the trace with the graticules. On some scopes, especially if fitted with readout a DC voltage is needed for calibration which can also be provided by the 2000 series calibrator.

Notes

1) Parallax errors

It is important to view the display straight on to avoid any parallax errors. This only applies to the older scopes, many modern digital scopes also display the graticules digitally on the screen.

2) Calibrate Each range
Even the high ranges as any range could have been damaged by the user applying excessive voltage to the input.

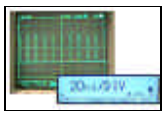
3) Shock Risk
The 2000 Series option produces voltages up to 300Volts needed for the calibration of the high ranges (50V/Div x 6 = 300Volts) found on some scopes.

4) Noise On Low Ranges
This can be reduced by using the scopes bandwidth limit function if fitted.

5) Ground Loops
An oscilloscope's input is almost always at power line earth - if the 2000 series also has the output grounded then noise / offsets could be caused by ground loop currents flowing between the power ground of the scope and that of the calibrator.

To calibrate amplitude with the 2000 series select 'Scope' from the soft menu keys, then amplitude. Use the range keys, stepping up or down through the ranges to match that of the scopes. Slew the calibrator using the digital pot to align waveform.

The Horizontal Deflection / Time Base Calibration.



- Typical ranges from 5s to 2ns

Calibration is performed using a comb type wave form which can easily be aligned to the graticule scale. This works well up to 100ns where bandwidth limits the use of very short pulses, so a sine wave is used instead. Like amplitude, the calibrators output is slewed to accurately align the first and ninth pulse up on the graticule scale. The error can then be read from the deviation applied by the calibrator. The linearity of the horizontal sweep can also be checked by looking at the alignment of every pulse.

Notes

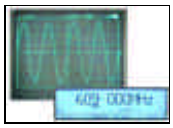
1) To help get the scope set to the correct settings for amplitude/trigger etc. use a midrange marker first, 1ms for example, auto-scale on DSO's will, in particular, find this waveform easily and set trigger and amplitude range for you.

2) Set the coupling to DC and the trigger mode to 'NORM' to capture slow time markers. Auto trigger may start the sweep before the first pulse.

3) Using a 50 Ohms input will improve the shape of the waveform but makes no difference to the accuracy of calibration.

To calibrate timebase with the 2000 series select 'Scope' from the soft menu keys, then Time. Use the range keys, stepping up or down through the ranges to match that of the scopes, slew the calibrator using the digital pot to align waveform.

Bandwidth / Leveled Sweep
From 5MHz upwards



Calibration of bandwidth requires a constant amplitude sine wave of variable frequency up to and above that of the oscilloscopes specification. Many calibration procedures also call for a 50kHz reference level to set the start amplitude.

Calibration involves setting the scope to display the 50kHz ref level at 6 graticules high then increasing the frequency until the waveform is only 5.4 graticules high (the 3db point). The frequency at this point is the bandwidth. On increasing the frequency the display should also be checked for any 'highs' or flat spots to ensure a level response. Bandwidth can also be obtained by using a fast rising edge (formula Bandwidth MHz =)

Notes

Bandwidth must be measured with either the oscilloscope's 50 Ohm input selected or an external feed through line terminator fitted to the oscilloscope's input.

To calibrate bandwidth with the 2000 series select 'Scope' from the soft menu keys, then bandwidth. Ensure the oscilloscope input is 50 ohms. Set the oscilloscope amplitude to show the waveform at 6 divisions high using the 50 kHz ref level selected from the soft keys, then return to the leveled sweep output increase the frequency until the 3db point (5.4 div high) is reached.

Trigger Level & Sensitivity

Trigger level can be tested by using a sinusoidal signal at 6 divisions high and adjusting the trigger level control to produce a stable trace starting at any point on either the positive or negative slope depending on scope selection. Sensitivity is tested by applying a much smaller signal (typically 10% of FS) and checking a stable trace can be obtained even when the position controls are used to move the trace to the top or bottom of the display. Bandwidth of the triggering and operation of the HF noise filters on some scopes can be tested by using the leveled sweep output and increasing the frequency or until stable triggering is lost. See oscilloscope manual for method and levels.

Other Parameters

There are many other functions on oscilloscope's which may require testing are listed below, The scopes manual will give the manufacturers recommend methods for testing other features which can be tested as required.

Display Geometry
Mainly for older scopes with separate graticules screens which require mechanical alignment with the CRT which may also need trace rotation to be adjusted.

Display & Controls
Operation of brightness, focus, astigmatism and position controls.

Selection of vertical channel operation
Chopped/Alternate/channel 1,2 etc.

DC balance
The change in DC level between ranges.

Input Coupling Selection
AC/DC/50 ohm/Gnd

Pulse Response
Leading edge Aberration.

X Input operation and bandwidth
For scopes with 'X' inputs

Vertical & Horizontal X10 function:

Trigger mode selection
Ch1, Ch2, Int, Ext, DC couple, noise reject, +/-ve edge etc

Time base mode selection
Auto, norm, hold off etc

Delay Time base operation and accuracy.

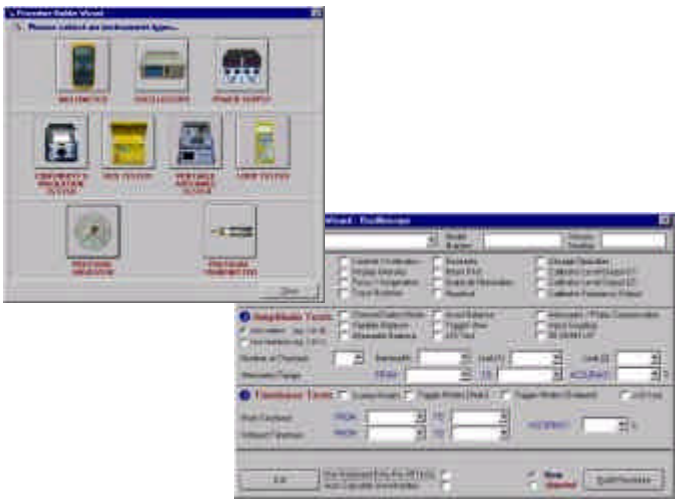
Cursor Readouts
Frequency, period, pk-pk amp, etc.

Automating Oscilloscope Calibration Using ProCal Software

Oscilloscope calibration can be fully automated by using ProCal to control the 2000 Series calibrator and even the oscilloscope under test using a PC. The 2000 Series calibrator is controlled via the RS232, removing the need for expensive interface cards. Alternatively, control can also be achieved via the GPIB interface option if required.

ProCal can also utilise its ability to control instrumentation via the RS232 or GPIB interfaces to automatically set the oscilloscope under test as well as the 2000 Series oscilloscope option, providing complete automation. This technique of controlling the 2000 Series calibrator and the UUT in this manner can be employed in many types of calibration, making ProCal a true multi-discipline software solution.

The ProCal oscilloscope calibration *procedure wizard* is one of a set of wizards which can assist in automatically creating procedures based on simple high level information such as ranges, number of channels, accuracy etc. Using these procedure wizards a procedure can be created in a matter of minutes.

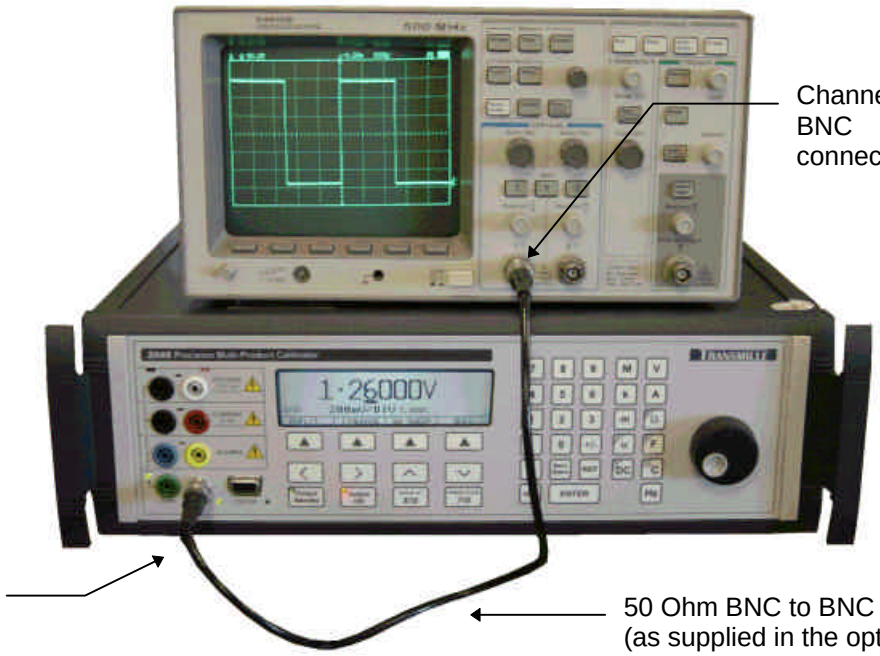


Oscilloscope Calibration Option - Operation

The oscilloscope calibration option can provide Amplitude, Time base and Bandwidth signals for calibration of oscilloscopes.

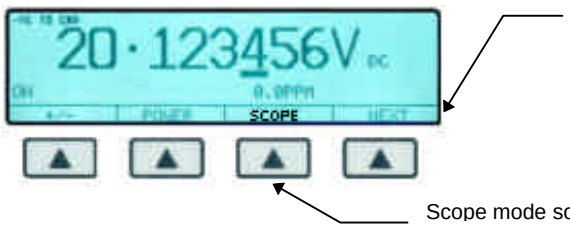
Oscilloscope Connection

Using a BNC to BNC 50 Ohm coax cable, connect the 2000 Series calibrator SCOPE BNC output connector to the oscilloscope connector (to begin with connect to channel 1, the progressively test each channel by connecting to any other additional channel input connectors as necessary).



Starting the Oscilloscope Calibration Option

To start the oscilloscope calibration option, press the softkey below the SCOPE menu item

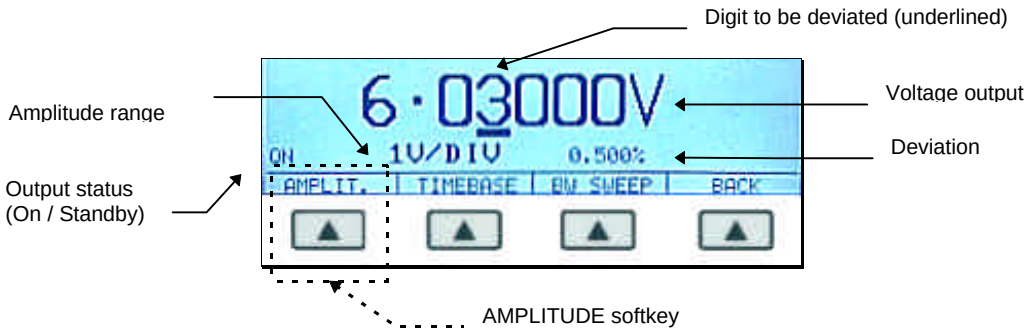


Oscilloscope Calibration : Amplitude

The oscilloscope amplitude is calibrated by applying a low frequency square wave and adjusting its gain to meet the height specified for different voltage levels (shown by the graticule line divisions on the oscilloscope).

The voltages that are used for calibration are selected using the corresponding setting as per the amplitude ranges on the oscilloscope. Using this output the waveforms should be aligned with the graticule markings on the oscilloscope display.

On entering oscilloscope mode, AMPLITUDE will be the default function. The display below will be shown indicating the currently selected range and output status :



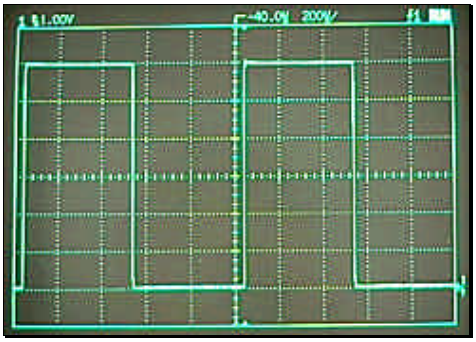
When calibrating the oscilloscope's amplitude gain, you will need to set different voltages and check that the gain matches the graticule height lines on the display of the oscilloscope within the specifications as supplied by the oscilloscope's manufacturer.

1. Using a BNC to BNC type lead (such as the lead supplied with the optional precision lead set available from Transmille) connect the 2000 series BNC connector to the oscilloscope Channel 1 BNC connector. Set the oscilloscope to the required range.

2. Using the RANGE UP **X10** RANGE DOWN **/10** buttons, select the range required, e.g. 200mV/Div and ensure the calibrator output is turned ON by pressing the Output ON key.

Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

3. Adjust the oscilloscope to display the waveform as shown below :



Graticule height = 6

4. To determine the deviation from nominal of the oscilloscope, use the deviation function to alter the output. This is controlled by using the keys to select the required digit on the voltage display (indicated by the underlined digit) then using either the keys or the digital potentiometer to increment or decrement the digit value

Increment Decrement

ⓘ Note : The % of deviation is shown in the bottom right hand side of the calibrator's display

For example if the displayed amplitude waveform was HIGH on the oscilloscope display, the value would be deviated down to the value at which the amplitude was within six graticules on the oscilloscope display for the waveform displayed above.

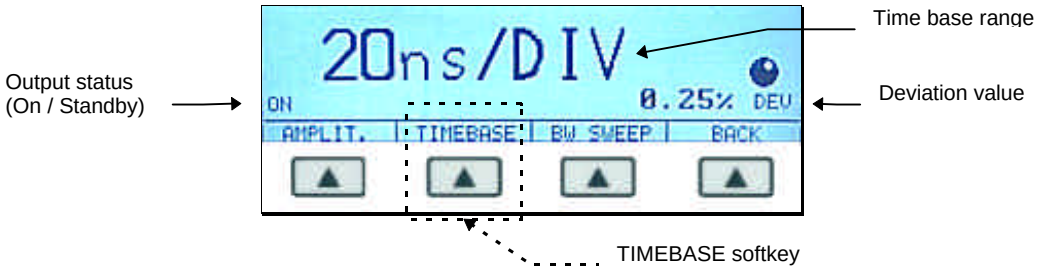
Note : The graticule height is set to 6 as default

5. The above operation should be performed for all of the ranges and on each of the channels on the oscilloscope. This normally lengthy process can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the oscilloscope's specifications.

Oscilloscope Calibration : Time base

The time base of an oscilloscope is calibrated to ensure the horizontal deflection meets the manufacturers specifications. A time marker signal is generated from the calibrator of which the peaks are aligned with the graticule scale on the oscilloscope display.

Select the TIMEBASE function using the softkey located beneath the TIMEBASE menu item.
The display below will be shown indicating the currently selected range and output status :

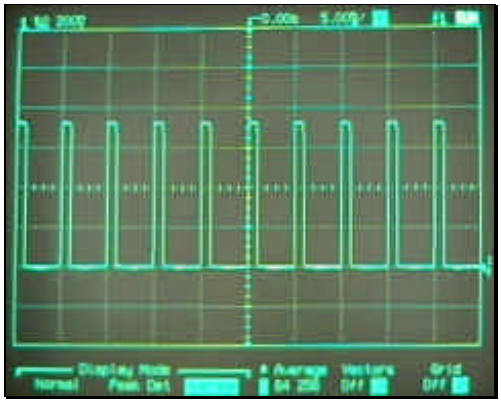


1. Using a BNC to BNC type lead (such as the lead supplied with the optional precision lead set available from Transmille) connect the 2000 series BNC connector to the oscilloscope Channel 1 BNC connector. Set the oscilloscope to the required range.

2. Using the RANGE UP **X10** RANGE DOWN **/10** buttons, select the range required, e.g. 20ms/Div and ensure the calibrator output is turned ON by pressing the Output ON key.

Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

3. Adjust the oscilloscope to display the waveform as shown below - the time marker signal peaks should be aligned with the divisions marked on the oscilloscope display :



4. To determine the deviation from nominal of the oscilloscope, use the deviation function to alter the output. This is controlled by using the digital potentiometer to increment / decrement the time marker signal.


Increment


Decrement

ⓘ Note : The % of deviation is shown in the bottom right hand side of the calibrator's display

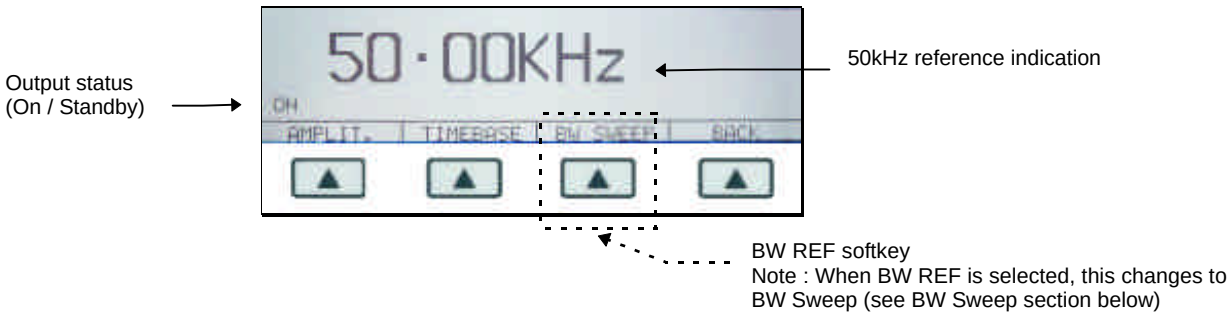
5. The above operation should be performed for all of the time base ranges on the oscilloscope.
This normally lengthy process can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the oscilloscopes specifications.

Oscilloscope Calibration : 50kHz Reference

The 50kHz bandwidth reference output of the 2000 series calibrator should be used to set an oscilloscope to display a waveform which is 6 graticules high by adjusting the amplitude gain (Volts / Div setting). This allows the oscilloscope to be correctly configured prior to performing bandwidth verification (detailed below), ensuring that when bandwidth sweep is selected the user can simply increase the frequency and determine the -3dB point (4.2 graticules) accurately.

In order to select the bandwidth reference (50kHz), it is necessary to select the BW SWEEP (Bandwidth Sweep) function first using the softkey. Once BW Sweep is selected, the menu item will change to indicate BW REF - simply press the softkey under this menu item to set the BW REF mode.

The display below will be shown indicating the current frequency and output status :



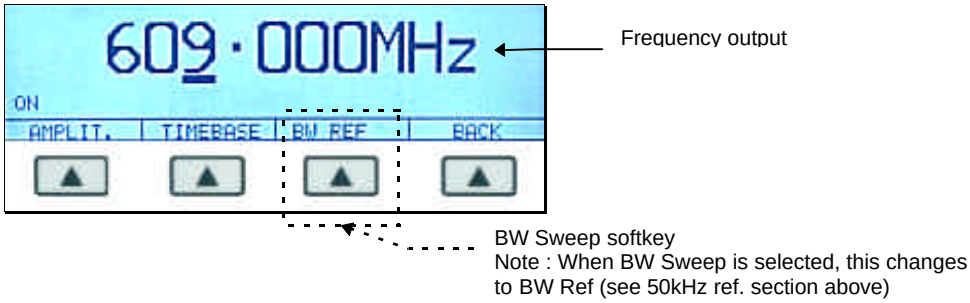
Ensure the calibrator output is turned ON by pressing the Output ON key.

Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

Oscilloscope Calibration : Bandwidth Sweep

The bandwidth calibration output of the 2000 series calibrator produces a levelled sine wave with a constant amplitude over its frequency span. To check the bandwidth of an oscilloscope this levelled sine wave is applied and the frequency gradually increased until the amplitude displayed on the oscilloscope display drops by 30% (this is the amplitude corresponding to the -3dB point)

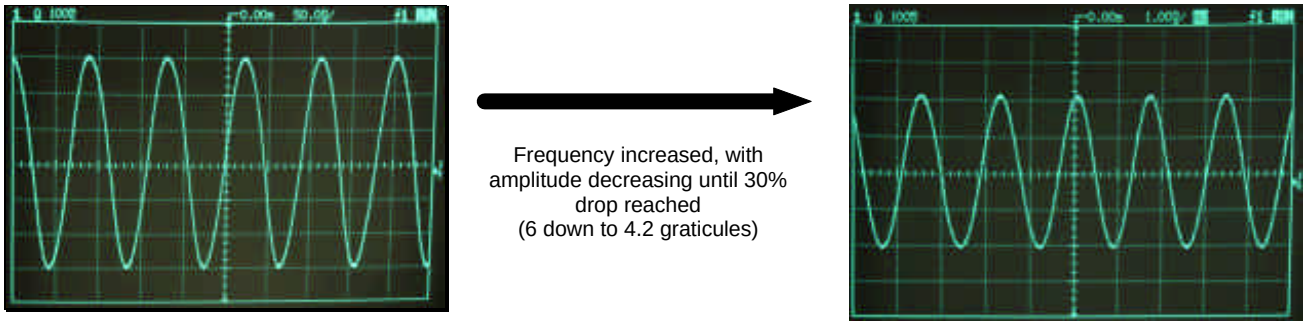
Select the BW SWEEP (Bandwidth Sweep) function using the softkey.
The display below will be shown indicating the current frequency and output status :



1. Using a BNC to BNC type lead (such as the lead supplied with the optional precision lead set available from Transmille) connect the 2000 series BNC connector to the oscilloscope Channel 1 BNC connector. Ensure the correct termination is used when connecting to the oscilloscope (for example 50 Ohms). Set the oscilloscope to the required range.

2. Using the digital potentiometer, select the required start frequency, e.g. 3MHz

3. The oscilloscope should display the waveform as shown below :



4. Gradually increase the frequency output from the calibrator by using the digital potentiometer until the waveform drops by 30% (this can be seen when the waveform drops from 6 graticules to 4.2 graticules high)

Increment

Decrement

5. The above operation should be performed for all of the time base ranges on the oscilloscope.
This normally lengthy process can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the oscilloscope's specifications.

2000 Series Oscilloscope Calibration Option Specifications

Amplitude	
Ranges	2mV/Div : 5mV/Div : 10mV/Div : 20mV/Div : 50mV/Div : 100mV/Div 200mV/Div : 500mV/Div : 1V/Div : 2V/Div : 5V/Div : 10V/Div : 20V/Div : 50V/Div
Sequence	1, 2, 5
Waveshapes	Square Wave (positive going from ground) : DC
Frequency	1kHz
Frequency Accuracy	30ppm
Graticule Height	6 Graticules
Rise Time	2us
Fall Time	2us
Output Terminal	Front BNC (Green LED indicates terminal active)

Range @ 1Mega Ohm loading	90 Day Rel. % ± uV	180 Day Rel. % ± uV	1 Year Rel. % ± uV	2 Year Rel. % ± uV
2mV to 50V/Div	0.009 ± 5	0.01 ± 5	0.01 ± 5	0.014 ± 5

High Voltage Safety

High voltage output is ramped to allow instruments to auto range
Auto standby is activated when passing through 20V or 200V output values
High voltage (> 20V) output is indicated to user through an audible warning beep
An external high voltage output/standby control switch is available as an option

Amplitude Deviation	
Deviation Range	±10% in 0.01% Steps
Deviation Resolution	Better than 1ppm

Range	90 Day Rel. % ± uV	180 Day Rel. % ± uV	1 Year Rel. % ± uV	2 Year Rel. % ± uV
-10% to +10%	0.008 5	0.01 ± 5	0.01 ± 5	0.014 ± 5

Timebase	
Ranges	2ns/Div : 5ns/Div : 10ns/Div : 20ns/Div : 50ns/Div : 100ns/Div : 200ns/Div 500ns/Div : 1ms/Div : 2ms/Div : 5ms/Div : 10ms/Div : 20ms/Div : 50ms/Div 100ms/Div : 200ms/Div : 500ms/Div : 1s/Div : 2s/Div : 5s/Div
Sequence	1, 2, 5
Waveshape	Comb below 100ns Sine Wave above 100ns
Oscillator	Internal Crystal TCXO
Output Terminal	Front BNC (Green LED indicates terminal active)

Range	90 Day Rel. ppm	180 Day Rel. ppm	1 Year Rel. ppm	2 Year Rel. ppm
2ns/Div to 5s/Div	4.5	4.75	5	6

Timebase Deviation	
Deviation Range	±10% in 0.01% Steps
Deviation Resolution	Better than 0.01%

Range	90 Day Rel. % ± uV	180 Day Rel. % ± uV	1 Year Rel. % ± uV	2 Year Rel. % ± uV
-10% to +10%	0.008 5	0.01 ± 5.00	0.01 ± 5	0.014 ± 5

Timebase Level		
	Accuracy	Rise Time
Into 1 Mega Ohm	800mV ± 30%	N/A
Into 50 Ohms	400mV ± 30%	20ns

Levelled Sweep				
Sweep Range	5MHz to 600MHz[1]			
Waveform	Sine Wave			
Levelled Sweep	600mV pk-pk into 50 Ohms			
Reference Level	50kHz			
Output Terminal	Front BNC (Green LED indicates terminal active)			
Range	**90 Day Rel. db**	**180 Day Rel. db**	**1 Year Rel. db**	**2 Year Rel. db**
5MHz to 600MHz[1]	0.8	0.90	1	1.4

Note 1 : 2050 Bandwidth range is 5MHz to 250MHz

Levelled Sweep	
Frequency Accuracy	See Time markers

50kHz Reference				
Accuracy	**90 Day Rel.**	**180 Day Rel.**	**1 Year Rel.**	**2 Year Rel.**
Frequency Accuracy	27 ppm	29 ppm	30 ppm	36 ppm
Level Accuracy	0.4 %	0.45 %	0.5 %	0.7 %

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

Inductance Calibration Option IND

- **8 Precision Inductance Values**
- **Cost Effective Option**
- **Allows Calibration of RLC Meters & Bridges**
- **Retro-fittable option - can be added at any time to a 2000 Series calibrator**

By incorporating this useful and easy to use option the work load of the calibrator can be increased to allow calibration of RLC (Resistance, Inductance and Capacitance) meters and bridges and also allows calibration of DMMs with inductance measurement ranges.

Incorporates 8 fixed values, including 19mH and 29mH for '3' range meters to allow testing of these types of meters at points which can verify their linearity at near full scale points.

Specifications

Range	Maximum Current	DC Resistance	Q	1 year Rel %
1mH	30mA	7.8Ω	1	0.5
10mH	25mA	24Ω	2.8	0.5
19mH	20mA	33Ω	3.8	0.5
29mH	20mA	41Ω	4.7	0.5
50mH	20mA	54Ω	6.1	0.5
100mH	20mA	78Ω	8.6	0.5
1H	10mA	260Ω	29	0.5
10H	1mA	950Ω	110	0.5

Measured Value Stored For Accurate Calibration

When the 2000 series inductance option is calibrated, the exact measured value of the inductors is stored in non volatile memory. This value is recalled and displayed each time a specific inductor is selected, allowing accurate calibration to be performed.

Automated Calibration of LCR Meters Using ProCal Calibration Software

By using the ProCal calibration software from Transmille, the inductor values stored in non volatile memory can be automatically downloaded and used as the nominal test value, allowing this type of calibration work to be carefully controlled. This de-skills these types of measurement and provides a way to reduce costs by allowing efficient throughput of calibration work.

Measured inductance value stored and displayed by the 2000 series calibrator

Inductance Calibration Option - Operation

Note The calibrator uses standard inductors of fixed values the nearest value available value to the entered value will be automatically selected. The example below selects 10mH.

1. Use the calibrator keypad to key in the required value, e.g. '10'

   [1] [0]

2. Key in the multiplier (if required), e.g. 'm' for milli :

   [m]

3. Select H by keying SHIFT then F :

   [SHIFT] [H / F] ← 'H' is a sub function of the 'F' key, shown in the top left hand corner of the 'F' key.

   ⓘ **Note** : The SHIFT key is required as the 'H' function is a sub-function of the 'F' key

4. Press the ENTER key to set the value

   [ENTER]

   Ensure the calibrator output is turned ON by pressing the [Output ON] key.

   Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

   Note : The digital potentiometer can be used to step up or down through the inductance values once an initial inductance value has been selected.

   
   Step Up

   
   Step Down

ⓘ **Note** The value displayed will be the CLOSEST value available for the value entered (e.g. if 14mH was entered, 10mH would be selected). The value displayed is the calibrated value held in the non volatile calibration memory for the selected inductor.

Calibration times using the inductance option can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the instrument's specifications.

ⓘ **Note** : ProCal will *automatically* use the inductance value stored by the 2000 Series calibrator.

2000 Series Inductance Option Specifications

General Specifications

Range	Maximum Current	DC Resistance	Q
1mH	30mA	7.8Ω	1
10mH	25mA	24Ω	2.8
19mH	20mA	33Ω	3.8
29mH	20mA	41Ω	4.7
50mH	20mA	54Ω	6.1
100mH	20mA	78Ω	8.6
1H	10mA	260Ω	29
10H	1mA	950Ω	110

All Inductance specifications ± 50uH.

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
1mH	0.4	0.45	0.5	0.7
10mH	0.4	0.45	0.5	0.7
19mH	0.4	0.45	0.5	0.7
29mH	0.4	0.45	0.5	0.7
50mH	0.4	0.45	0.5	0.7
100mH	0.4	0.45	0.5	0.7
1H	0.4	0.45	0.5	0.7
10H	0.4	0.45	0.5	0.7

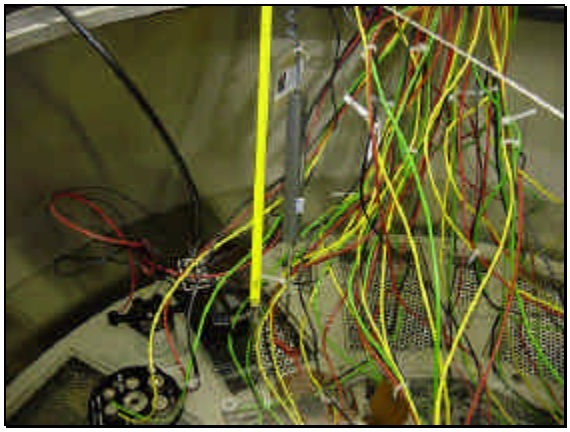
Measurement methods
L_s up to 1H
L_p from 1H to 10H

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

Resistance Thermometer Calibration Option PRT



- **Ultra Accurate Resistance Value**
- **2, 3 or 4 Wire Simulation of Probe**
- **8 Passive Resistance Values**

The PRT option makes the calibration of high accuracy resistance thermometers easy. Simply connect in place of the probe and compare the displayed value with the calibrated value from the 2000 series calibrator. Because the calibrator uses passive precision resistors, reliable readings are guaranteed regardless of the measurement technique used by the thermometer.

Specifications

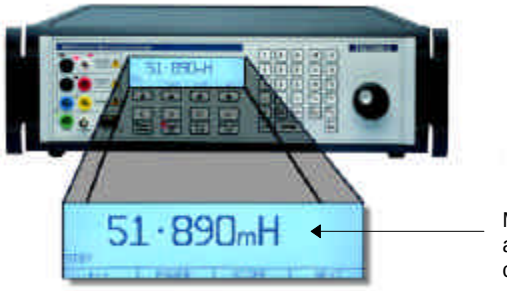
Range	Actual Value (Ohms)	Max. Power Rating (Watts)	Maximum Voltage (V)	Maximum Current (mA)	1 year Rel %
-100°C	60.25	0.2	3.47	57.62	0.01
0°C	100.00	0.2	4.47	44.72	0.01
+30°C	111.67	0.2	4.73	42.32	0.01
+60°C	123.24	0.2	4.96	40.28	0.01
+100°C	138.50	0.2	5.26	38.00	0.01
+200°C	175.84	0.2	5.93	33.73	0.01
+300°C	247.04	0.2	7.03	28.45	0.01
+800°C	375.51	0.2	8.67	23.08	0.01

Measured Value Stored For Accurate Calibration

When the 2000 series inductance option is calibrated, the exact measured value of the PRT resistor is stored in non volatile memory. This value is recalled and displayed each time a specific PRT resistor is selected, allowing accurate calibration to be performed.

Automated Calibration of Temperature Meters Using ProCal Calibration Software

By using the ProCal calibration software from Transmille, the PRT values stored in non volatile memory can be automatically downloaded and used as the nominal test value, allowing this type of calibration work to be carefully controlled. This de-skills these types of measurement and provides a way to reduce costs by allowing efficient throughput of calibration work.



Measured PRT resistor value stored and displayed by the 2000 series calibrator

Resistance Thermometer Calibration Option - Operation

Starting the PRT Calibration Option

To start the oscilloscope calibration option, press the softkey below the [PRT] menu item

ⓘ **TIP** : If the [PRT] menu item is not displayed, press the [PRT] softkey to go to the next menu level.

PRT Option Operation

1. Using two sets of 4mm to 4mm safety plug type leads (such as the leads supplied with the optional precision lead set available from Transmille) connect the 2000 series *Voltage* and *Low Current* sockets (indicated by LEDs when in PRT mode) to the 4-wire terminals of the UUT.
   ⓘ **Note** Some instruments will require a custom lead to be made, depending of the probe connection type.

2. Using the [RANGE UP X10] [RANGE DOWN /10] buttons, select the range required, e.g. 200°C and ensure the calibrator output is turned ON by pressing the [Output ON] key.

   Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

   Note : The digital potentiometer can be used to step up or down through the PRT values

Step Up Step Down

Calibration times using the PRT option can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the instrument's specifications.

ⓘ **Note** : ProCal will *automatically* use the PRT resistor value stored by the 2000 Series calibrator.

2000 Series Resistance Thermometer (PRT) Option Specifications

General Specifications

Range	Actual Value (Ohms)	Max. Power Rating (Watts)	Maximum Voltage (V)	Maximum Current (mA)
-100°C	60.25	0.2	3.47	57.62
0°C	100.00	0.2	4.47	44.72
+30°C	111.67	0.2	4.73	42.32
+60°C	123.24	0.2	4.96	40.28
+100°C	138.50	0.2	5.26	38.00
+200°C	175.84	0.2	5.93	33.73
+300°C	247.04	0.2	7.03	28.45
+800°C	375.51	0.2	8.67	23.08

4-Wire connection. Allow 1mW on all resistance specifications.

Accuracy Relative to Calibration Standards Specifications

Range	Actual Value (Ohms)	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
-100°C	60.25	0.009	0.008	0.01	0.014
0°C	100.00	0.009	0.008	0.01	0.014
+30°C	111.67	0.009	0.008	0.01	0.014
+60°C	123.24	0.009	0.008	0.01	0.014
+100°C	138.50	0.009	0.008	0.01	0.014
+200°C	175.84	0.009	0.008	0.01	0.014
+300°C	247.04	0.009	0.008	0.01	0.014
+800°C	375.51	0.009	0.008	0.01	0.014

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

Thermocouple Simulation Adapter

For the 2000 Series Calibrators

Thermocouple Simulation THER

- **External Unit**
- **Low noise & Thermally stable**
- **Integrated temperature sensor for accurate cold junction compensation**
- **Supports types K • J • T • R • S • E • N • B**
- **Works with ProCal Calibration software and 2000 Series Virtual Front Panel.**

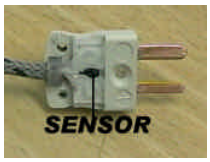
Dedicated External Adapter For the Ultimate in Accuracy

Temperature gradients / thermal EMFs which can be introduced by internally mounted thermocouple simulation methods are one of the greatest sources of error with thermocouple temperature calibration.

For the ultimate in accuracy, Transmille has designed a dedicated external unit. This keeps the electronics required to generate the low level signals used for thermocouple simulation as close as possible to the measuring input of the thermometer. This allows the signal to be as free from electrical noise as possible, and also eliminates errors caused by heat generated by surrounding electronics in the calibrator.

Direct Connection - No compensation cables required

- **Uses neutral (copper) thermocouple plug -** For direct connection to any thermocouple type input without the need for compensation cables
- **CJC sensor built in to thermocouple plug** For automatic CJC compensation



Special care has been taken over the cold junction compensation - a common source of errors in thermocouple calibration. The cold function compensation (CJC) sensor is mounted in the thermocouple plug itself. By measuring the cold junction at the instruments input allows any type of thermocouple to be simulated without using compensation cables.

Intuitive Operation & Control

- Easy selection of thermocouple type
- Auto / Manual Cold Junction compensation

Quick and easy to use, simply plug in the temperature adapter into the 2000 Series calibrator, select thermocouple simulation mode and thermocouple type using the softkeys and enter the temperature required.

Supports any temperature standard using Virtual Front Panel software

- Control directly from a PC
- Extend functionality
- Create custom conversion tables for any thermocouple standard

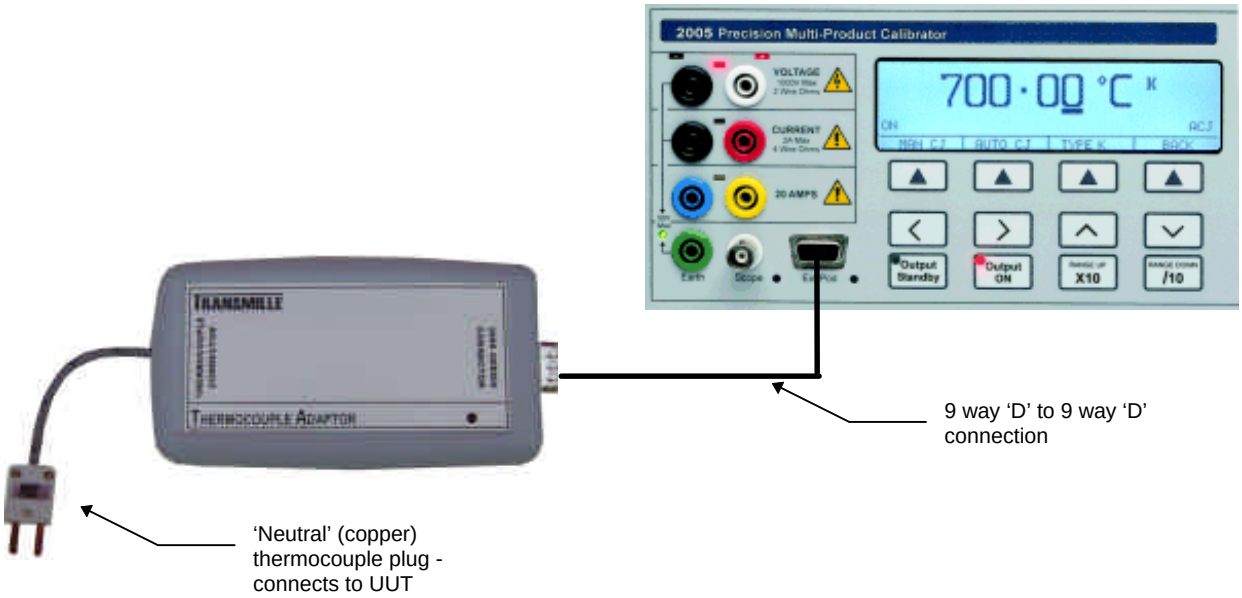
Using the Virtual Front Panel software from Transmille, custom configuration of temperature values can be achieved to any temperature standard providing the best flexibility.

See Extended specifications for full details

Thermocouple Simulation Option - Operation

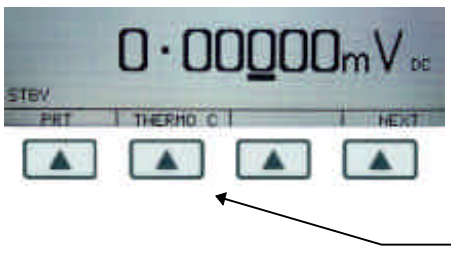
Thermocouple Adapter Connection

Using the supplied adapter connection lead (9 way 'D' type to 9 way 'D' type), connect the thermocouple adapter to the feature connection on the front panel of the 2000 series calibrator.



Starting the Thermocouple Simulation Option

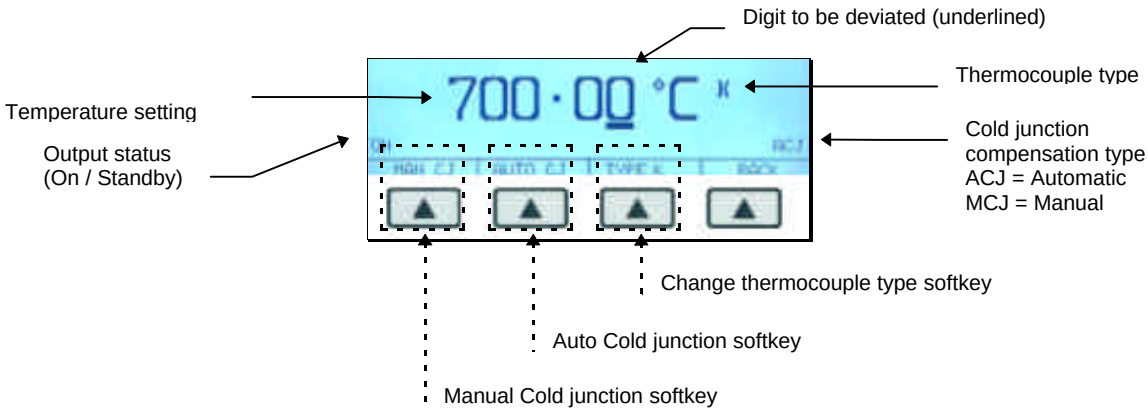
To start the oscilloscope calibration option, press the softkey below the THERMO C menu item



ⓘ **TIP** : If the THERMO C menu item is not displayed, press the NEXT softkey to go to the next menu level.

Thermocouple Simulation Option Operation

The thermocouple simulation option allows the user to enter a temperature in °C and set the calibrator to the specific voltage output which corresponds to the thermocouple type selected. On entering thermocouple simulation mode, type K will be the default function. The display below will be shown indicating the currently selected range and output status :



Once in thermocouple mode, the menus available at the bottom of the screen will change to reflect the thermocouple mode options - the available menu items are :

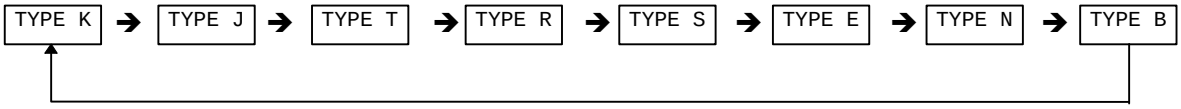
MAN CJ	Selects the manual cold junction compensation mode This allows cold junction value to be set to zero.
AUTO CJ	Selects the automatic cold junction compensation mode This allows the calibrator to use the built in temperature sensor within the adapter's thermocouple plug to compensate for the cold junction measured between the adapter plug and the UUT socket.
TYPE K	Selects the thermocouple type currently being simulated. Pressing this softkey allows the user to cycle through the available thermocouple types in the following order

TYPE K → TYPE J → TYPE T → TYPE R → TYPE S → TYPE E → TYPE N → TYPE B → TYPE K

1. Connect the thermocouple simulation adapter to the 2000 Series calibrator via its feature connector using the supplied 9 way 'D' type to 9 way 'D' type lead. Connect the UUT to the thermocouple plug extending from the opposite end of the thermocouple simulation adapter.

   Set the UUT to the required range.

2. Select the thermocouple type to be simulated using thermocouple type selection softkey [TYPE K] Pressing this softkey allows the user to cycle through the available thermocouple types in the following order :



3. Select the cold junction setting using the softkeys :

   Manual Cold Junction Compensation [MAN CJ]

   Sets the cold junction to zero

   Automatic Cold Junction Compensation [AUTO CJ]

   Activates the built in temperature sensor in the thermocouple plug to accurately compensate for the temperature at the point of connection.

4. Use the calibrator keypad to key in the required temperature, for example 450.5° :

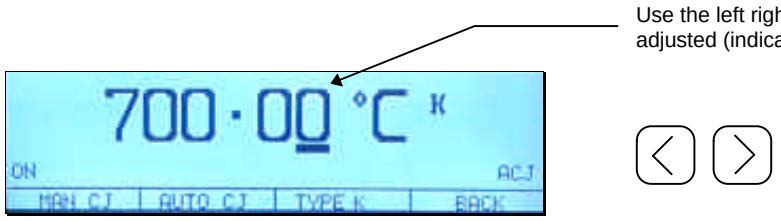
   [4] [5] [0] [.] [5] [°C] [ENTER]

   Ensure the calibrator output is turned ON by pressing the [Output ON] key.

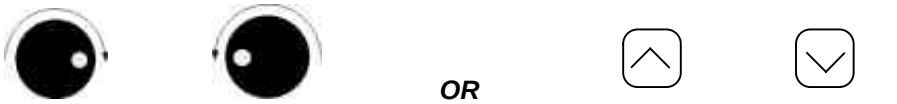
   Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

5. To deviate the temperature output from the nominal value, use the deviation function.

This is controlled by using the left and right arrow keys to select the digit to be increased or decreased



To increase or decrease the digit, simply use the up down keys on the calibrator's keyboard or use the digital potentiometer



Increment Decrement Increment Decrement

Note : The thermocouple type, temperature and cold junction compensation settings can be changed at any time by re-entered / selecting the setting required

TIP

Automatic or manual cold junction value is only updated when a temperature is entered or the output is set to standby, then on (i.e. to apply the change from automatic to manual cold junction, the output must be re-entered or the output set to *standby*, then to *output on*).

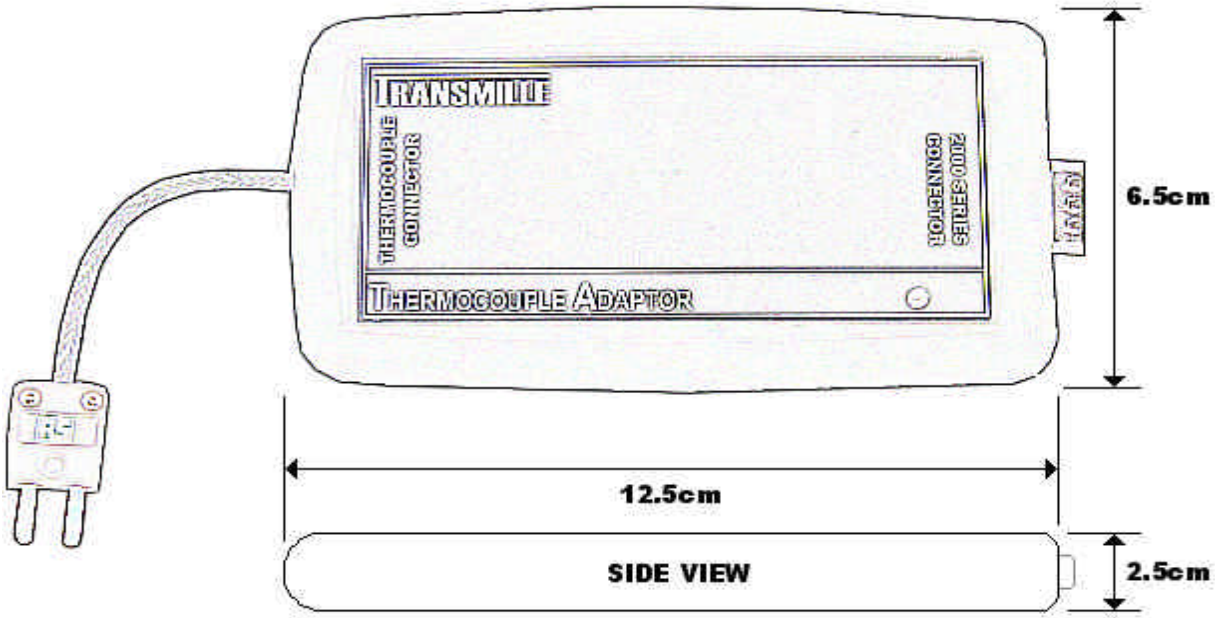
Calibration times using the thermocouple simulation option to calibrate temperature instrumentation can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the instrument's specifications.

2000 Series Thermocouple Simulation Adaptor Specifications

General Specifications	
Adaptor connection	Connects to male 'D' type feature connector on 2000 Series front panel
Indicators	Incorporates an 'Active' LED mounted in the adaptor case
Adaptor Dimensions	12.5cm x 6.5cm x 2.5cm
Connections	1 x 9 way male 'D' type connector
	1 x Neutral (copper) industry standard thermocouple plug with **integral temperature sensor**
Connection to Calibrator	Via supplied 9 Way male to female serial lead (straight through connection)
Sensor Type	Thermistor Sensor incorporated into thermocouple plug to eliminate any lead effects
Output impedance	10 Ohms

Thermocouple Type	Range	90 Day[1] Rel. (°C)	180 Year[1] Rel. (°C)	1 Year[1] Rel. (°C)	2 Year[1] Rel. (°C)
J	-210°C to 150°C	0.04	0.05	0.05	0.07
	150°C to 1200°C	0.24	0.27	0.30	0.42
K	-270°C to 200°C	0.08	0.09	0.10	0.14
	200°C to 1250°C	0.28	0.32	0.35	0.49
T	-200°C to 400°C	0.16	0.18	0.20	0.28
R	-50°C to 500°C	0.16	0.18	0.20	0.28
	500°C to 1750°C	0.80	0.90	1.00	1.40
S	-100°C to 1200°C	0.24	0.27	0.30	0.42
	1200°C to 1800°C	1.12	1.26	1.40	1.96
B	-100°C to 1200°C	0.08	0.09	0.10	0.14
	1200°C to 1800°C	1.04	1.17	1.30	1.82
N	-270°C to 260°C	0.08	0.09	0.10	0.14
	260°C to 1300°C	0.32	0.36	0.40	0.56

Note 1 : Does not include cold junction compensation errors
Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.
Due to continuous development specifications may be subject to change.



1 / 5 / 50 Turn Precision Clamp Coil Adapter EA COIL

- **Calibrates Clamp Meters up to 1000Amps**
- **1 / 5 / 50 Turn Coils**
- **High Accuracy Balanced Design**
- **Wide range of clamp sizes covered**
- **Complete with connection leads**

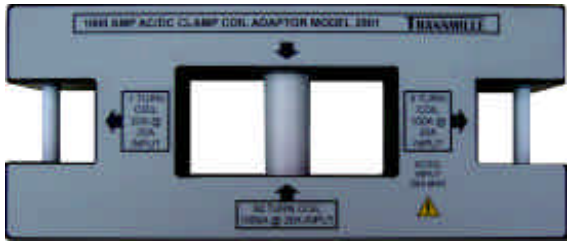
Designed for the calibration of both wound (AC only) & Magnetic field (hall effect) AC/DC clamp meters the Transmille current coil offers several unique features built in a robust construction.

Theory of Operation

The coil effectively multiplies the current produced by the calibrator by the number of turns of the coil, e.g. 1, 5, and 50 with the Transmille coil. The principle is each turn of the coil produces a magnetic field proportional to the current flowing in it. If you take 50 wires all side by side with the same current flowing in the same direction the magnetic field for each turn of wire will add together and produce a magnetic field 50 times stronger, e.g. the same magnetic field as one wire with 50 times the current flowing in it. By using a 50 turn coil it is possible to calibrate clamp meters up to 1000 Amps without having to actually generate more than 20 Amps (available from the 2000 Series calibrators). Clamp meters up to 2000 Amps can be calibrated when using Transmille's 50 Amp transconductance amplifier.

High Accuracy Design

Clamp meters can measure current by using the invisible magnetic field generated round any conductor carrying a current. The degree of magnetic coupling between the field produced by the conductor and the jaws of the clamp meter varies due to the position of the conductor within the jaws - this changes the current reading. Transmille's coil is designed to immerse both jaws of he clamp meter in the magnetic field while allowing the 'gap' or opening where magnetic flux will escape to protrude through the coil and stay out of the strongest part of the field. This makes the reading less dependent on the position of the clamp within the coil and also the quality of the jaw closing, allowing greater confidence in the calibration.



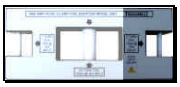
Calculating Clamp Meter Accuracy.

There are two contributions to the total accuracy which should be taken into account when calibrating clamp meters using a coil. The first is the accuracy of the current produced by the calibrator, the second is the coupling between the coil and clamp meter. These must be combined using a *root sum of the squares*. Empirical tests made on a wide range of clamp meters calibrated by Transmille at its laboratory have shown that *torroidal wound current transformer* type clamps typically exhibit better performance and will give coupling errors of 0.2% and *hall effect devices* slightly higher at around 0.4%.

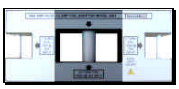
Innovative Closed Construction Design

Three coils in one provide the ability to calibrate a wide range of coils, from small lower clamps down to 10mm jaw diameter to larger 2000A clamps. The low inductance, low resistance properties allow the calibrators to easily drive the coil, giving plenty of overhead for calibrating older clamps. The coils are fully enclosed in a strong, robust and compact plastic enclosure preventing mechanical damage. This rugged design is ideal for using the coil on-site and in harsh environments.

1 Turn Coil
Minimum 10mm inside jaw diameter.



5 Turn Coil
Minimum 10mm inside jaw diameter.



50 Turn Coil
Minimum 25.4mm inside jaw diameter.

Specifications: See extended specifications for full details

2000 Series Clamp Coil Adapter Specifications

General Specifications	
Adapter Connection	2x 4mm safety sockets mounted on the rear of the unit
Adapter Dimensions	28cm x 12cm x 6cm
Colour	Black
Connection to Calibrator	Via supplied 4mm to 4mm connection leads (x2) to 2000 series current terminals
Coil Configuration	1 Turn (LHS) : 5 Turn (RHS) : 50 Turn (CENTRE)
Coil Type	High accuracy balanced configuration
Min. internal jaw dimensions	9mm (1 Turn & 5 Turn) : 25mm (50 Turn)
Maximum Current	40A
Maximum RMS voltage	4V
Frequency Range	DC to 500Hz
Construction	Loose wound coil (for heat dissipation) in moulded ABS enclosure
Durability	Fully enclosed coil for maximum protection from mechanical damage
Compatibility	Designed for use with Transmille 2000 Series calibrators and ProCal Software

1 Turn Coil Accuracy (Input 0 to 40A : Freq. DC - 30Hz to 60Hz : Effective Output 0 to 40A)	90 Day Rel.		180 Day Rel.		1 Year Rel.		2 Year Rel.	
	%	A	%	A	%	A	%	A
Effective accuracy - Coil only (wound clamps)	0.35	+ 0.008	0.35	+ 0.008	0.35	+ 0.008	0.35	+ 0.008
Effective accuracy - Coil only (hall effect clamps)	0.48	+ 0.07	0.48	+ 0.07	0.48	+ 0.07	0.48	+ 0.07
Total uncertainty with 2050 (All clamps)	0.51	+ 0.09	0.51	+ 0.09	0.52	+ 0.09	0.56	+ 0.10
Total uncertainty with 2041A (wound clamps)	0.36	+ 0.028	0.36	+ 0.028	0.36	+ 0.028	0.38	+ 0.036
Total uncertainty with 2041A (hall effect clamps)	0.49	+ 0.090	0.49	+ 0.090	0.49	+ 0.090	0.50	+ 0.098
Total uncertainty with 2006A calibrator (wound clamps)	0.36	+ 0.010	0.36	+ 0.010	0.36	+ 0.010	0.37	+ 0.010
Total uncertainty with 2006A (hall effect clamps)	0.48	+ 0.072	0.49	+ 0.072	0.49	+ 0.072	0.49	+ 0.072

5 Turn Coil Accuracy (Input 0 to 40A : Freq. DC - 30Hz to 60Hz : Effective Output 0 to 200A)	90 Day Rel.		180 Day Rel.		1 Year Rel.		2 Year Rel.	
	%	A	%	A	%	A	%	A
Effective accuracy - Coil only (wound clamps)	0.41	+ 0.01	0.41	+ 0.01	0.41	+ 0.01	0.41	+ 0.01
Effective accuracy - Coil only (hall effect clamps)	0.59	+ 0.11	0.59	+ 0.11	0.59	+ 0.11	0.59	+ 0.11
Total uncertainty with 2050 (All clamps)	0.61	+ 0.13	0.62	+ 0.13	0.62	+ 0.13	0.65	+ 0.14
Total uncertainty with 2041A (wound clamps)	0.42	+ 0.03	0.42	+ 0.03	0.42	+ 0.03	0.43	+ 0.04
Total uncertainty with 2041A (hall effect clamps)	0.60	+ 0.13	0.60	+ 0.13	0.60	+ 0.13	0.61	+ 0.14
Total uncertainty with 2006A calibrator (wound clamps)	0.41	+ 0.012	0.42	+ 0.012	0.42	+ 0.012	0.42	+ 0.012
Total uncertainty with 2006A (hall effect clamps)	0.59	+ 0.112	0.59	+ 0.112	0.60	+ 0.112	0.60	+ 0.112

50 Turn Coil Accuracy (Input 0 to 40A : Freq. DC - 30Hz to 60Hz : Effective Output 0 to 2000A)	90 Day Rel.		180 Day Rel.		1 Year Rel.		2 Year Rel.	
	%	A	%	A	%	A	%	A
Effective accuracy - Coil only (wound clamps)	0.24	+ 0.04	0.24	+ 0.04	0.24	+ 0.04	0.24	+ 0.04
Effective accuracy - Coil only (hall effect clamps)	0.45	+ 0.42	0.45	+ 0.42	0.45	+ 0.42	0.45	+ 0.42
Total uncertainty with 2050 (All clamps)	0.48	+ 0.44	0.48	+ 0.44	0.49	+ 0.44	0.53	+ 0.45
Total uncertainty with 2041A (wound clamps)	0.25	+ 0.06	0.26	+ 0.06	0.26	+ 0.06	0.28	+ 0.07
Total uncertainty with 2041A (hall effect clamps)	0.46	+ 0.44	0.46	+ 0.44	0.46	+ 0.44	0.47	+ 0.45
Total uncertainty with 2006A calibrator (wound clamps)	0.25	+ 0.042	0.25	+ 0.042	0.25	+ 0.042	0.26	+ 0.042
Total uncertainty with 2006A (hall effect clamps)	0.45	+ 0.42	0.46	+ 0.42	0.46	+ 0.42	0.46	+ 0.42

Accuracy is dependant on proper alignment of the clamp meter within the coil

Certain clamp meters have alignment marks which should be aligned with the centre of the coil.

Certain types of clamp meter may have additional errors, or be outside the range which can be driven by the 2041A directly

Use of the Transmille 2400 Transconductance amplifier may be used to provide additional drive.

Uncertainty calculated as the square root of the square of coil accuracy + square of calibrator accuracy

using empirical data obtained for both wound & hall effect instruments from a wide range of manufacturers

2000 Series Clamp Coil Adapter Specifications (Cont'd)

DC Resistance	
At Coil	0.14Ω
With Connection Leads	0.18Ω

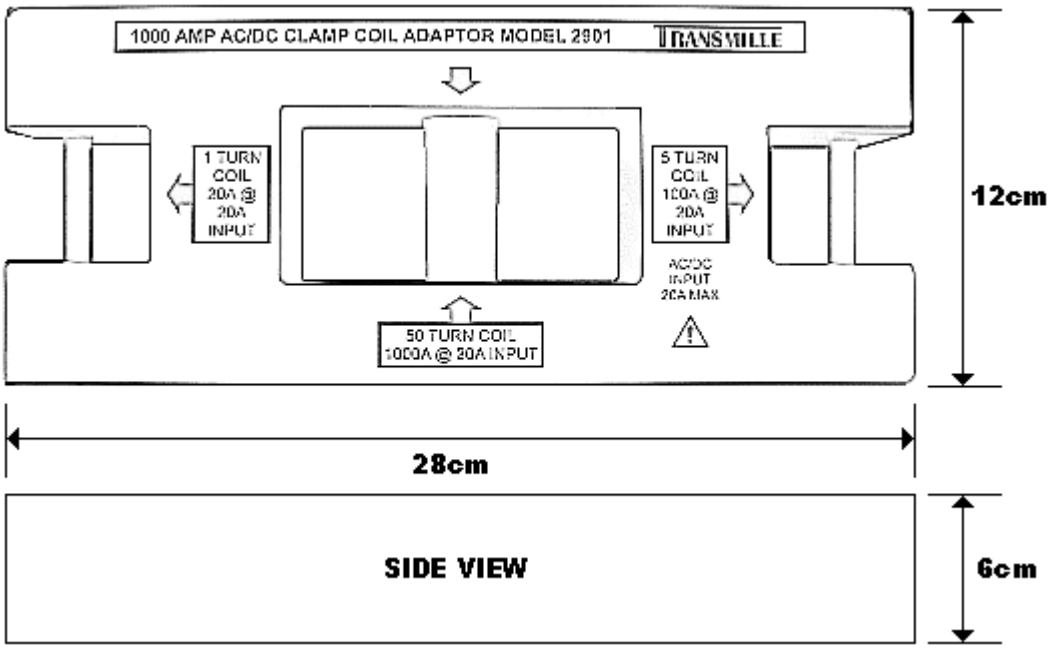
Duty Cycle	
10A	Continuous
20A	2mins on ~ 5mins off
40A	30secs on ~ 5mins off

Inductance	
Coil Only	120uH
Coil with typical clamp meter on 50 Turn coil	230uH
Coil with typical clamp meter on 5 Turn coil	122uH

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.

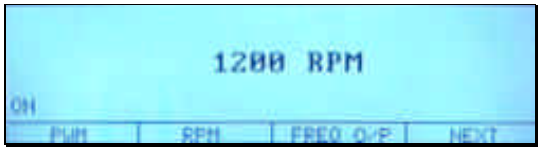


Optical Tachometer Calibration Option — EA TACH

- **Complete solution calibrates optical tachometers up to 60,000 RPM**
- **Complete with adapter unit incorporating high intensity LED**
- **Easy to use**
- **Works with ProCal & 2000 Series Virtual Front Panel Software**

Simply connect the adapter to the feature connector on the 2000 series calibrator, select the RPM mode and value and point the tachometer at the high intensity LED to perform accurate and repeatable calibration, removing the need for ad-hoc setups and de-skilling calibration of these instrument types.

Integrated RPM Mode for direct control



The 2000 Series calibrators incorporate a dedicated RPM mode to control the optical tachometer adapter

External Adapter to provide optical triggering of tachometer instruments

Connects directly to the ‘feature’ connector on the 2000 series calibrator. Incorporates high intensity LED.

Specifications - For full details see extended specifications

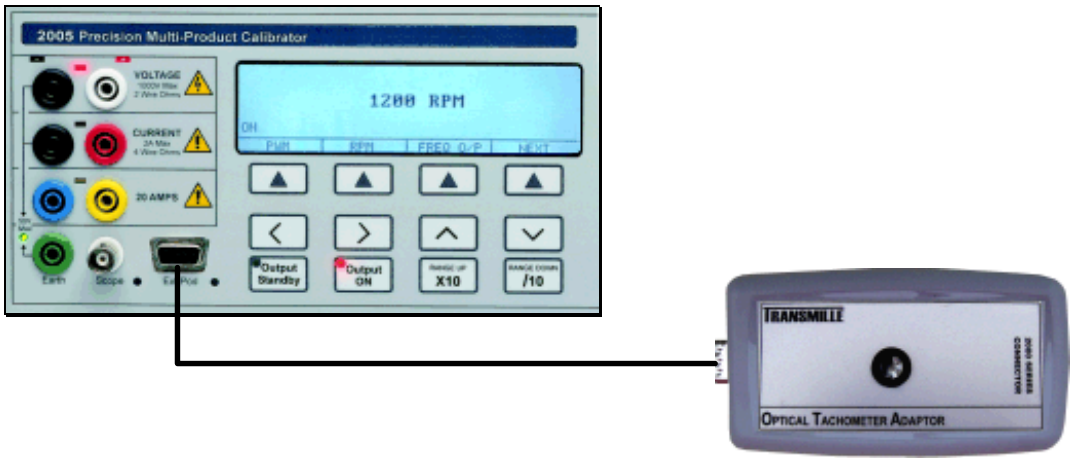
General Specifications	
Adapter connection	Connects to male 'D' type feature connector on 2000 Series front panel
Indicators	Incorporates red 8mm 20° Spread Ultra bright LED mounted in the adaptor case
Brightness	1000mcd (wavelength 660nm)
Duty cycle	20% (5:1)
Adaptor Dimensions	12.5cm x 6.5cm x 2.5cm
Connections	1 x 9 way male 'D' type connector
Connection to Calibrator	Via supplied 9 Way male to female serial lead (straight through connection)

Optical Tachometer Adaptor Accuracy				
Range	**Resolution**	**180 Day Rel. %**	**1 Year Rel. %**	**2 Year Rel. %**
240 to 60,000 RPM	6 RPM	0.0029	0.0030	0.0036

Optical Tachometer Calibration Option - Operation

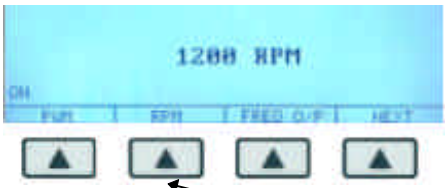
Optical Tachometer Calibration Adapter Connection

Using the supplied adapter connection lead (9 way 'D' type to 9 way 'D' type), connect the optical tachometer calibration adapter to the feature connection on the front panel of the 2000 series calibrator.



Starting the Optical Tachometer Calibration Option

To start the oscilloscope calibration option, press the softkey below the RPM menu item

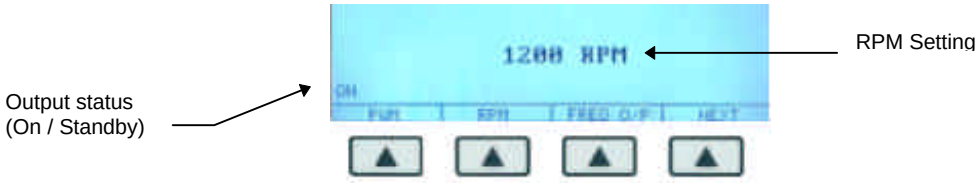


Thermocouple simulation mode softkey

ⓘ **TIP** : If the RPM menu item is not displayed, press the NEXT softkey to go to the next menu level.

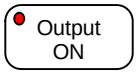
Optical Tachometer Calibration Option Operation

The optical tachometer calibration option allows the user to enter a value *directly in RPM* and use the calibrator to control the optical tachometer adapter. The integrated LED is pulsed at the required frequency to simulate the RPM value entered.



1. Use the calibrator keypad to key in the required RPM, for example 3500 :

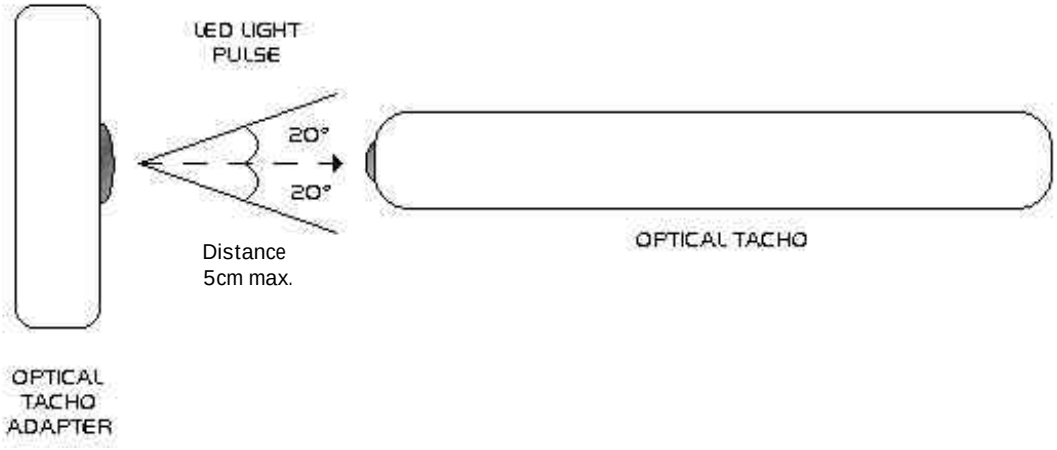
ⓘ **Note** : Valid RPM settings are from 240 RPM to 60,000 RPM

Ensure the calibrator output is turned ON by pressing the 

key.

Note : The LED in the top left hand corner of the Output ON key will illuminate and the display will indicate **ON** in the left hand corner.

2. The optical tachometer should be pointed at the LED on the adapter with no more than 20° angle to ensure consistent detection by the tachometer. Distance from the LED should also be restricted to within 5cm, again, for consistent detection.



Optical tachometer calibration times can be significantly reduced by using the ProCal calibration software available from Transmille which allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the instrument's specifications.

2000 Series Optical Tachometer Adaptor Specifications

General Specifications	
Adaptor connection	Connects to male 'D' type feature connector on 2000 Series front panel
Indicators	Incorporates red 8mm 20° Spread Ultra bright LED mounted in the adaptor case
Brightness	1000mcd (wavelength 660nm)
Duty cycle	20% (5:1)
Adaptor Dimensions	12.5cm x 6.5cm x 2.5cm
Connections	1 x 9 way male 'D' type connector
Connection to Calibrator	Via supplied 9 Way male to female serial lead (straight through connection)

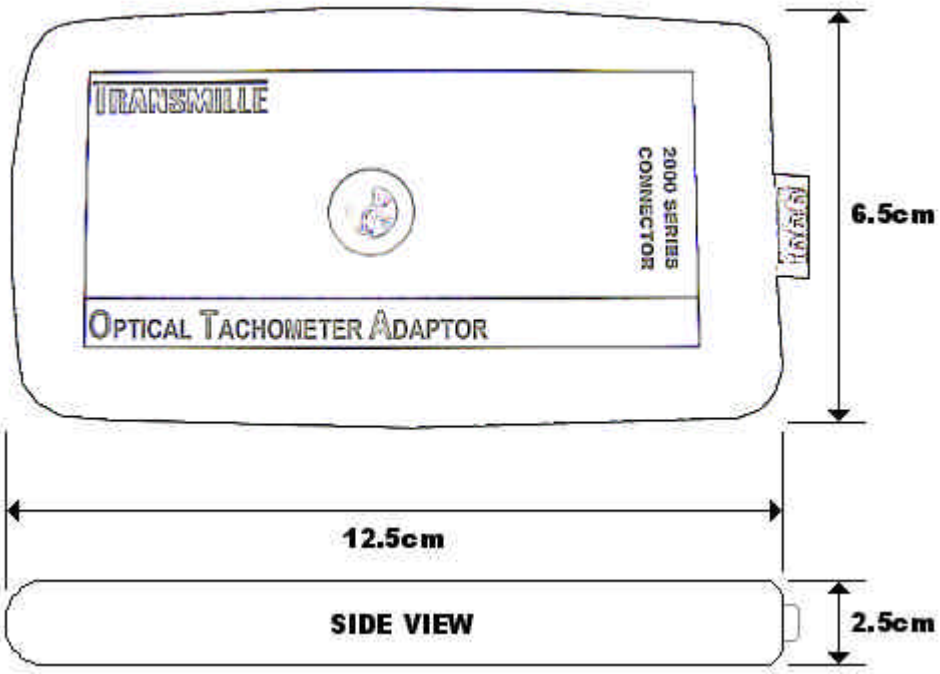
Optical Tachometer Adaptor Accuracy				
Range	**Resolution**	**180 Day Rel. %**	**1 Year Rel. %**	**2 Year Rel. %**
240 to 60,000 RPM	6 RPM	0.0029	0.0030	0.0036

Frequency Input	RPM Simulation
40	240
100	600
200	1200
400	2400
600	3600
800	4800
1000	6000
2000	12000
4000	24000
8000	32000
10000	60000

Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Power Supply Calibration Adapter EA2023

- **Measure Output voltage to 33 Volts**
- **Active Current load to 4 Amps**
- **Measure output Resistance**
- **Connects to Feature port on calibrator**
- **Safety overload cut-out & Indicator**
- **Requires ProCal calibration or 2000 Series virtual front panel Software**

Overview

A unique and very useful option for simplifying calibration of power supplies. The PSU adapter can measure the supplies output voltage and also provide a precision current load allowing volts, current and even output resistance to be calibrated by one compact unit.

The PSU adapter connects to the feature connector on the calibrator and to the power supply to be calibrated by a 4 wire connection for Current load/Voltage Sense.

Technical Details

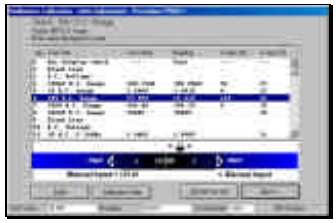
The output from the calibrator is converted by the PSU adapter into a precision current load and the supply output voltage is measured by using the calibrators internal high accuracy A/D converter.

The operation is controlled using a PC running either the Virtual front panel program or ProCal software. The software sends commands to the calibrator to set the output or read back the voltage which is displayed on the computer.

Controlling Calibration of Power Supplies

Basic control using the **2000 Series Virtual Front Panel Software** (Optional) can be achieved with readings displayed on the PC screen. Multiple current loads can be set up using the customisable 'POD' mode.

Automated Calibration of Power Supplies



Advanced control using the **ProCal Calibration Software** (Optional), with readings displayed and automatically recorded in certificates.

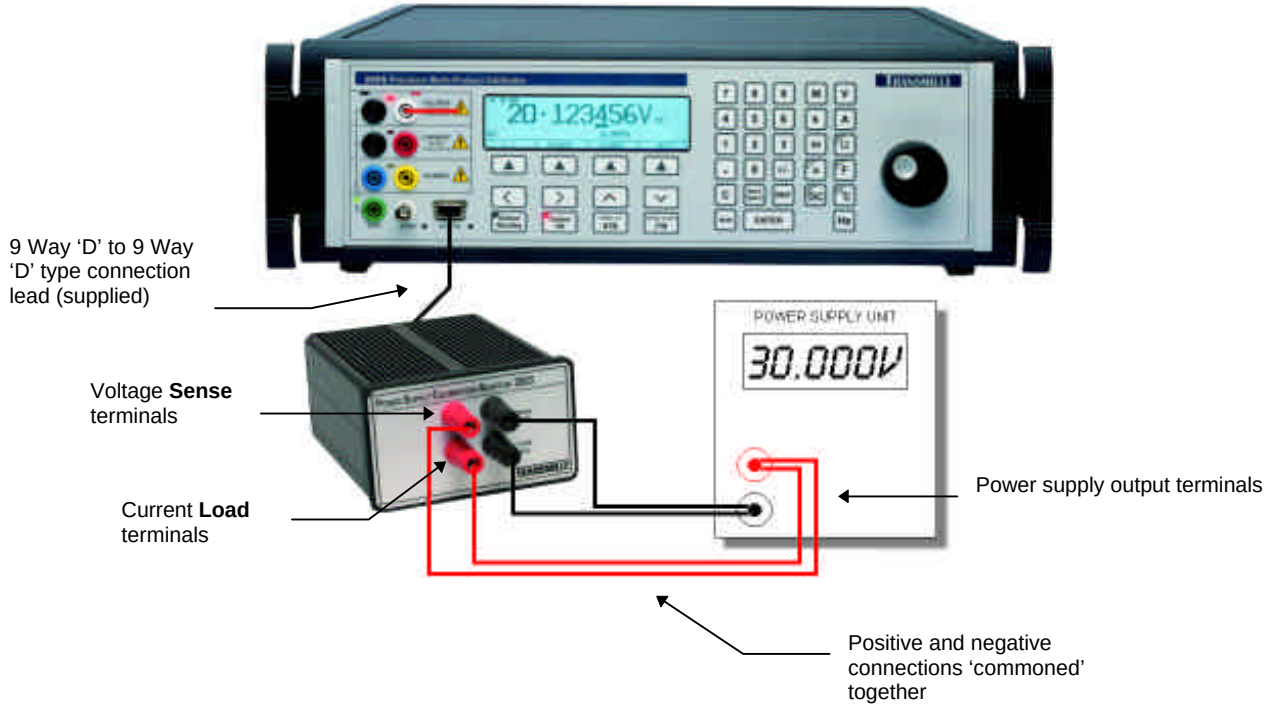
Specification - See extended specifications for full details

DC Voltage Measurement Accuracy				
Range	**Resolution**	**1 Year Rel.**		
		%	**±**	**mV**
0 to 33 Volts	0.01V	0.02	±	20

DC Current Load Accuracy				
Range	**Resolution**	**1 Year Rel.**		
		%	**±**	**mA**
0 to 4 Amps	0.01A	0.05	±	1

Power Supply Calibration Adapter Connection

Using the supplied 9 Way 'D' to 9 Way 'D' lead connect the PSU adapter to the 'feature' connector on the front of the 2000 Series calibrator. To connect to the PSU, use two pairs of 4mm to 4mm tests leads (for example, as supplied with the optional Transmille precision lead set) and connect the positive terminals of the PSU adapter (both *V Sense* and *I Load*) to the positive terminal of the power supply. Repeat for the negative terminals - this configuration is the optimal setup for minimising lead changes during power supply calibration.

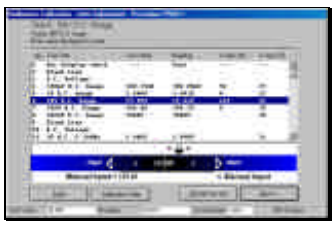


Using the Power Supply Calibration Option

Calibration using the power supply adapter is achieved using one of two methods :

1. *Basic* control using the **2000 Series Virtual Front Panel Software** (Optional) with readings displayed on the PC screen.

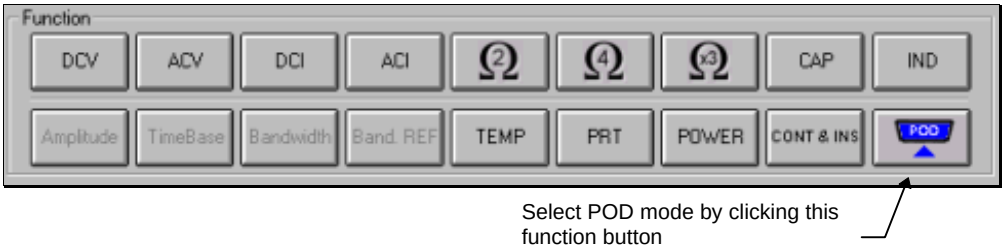
2. *Advanced* control using the **ProCal Calibration Software** (Optional), with readings displayed and automatically recorded for use in certificate creation.



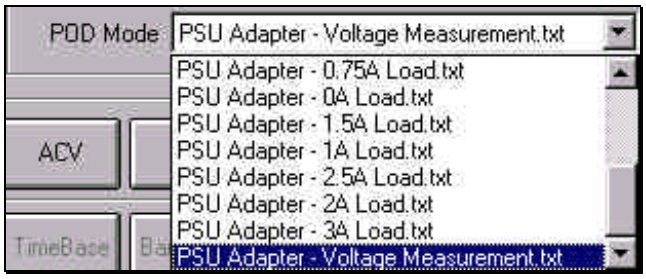
Power Supply Calibration Adapter - Operation Using the Virtual Front Panel

1. Start the 2000 Series Virtual Front Panel by choosing
   START -> PROGRAMS -> 2000 Series Virtual Front Panel

2. Select POD mode by clicking on the POD button



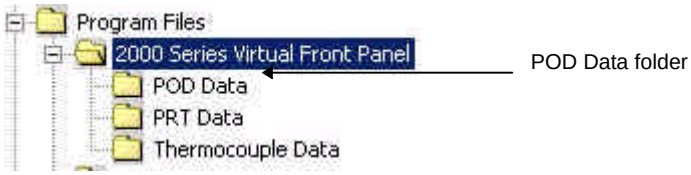
3. From the drop down list, select the one of the default functions from the list :
   - PSU Adapter : Voltage Measurement
   - PSU Adapter : 0A Load
   - PSU Adapter : 0.25A Load
   - PSU Adapter : 0.5A Load
   - PSU Adapter : 0.75A Load
   - PSU Adapter : 1A Load
   - PSU Adapter : 1.5A Load
   - PSU Adapter : 2A Load
   - PSU Adapter : 2.5A Load
   - PSU Adapter : 3A Load



Creating a Custom Datafile For the Virtual Front Panel

If the default functions do not cover the current load required, a custom datafile can be created as follows :

A. Start *Windows Explorer* and look in the '**C:\Program Files\2000 series virtual front panel**' folder.
This folder should contain a sub-folder called 'POD Data' (If it does not, then create it).

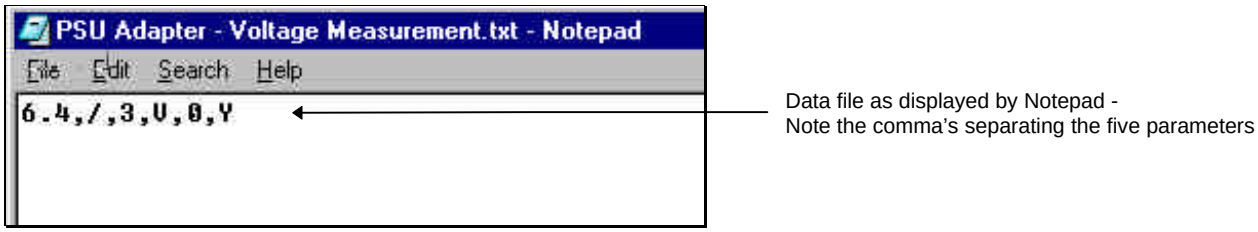


B. Create a Notepad file which contains a one line control string (5 parameters separated by a comma)
ⓘ **TIP** : To simplify this task copy an existing datafile and rename it using *Windows Explorer*

C. Using the worked example below as a guide, enter the parameters to create the custom datafile

Worked Example

The example below sets a 0.5A Load.



6.4	Gain Factor of the voltage measurement. This factor will be different for each adapter, if incorrect the voltage reading displayed will be wrong.
*****	**Multiply** the reading returned from the calibrator by the gain factor
3	Number of decimal places shown by the VFP Program
V	The units character displayed after the reading by the VFP
R2/O0.5/#LOAD 0.5A	Command to set the calibrator to the 2 Volt range and output to 0.5 Volts which will set a 0.5A load on the adapter. The '#' command sets the calibrator display to show 'LOAD 0.5A'.
Y	Readback option : Y = Readback data from feature connector N = No readback

D. Once the datafile has been saved, restart the virtual front panel program.
Your custom datafile should now be listed in the drop down list and is ready to use.

ⓘ **Note** : As many files as required can be created with different names for different loads.

Operation Using ProCal Calibration Software

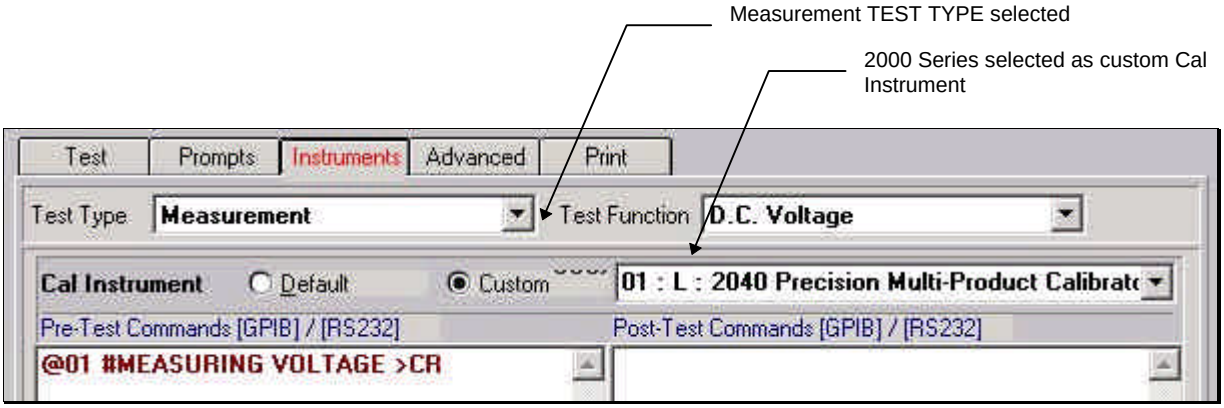
These instruction assume basic knowledge of the ProCal calibration software - ProEdit should be used to create a procedure prior to following the instructions below.

ⓘ **Note** : The ProEdit *procedure builder wizard* function supports power supply procedure creation - Simply run ProEdit and choose File -> Procedure Builder Wizard to run. This function will automatically create the necessary formulas and simplify the writing of power supply procedures.

Output Voltage Testing Using ProCal

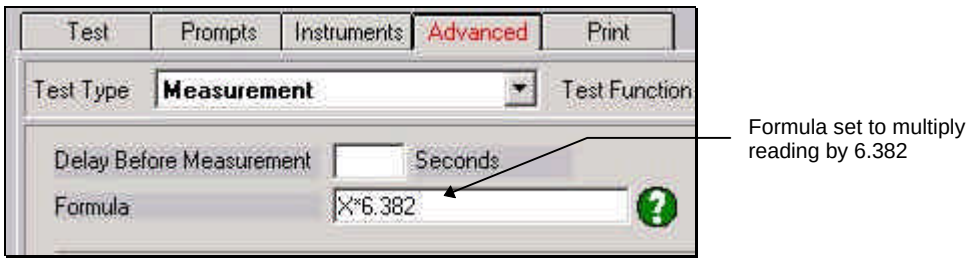
1. Select the '**MEASUREMENT**' test type and '**DC VOLTAGE**' test function - then complete the boxes for test title, test value and accuracy etc. as normal.

2. Under the **'INSTRUMENTS'** instruments tab select the *2000 series calibrator* in the **Custom Cal Instrument** section.



ⓘ **Note** : You can also display a message in the 2000 series display whilst this test is running by entering a command in the **Pre-Test Commands** box (as shown above in the **Pre-Test Command** box)

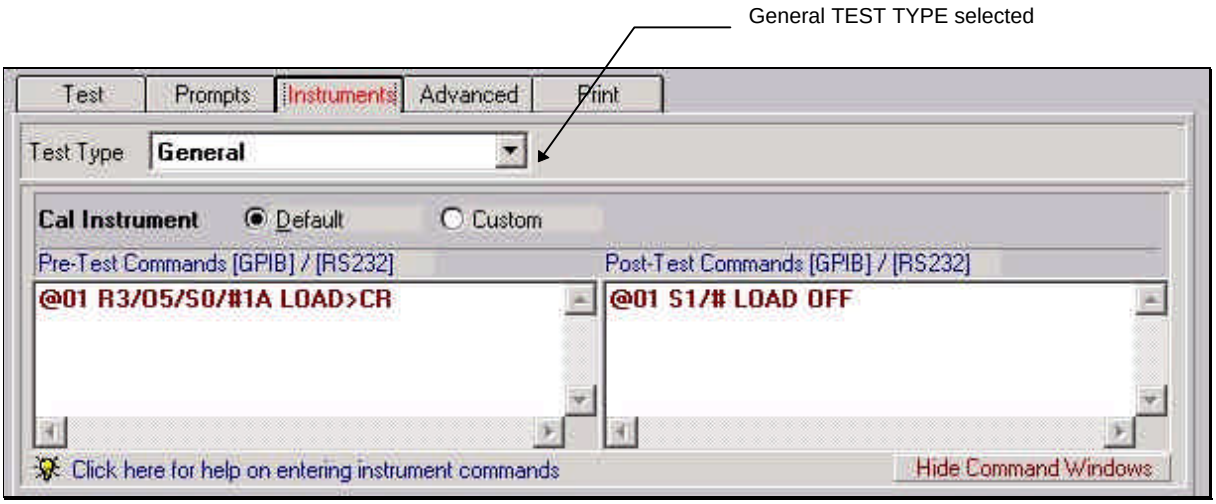
3 Under the **'ADVANCED'** tab set the formula to multiply the returned reading (X) by the gain factor for the adapter (default = 6.382)



Current Measurement Testing using ProCal

1. Select '**GENERAL**' type test - then complete the boxes for test title, test value and accuracy etc. as normal.

2. Select the '**INSTRUMENTS**' tab and enter the commands for setting the required load current.
In the example below the load current is 1A.



ⓘ **Note** : The PSU voltage should be set to 5 Volts to avoid excessive dissipation in the PSU adapter
You can send a command to turn off the load after the test. (*Post Test Commands*)

Output Resistance Testing Using ProCal

1. This requires two voltage measurement tests -
   Set up a test to record the voltage under no load at, for example, 5 Volts -
   this test can be set to *non printing* under the *print tab*.

2. Set up a second test to measures the same voltage (Copy & Paste above test) but under, for example, 1A load.

   ⓘ **Note** : This test will be reading back in **OHMS**, so although the Test Type should be set to **DC VOLTAGE**, the test value should be set to zero **OHMS**.

   Using the formula box in the '**ADVANCED**' tab, take the first test away from the second test and multiply with gain factor & divide by current (Ohms law) to get resistance.

   The '**DUAL UNITS**' check box under the '**ADVANCED**' tab should be ticked as measurement is in volts but result in ohms.

2000 Series Power Supply Calibration Adapter Specifications

General Specifications	
Adaptor connection	Connects to male 'D' type feature connector on 2000 Series front panel
Indicators	Incorporates 1x Power indicator LED : 1 x Overload indicator LED
Adaptor Dimensions	10.5cm x 13.2cm x 5.5cm
Connections	1 x 9 way male 'D' type connector 2x Voltage input 4mm terminals (Red & Black) 2x Current load 4mm terminals (Red & Black)
Connection to Calibrator	Via supplied 9 Way male to female serial lead (straight through connection)

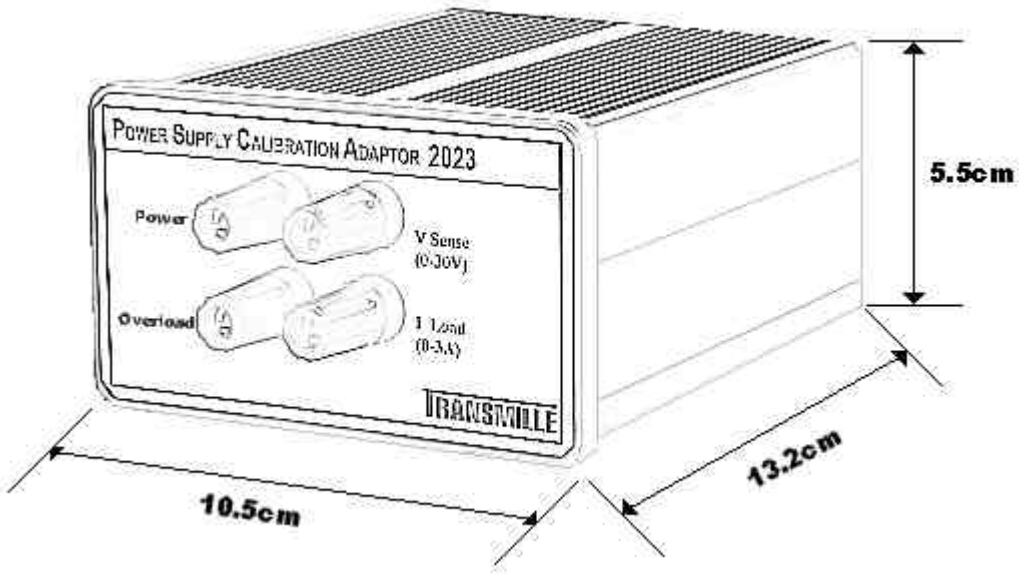
DC Voltage Measurement Accuracy					
Range	**Resolution**	**90 Day Rel.**	**180 Day Rel.**	**1 Year Rel.**	**2 Year Rel.**
		% ± mV	**%** ± mV	**%** ± mV	**%** ± mV
0 to 33 Volts	0.01V	0.016 ± 20	0.016 ± 20	0.02 ± 20	0.028 ± 20

DC Current Load Accuracy					
Range	**Resolution**	**90 Day Rel.**	**180 Day Rel.**	**1 Year Rel.**	**2 Year Rel.**
		% ± mA	**%** ± mA	**%** ± mA	**%** ± mA
0 to 4 Amps	0.01A	0.040 ± 1.0	0.045 ± 1.0	0.05 ± 1	0.070 ± 1.0

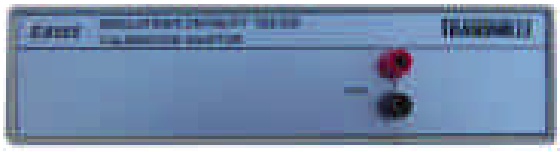
Specifications apply between 17°C and 27°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Due to continuous development specifications may be subject to change.



Insulation Tester Calibration Adapter EA005



- **Calibrates Insulation Testers**
- **Insulation Resistance to 100MOhms**
- **Insulation Test Voltage Measurement**
- **Continuity Resistance 1 Ohm/10 Ohm**

Overview

Calibration of insulation testers require functions outside that of the 2000 series calibrators. The special functions required for calibrating these instruments are available by using the Insulation calibration adapter.

Operation

Controlled from the feature connector on the calibrator the adapter provides the high voltage/ high value resistors for calibrating the Megohm ranges and also by using the measurement capability of the calibrator the insulation test voltage 1000V, 500V, 250V, 100V & 50 Volt at a nominal 1mA load can also be measured.

High current low ohm values are also available for calibrating the continuity ranges of the tester.
Calibration can also be automated by using ProCal.

For those laboratories whose requirements go beyond calibrating insulation testers Transmille also manufacture a calibrator (2100) specifically for the calibration of electrical test tools i.e. PAT's, Loop & RCD Testers as well as insulation testers.

Specifications

Insulation Test Resistance	
Range	100k, 250k,500k,1M,10M,100M
Accuracy	0.1% to 1M, 1% to 100M
Max Voltage	1000 Volts

Insulation Test Voltage Measurement	
Range	0 to 1000 Volts
Load	1mA

Continuity Resistance	
Range	1 Ohm & 10 Ohms
Accuracy	0.1% + 30mOhms
Max Current	300mA

Pressure Calibration Using Pressure Transducers EA006

Fig 1 : Calibrating a 10Barg pressure gauge using the Druck PV411 hand pump and 0-10Barg transducer.

- **Works with a wide of pressure transducers produced by Druck, Keller etc.**
- **Accuracy : Transducers available to 0.05%**
- **Easy to Use with VFP or ProCal Software**
- **Supports all Pressure units *PSI, bar, mm, "Hg***

Overview

Using the DRUCK range of accurate pressure transducers which connect directly to the feature connector on the 2000 series calibrator* pressure calibration can be performed in any units of pressure for either Gauge or Absolute calibration.

Using external transducers for pressure calibration allows a range of pressures to be calibrated.

Technical Details

Operation is controlled from the interface using either the Virtual front panel program or ProCal software. The software reads back the voltage signal from the transducer which can be converted to pressure units (Bar, psi etc.) which is displayed on the computer.

The ProCal calibration software allows a pre-defined sequence of tests (known as a procedure) to be set up. This allows the computer to automatically step through these tests, control the calibrator, set the correct outputs and record the amount of deviation in relation to the pressure device's specifications.

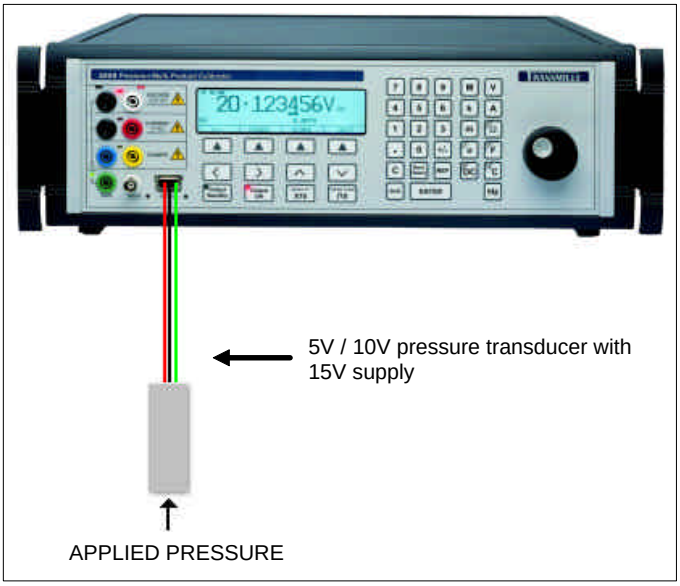


Fig 2 : Connecting a transducer to the 2000 Series

Pressure Ranges & Transducers Available

The system will work with *any* transducer using a 5V or 10V output powered from 15V supply

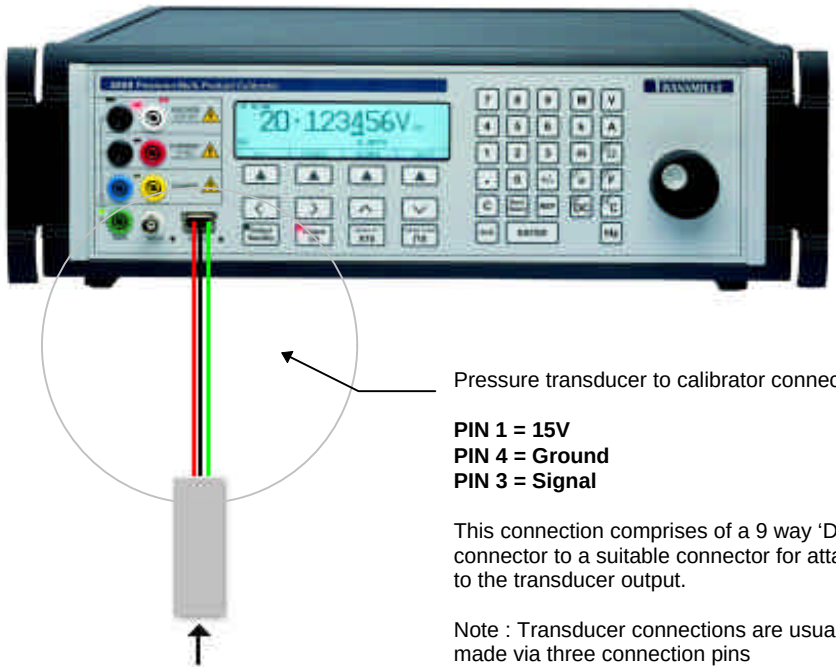
Pressure Range : Dependant on transducer used.
Optional Equipment : Druck PV411 pneumatic / hydraulic / vacuum hand pump

Transmille recommend & can supply any required transducer from the Druck range
See *www.druck.com* for the full range of available transducers.

Pressure Calibration Option - Operation

Pressure Transducer Connection

The pressure transducer is connected to the 'feature' connector of the 2000 series using a 9 way 'D' type connector to an appropriate connector for the transducer.



Pressure transducer to calibrator connection :

PIN 1 = 15V
PIN 4 = Ground
PIN 3 = Signal

This connection comprises of a 9 way 'D' type connector to a suitable connector for attaching to the transducer output.

Note : Transducer connections are usually made via three connection pins

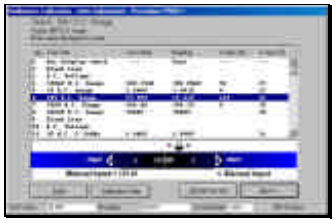
Input to transducer from pressure source.

Using the Pressure Transducer Option

Calibration using the pressure transducer is achieved using one of two methods :

1. *Basic* control using the **2000 Series Virtual Front Panel Software** (Optional) with readings displayed on the PC screen.

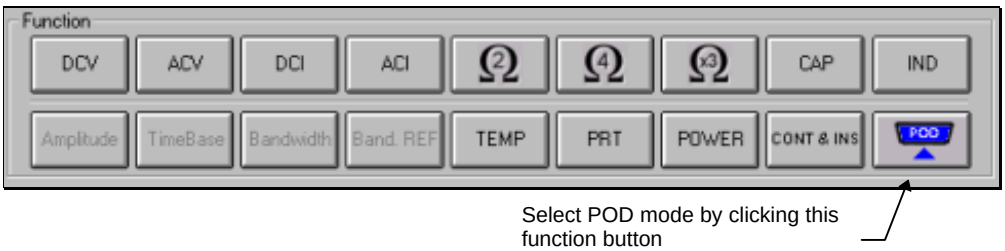
2. *Advanced* control using the **ProCal Calibration Software** (Optional), with readings displayed and automatically recorded for use in certificate creation.



Pressure Transducer - Operation Using the Virtual Front Panel

1. Start the 2000 Series Virtual Front Panel by choosing
   START -> PROGRAMS -> 2000 Series Virtual Front Panel

2. Select POD mode by clicking on the POD button

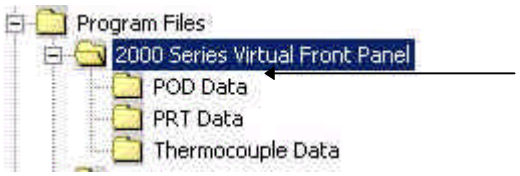


3. From the drop down list, select the one of list items (if available).
   If no pressure list items are available, proceed to the next section detailing creation of a custom datafile for transducer readback.

Creating a Custom Datafile For the Virtual Front Panel

If the default functions do not cover the pressure range required, a custom datafile can be created as follows :

A. Start *Windows Explorer* and look in the '**C:\Program Files\2000 series virtual front panel**' folder.
This folder should contain a sub-folder called 'POD Data' (If it does not, then create it).

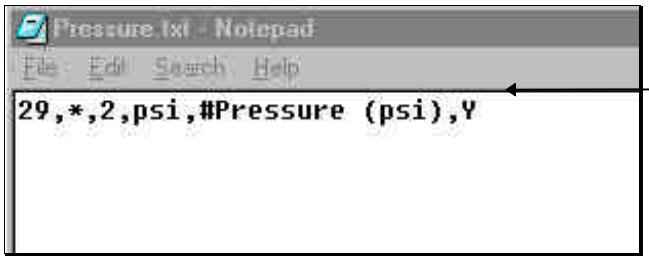


B. Create a Notepad file which contains a one line control string (6 parameters separated by a comma)
ⓘ **TIP** : To simplify this task copy an existing datafile and rename it using *Windows Explorer*

C. Using the worked example below as a guide, enter the parameters to create the custom datafile

Worked Example

The example below is configured to readback in psi.



29	Gain Factor This factor will be different for each transducer, if incorrect the pressure reading displayed will be wrong.
*****	**Multiply** the reading returned from the calibrator by the gain factor
2	Number of decimal places shown by the VFP Program
psi	The units character displayed after the reading by the VFP
#Pressure (psi)	Command to set the calibrator to the 2 Volt range and output to 0.5 Volts which will set a 0.5A load on the adapter. The '#' command sets the calibrator display to show '*Pressure (psi)*'.
Y	Readback option : Y = Readback data from feature connector N = No readback

D. Once the datafile has been saved, restart the virtual front panel program.
Your custom datafile should now be listed in the drop down list and is ready to use.

ⓘ **Note** : As many files as required can be created with different names for different transducers & pressure ranges.

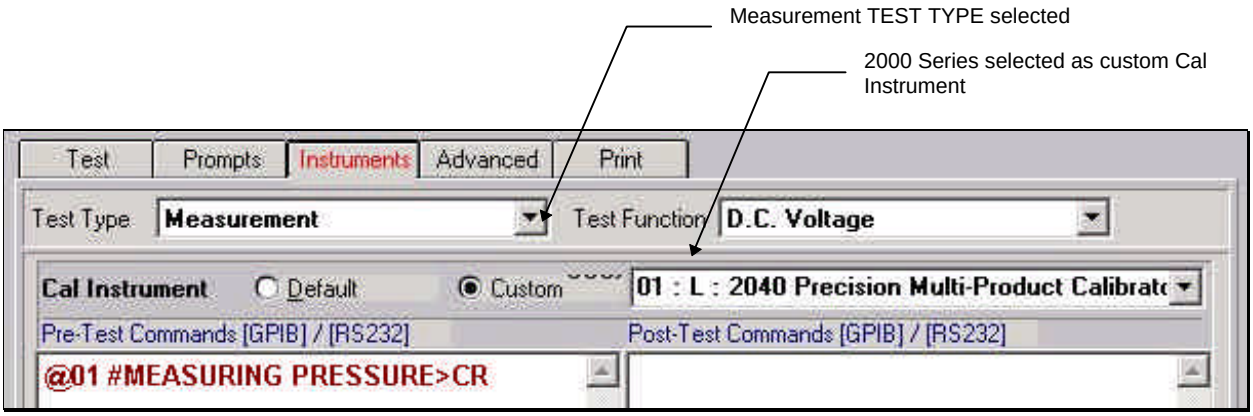
Operation Using ProCal Calibration Software

These instruction assume basic knowledge of the ProCal calibration software - ProEdit should be used to create a procedure prior to following the instructions below.

1. Select the '**MEASUREMENT**' test type and '**DC VOLTAGE**' test function - then complete the boxes for test title, test value (***with pressure units***) and accuracy etc. as normal.

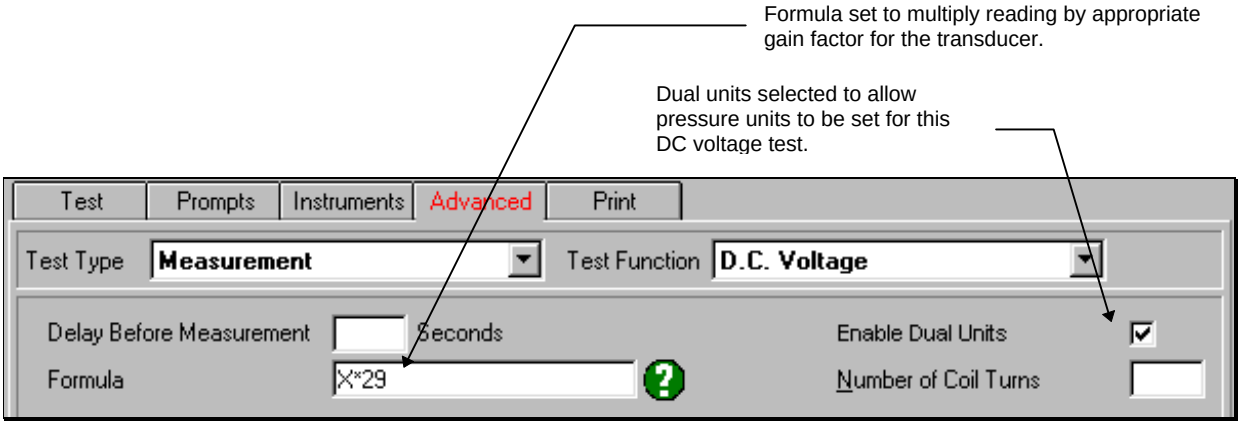
   ⓘ **Note** : DC Voltage is used as the output from the transducer is measured in volts (dual units will be used to display the reading in pressure)

2. Under the **'INSTRUMENTS'** instruments tab select the *2000 series calibrator* in the **Custom Cal Instrument** section.



   ⓘ **Note** : You can also display a message in the 2000 series display whilst this test is running by entering a command in the **Pre-Test Commands** box (as shown above in the **Pre-Test Command** box)

3 Under the **'ADVANCED'** tab set the formula to multiply the returned reading (X) by the gain factor for the transducer



Programmable Switch / Scanner EA007

- **8 Programmable Relays**
- **2 x High Current 20Amp Channels**
- **2 x High Voltage 1kV Channels**
- **4 x Signal Level Channels**
- **Requires 2000 Series calibrator**
- **Works with Virtual Front Panel or ProCal Calibration Software**
- **Fully programmable for use in ATE Test stations**

Automated Switching - eliminates lead changing

Bring an end to lead changing with this programmable switching unit. Connects directly to the 2000 Series calibrator's feature connector to bring automated switching capabilities to your calibration workstation.

Incorporates two 9 Way 'D' type connections for control input and through connection to additional scanner units. This provides the facility to 'daisy-chain' units and provide multiple channels for any task.

Connections

Channels 1-4

High performance low thermal switching (less than 1uV) for low level signals. 4-pole switching is provided, making these channels ideal for 4-wire applications including resistance measurements. Utilising a 25 Way 'D' type connector, multiple wiring looms can be easily interchanged for different configurations.

Channels 5-6

Channels 5 and 6 incorporate low thermal 4mm terminals for use in voltage switching up to 1kV, allowing either socket or bare wire connection end for maximum flexibility.

Channels 7-8

Channels 7 and 7 also use 4mm terminals for use in current switching up to 20A, again allowing either socket or bare wire end connection.

Front Panel Display

The front panel incorporates a 'power on' LED indicator. Each channel also displays its status (on/off) via an LED indicator (one per channel).

Control Interface

Full remote control of these scanner units is made in conjunction with the ProCal Calibration software or any RS232 capable program. A simple control language provides control of one or more scanner units to allow channels to be easily configured (with ProCal, channels can be set on a test by test basis to provide **ATE** testing).

Specifications - See extended specifications for full details

CH1-4 : 4xDPDT Signal Switching @ 250V / 2A • **CH5-6** : 2xSPST @ 1000V / 200mA • **CH7-8 :** 2xSPST @ 100V / 20A

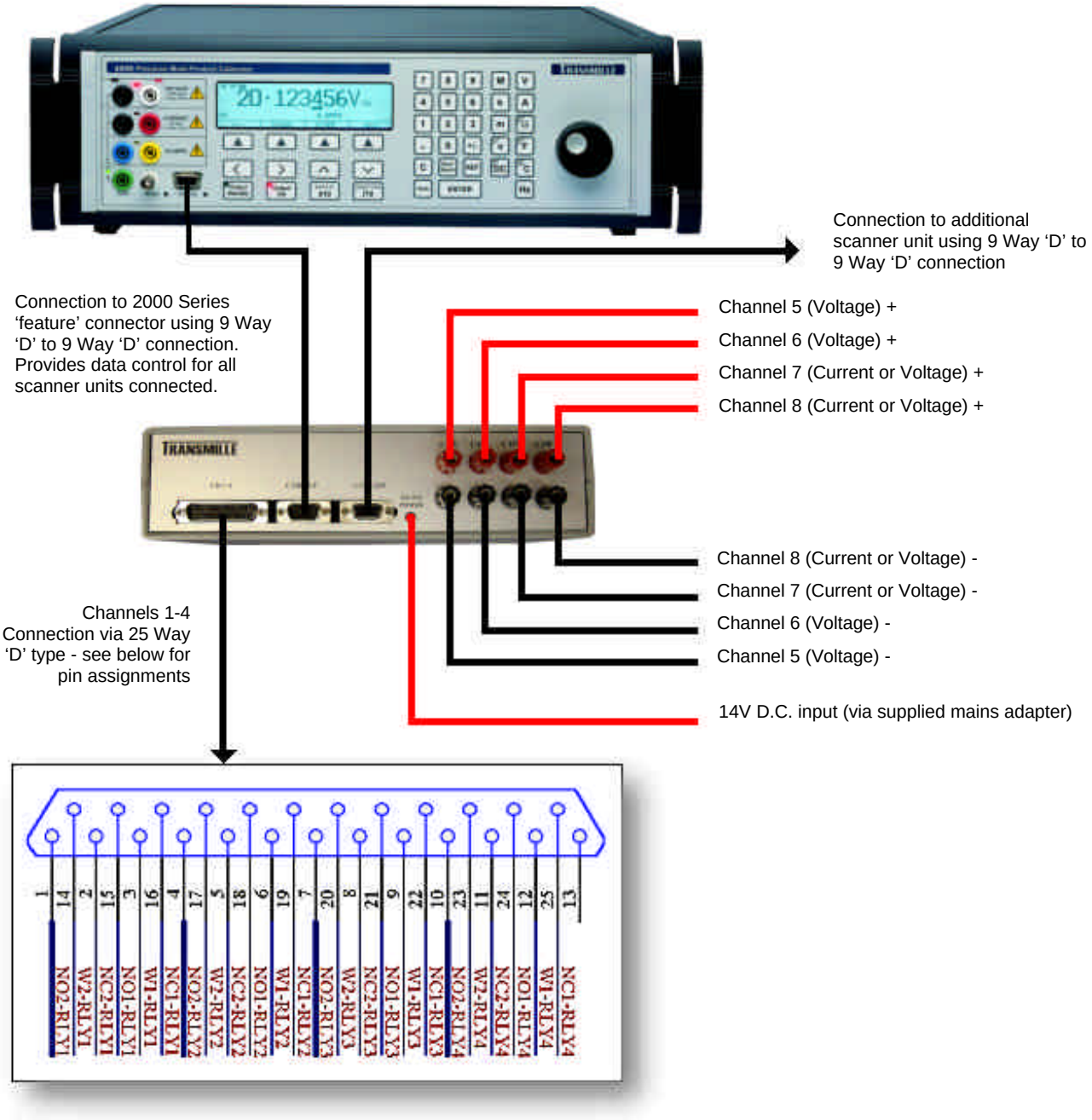
ⓘ **Important Note** : The scanner unit must be connected to a 2000 series calibrator - it cannot be used as a stand-alone unit.

Programmable Switch / Scanner - Connection

Using the supplied 9 Way 'D' to 9 Way 'D' lead connect the scanner unit **COM I/P** connector to the 'feature' connector on the front of the 2000 Series calibrator. External power for the scanner unit should be connected to the **14V D.C. Power** socket using the supplied mains adapter.

Additional units can be 'daisy chained' using the **COM O/P** connector. See connection diagram below for connector assignments.

ⓘ **Note** : The current channels can be used to provide additional voltage channels if required.



Programmable Switch / Scanner - Operation

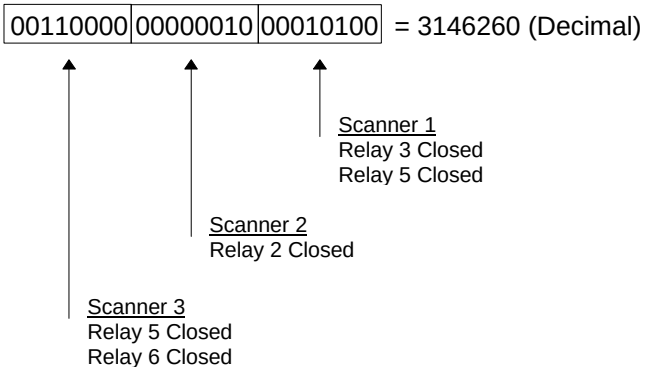
The scanner unit uses a simple binary coding to determine which channels are switched on or off, and which scanner unit is being set (in a multi-scanner, or 'daisy-chained' set up)

Using **24 Bit binary**, work out the relay combination where relay 1 on scanner 1 is the least significant bit - then convert this to decimal.

Example

The following example is for a set up using 3 scanner units, setting relays on all three of these units :

Relays 3 & 5 *closed* on **Scanner 1, relay 2** *closed* on **Scanner 2** and **relays 5 & 6** *closed* on **Scanner 3**



To set the scanner(s) up using the decimal command, simply add a lower case 'p' to the start of the command, and send a carriage return (ASCII character 13) to terminate the string, for example

p3146260<*CR*>

Where <*CR*> is a carriage return (ASCII character 13)

ⓘ **Note** : To turn of all channels (relays) of all scanner units send the command p0<*CR*>

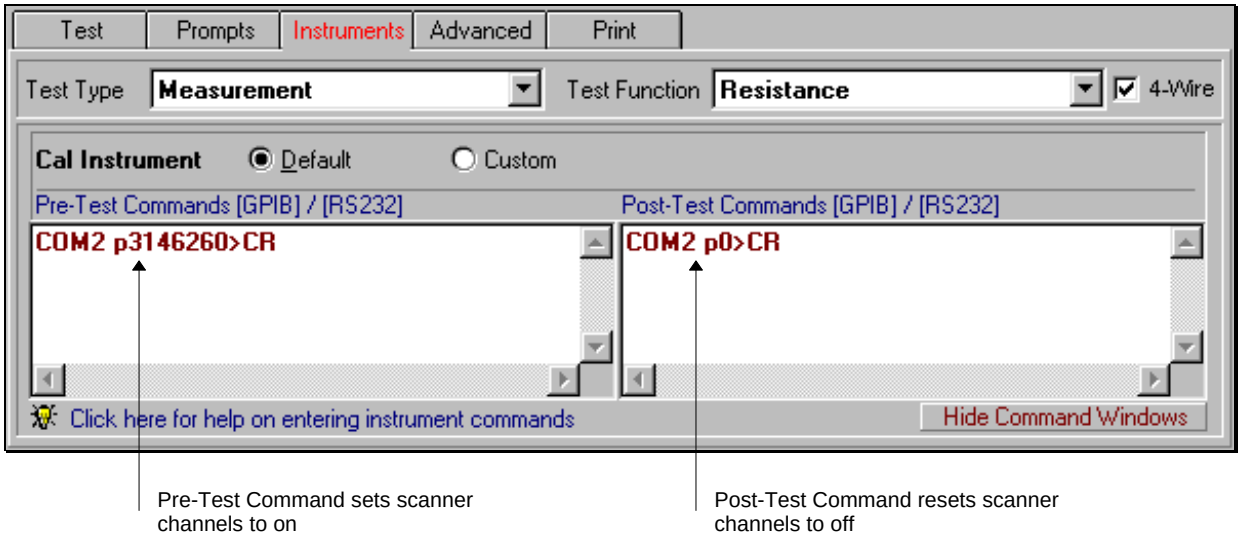
Command List (individual channels)

Listed below, for reference are the *individual* relay commands - for *combinations* of relays, the binary to decimal conversion method detailed previously is required.

Scanner Unit	Relay	Command
1	1	p1
1	2	p2
1	3	p4
1	4	p8
1	5	p16
1	6	p32
1	7	p64
1	8	p128
2	1	p256
2	2	p512
2	3	p1024
2	4	p2048
2	5	p4096
2	6	p8192
2	7	p16384
2	8	p32768
3	1	p65536
3	2	p131072
3	3	p262144
3	4	p524288
3	5	p1048576
3	6	p2097152
3	7	p4194304
3	8	p8388608
all off		p0

Sending scanner commands using ProCal

Pre-programmed (procedure based) control using the ProCal Calibration software can be achieved - this allows a pre-set channel configuration to be set on a test-by-test basis, which is ideal for automated lead switching or use in creating an automated test equipment (ATE) set up. Within a ProCal procedure, use the **pre-test** and **post-test** command boxes (under the Instruments tab) to enter scanner configuration commands, as shown below :



Pre-Test Command sets scanner channels to on

Post-Test Command resets scanner channels to off

ⓘ **TIP** : Any RS232 capable program can be used to control the scanner unit (e.g. Windows Hyper terminal)

Programmable Switch / Scanner - Specifications

High Voltage Switching	
Relays	2 x N/O SPST
Max DC Volts	1000V
Max AC Volts	1000V
Max Current	20mAmps AC/DC
Connection	4mm low thermal safety sockets

High Current Switching	
Relays	2 x N/O SPST
Max DC Volts	100V
Max AC Volts	100V
Max Current	20Amps AC/DC
Connection	4mm terminal posts

Signal Switching	
Relays	4 x DPDT
Max DC Volts	250V AC/DC
Max Current	2Amps AC/DC
Connection	25 Way ‘D’ type connector

General	
Power	14V D.C.
Interface	Feature connection to 2000 Series calibrator 1x I/P Connection (9 Way ‘D’ type) 1x O/P Connection (9 Way ‘D’ type)
Indicators	1x Power indicator 8x Channel indicators
Connections	Channels 1-4 (signal) : 25 Way ‘D’ type connector Channels 5 & 6 (Voltage) : 4mm Low thermal Safety Sockets Channels 7 & 8 (Current) : 4mm Terminal Posts

High Ohm / pA Measurement Option EA008

- **Measures Resistance up to 10T Ohms**
- **Measures Current down to 0.1pA**

Overview

The High Resistance measurement adapter makes full use of the calibrators ability to accurately source and measure voltages at the same time to provide a low cost solution to the accurate measurement of high resistance without the need to purchase a specialised instrument.

Operation

The adapter works by converting nano amps to volts. Using an ultra low leakage amplifier allowing measurement at sub pico amp levels, precision gain networks and a switched capacitor filter for fast response the 2000 series calibrator is converted into a high performance pico amp meter. Use the DC output from the calibrator as well and you have all that is required to accurately measure high value resistance's.

Specifications

Current Measurement	
Ranges	10nA, 1uA, 100uA
Resolution	0.01pA,1pA,0.1nA
Accuracy	0.5% +4 digits
Max. Current	20mAmps AC/DC
Connections	4mm safety sockets

High Resistance Measurement	
Relays	2 x N/O SPST
Max. Voltage	100V
Max. Current	20mAmps AC/DC
Connections	4mm terminal posts

DC Measurement Option EA009

Measures

- **DCV to 10V**
- **DCI to 100mA**
- **DC Resistance 10kOhm**

Calibrates

-
- **Thermocouple simulators & probes**
- **Process control calibrators**
- **PT100 Simulators & probes**
- **4 Wire resistance current shunts**
- **4 to 20mA Transducers**
- **Source / Measure calibrators**
- **And more…**

Overview

This measurement adapter working with the 2000 series calibrator provides the perfect solution for the calibration of the growing number of process control calibrators which can both measure and source signals used by transmitters and sensors in the process control industry.

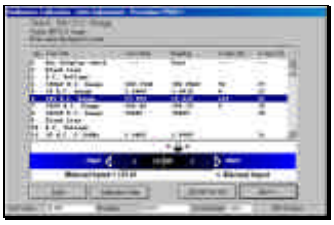
Normally these products would require both a calibrator & DMM to certify so this simple solution can save both time and money. In addition low value resistance & current shunts can also be calibrated by using the calibrator to generate the test current up to 20 Amps and then measuring the voltage generated using the adapter

The operation is controlled using a PC running either the Virtual front panel program or ProCal software. The software sends commands to the calibrator to read back the signals which are then displayed on the computer.

Using The VFP Software To Control Outputs And Make Measurements

Basic control using the **2000 Series Virtual Front Panel Software** (Optional) can be achieved with readings displayed on the PC screen. Multiple measurement types and ranges can be set up using the customisable 'POD' mode, including scaling and custom units to provide, for example, mV to PSI conversion using.

Automated Calibration using ProCal



Advanced control using the **ProCal Calibration Software** (Optional), with readings displayed and automatically recorded in certificates.
Calibration procedures to automate the calibration of both output and measurement functions (using the 2000 Series output) of process control calibrators can easily be created, allowing rapid calibration and efficient throughput of work, saving the cost of a DMM.

Specification - See extended specifications for full details

DC Voltage Measurement	
Ranges	100mV • 1V• 10V
Resolution	1uV • 10uV • 0.1mV
Accuracy	0.01% ± 2 Digits
Connections	4mm Terminals

DC Current Measurement	
Ranges	0 to 100mA
Resolution	1uA
Accuracy	0.02% ± 3 Digits
Connections	4mm Terminals

Transconductance & kV Amplifier Options

For the 2000 Series Calibrators

AC / DC kV Amplifier — EA2024

- **DC Output 1 to 10 kVolts**
- **AC Voltage 1 to 7.5 kVolts**
- **Controlled by ProCal or VFP Software**

Working with and controlled from the 2000 series calibrator the kV amplifier provides the solution to the calibration of High Voltage probes and dividers. The amplifier/calibrator combination can be used only with our VFP or ProCal Software.

Specifications

DC Voltage		AC Voltage	
Range	1kV to 10kVolts	Range	1kv to 7.5kV
Resolution	100mV	Resolution	100mV
Accuracy	0.1%+ 20mV	Accuracy	0.5%
DCI Load (Max.)	100uA	Freq. Range	40Hz to 100Hz

50A Transconductance Amplifier — EA012

- **AC / DC Output 0 to 50 Amps**
- **3V RMS Compliance voltage**
- **Controlled by ProCal or VFP Software**

Working with and controlled from the 2000 series calibrator the transconductance amplifier provides the solution to the calibration of high current clamp meters and shunts. The amplifier/calibrator combination can be used only with our VFP or ProCal Software.

Specifications

AC / DC Voltage	
Range	0 to 50 Amps AC /DC
Compliance Voltage	3 Volts RMS
Accuracy	0.08%
Freq. Range	100Hz to 1kHz

Capacitance & Inductance Measurement Bridge Adapter EA011

- **Calibrate Capacitance & Inductance Boxes**
- **Cost effective solution for AC capacitance Measurement**
- **Measure Frequencies from 100Hz to 10Khz**
- **Measurement level from 200mV to 20 Volts**

Using the calibrators high accuracy AC Voltage output this Adaptor measures the impedance of the component under test and uses the internal A/D in the calibrator to read the voltage generated. The VFP software then performs the calculations to convert the combination of applied voltage and frequency and measured voltage into capacitance or inductance display.

Specifications

Capacitance Measurement	
Ranges	200pF,2nF,20nF,200nF,2uF,20uF
Resolution	4.5 digits
Accuracy	0.08% + 2 Digits + 1pF @ 1kHz
Measurement Level	100 Hz to 10kHz in 2Hz steps

Picoamp / Electrometer Calibration Adapter EA013

- **Source Accurate Current down to pico amp level**
- **Low open circuit compliance voltage**
- **Safe to use on sensitive input circuits.**

Provide accurate calibration of sensitive Electro meters and low level pica amp meters safely & quickly with this purpose designed option.

Overview

A unique and ingenious circuit designed at Transmille converts the accurate voltage output from the calibrator into low noise precision currents without the use of the destructive high voltages and unstable high value resistors often used for this. Yet another example of Transmille's pioneering ideas and designs for providing solutions to some of the common problems faced by calibration laboratories everywhere.

Specifications

Current Source	
Range	2uA, 200nA,20nA
Accuracy	0.1%+ 20mV
Resolution	0.1nA,10pA,1pA
Max Compliance	12V

Precision Measurement Lead Set 2000LEAD

A comprehensive collection of test leads and adapters is provided to cover requirements from low level DC through to high current and high resistance measurements.

The leads and materials supplied in this measurement set have been carefully selected to minimise connection/lead errors. The safety of the leadset is ensured by the use of non-retractable shrouded connectors for the voltage test lead set.

The leads are stackable to allow connections to be commoned together where required

Low Thermal Gold Plated Connections

The use of gold plated connectors is essential to reduce thermally generated EMFs caused by temperature differences across metal junctions (i.e. thermocouple type effects). Gold connections, which produce less than 0.2uV/°C, are used as opposed to nickel plated brass which can produce in excess of 15uV/°C. This allows typical uncertainty contributions from this type of leadset to be in the order of 0.5uV.

Low resistance 32A current leads

The leadset provided for high current measurement is manufactured using very low resistance cable and connectors. Low resistance is essential to carry current without excessive heating effects or voltage drop. As there are no errors introduced by thermal effects connectors are made from hard wearing nickel plated brass. Retractable shroud type connectors are used as there is no potential for shock.

Low noise measurements using screened leadset

For high resistance and low level AC measurements a BNC to BNC screened lead complete with BNC to 4mm adapters is provided. This lead is essential for this type of measurement where unscreened leads can cause errors by introducing unwanted line frequency (mains) pickup, ‘swamping’ the measured signal.
The very high resistance of the lead supplied also avoids leakage errors caused by using inferior (leaky) test leads which can effectively shunt the value being measured (for example a leakage
of only 100 GigaOhms on a measurement of 1 GigaOhm will give a 1% error).

Flexible range of adapters, converters & terminators

For the ultimate in flexibility, a selection of adapters, converters and terminators are provided as standard to maximise the inter-connectivity of the leadset.

Test Lead Set Specifications

Voltage Measurement Leads	1 pair of Black & White leads fitted each end with low thermal 4mm non-retractable shroud safety terminals. Plating: Gold Length: 1m Rating: 1000VAC / 16A Thermal Effect: 0.7uV
Voltage Measurement Adapters	
4mm plug to spade adapters 	2 pairs of low thermal (gold plated) Black & Red 4mm plug to spade adapters suitable for connection to standard resistors etc. **1000VAC rating does not apply when using these spade adapters due to electric shock hazard**
4mm safety plug to unshrouded open end adapters 	1 pair of low thermal (gold plated) adapters suitable for use with high voltage safety leads when connecting to instruments without safety terminals. **1000VAC rating does not apply when using these adapters due to electric shock hazard**
4mm plug to cable adapters 	1 pair of low thermal (gold plated) adapters suitable for connecting bare-ended cables to 4mm terminals. **1000VAC rating does not apply when using these adapters due to electric shock hazard**

Recommended use of voltage measurement leads

- DC voltage measurements up to 1000V.
- Combine with low current leadset and spade adapters - ideal for 4-wire kelvin measurements.

As these are unscreened, they are not suitable for high value resistance or low AC voltage & current.

It is important to remember that the terminals of mains powered instrument may be warm, or above ambient temperature. The test leads will almost certainly be at ambient (room) temperature and connecting these leads to a mains powered instrument will cause a significant 'cold-junction'. This will require a period of time before the temperature variation stabilises between the instrument terminals and the leadset.

Current Measurement Leads	1 pair of Black & Red leads fitted each end with 4mm retractable shroud safety terminals. Plating — Nickel plated brass Length — 1m Rating — 150VAC / 16A
Recommended use of current Measurement Lead • AC/DC current measurements from 1mA up to 2A. This leadset can be used at lower currents, however to reduce noise / pickup use the BNC to BNC lead.	

High Current Measurement Leads	1 pair of low resistance Blue & Yellow leads fitted each end with 4mm retractable shroud safety terminals. Plating — Nickel plated brass Length — 1m Rating — 150VAC / 32A
Recommended use of current measurement Lead • AC/DC current measurements from 2A up to 20A This lead is not suitable for low DC measurements due to thermal EMFs created by the contact material used.	

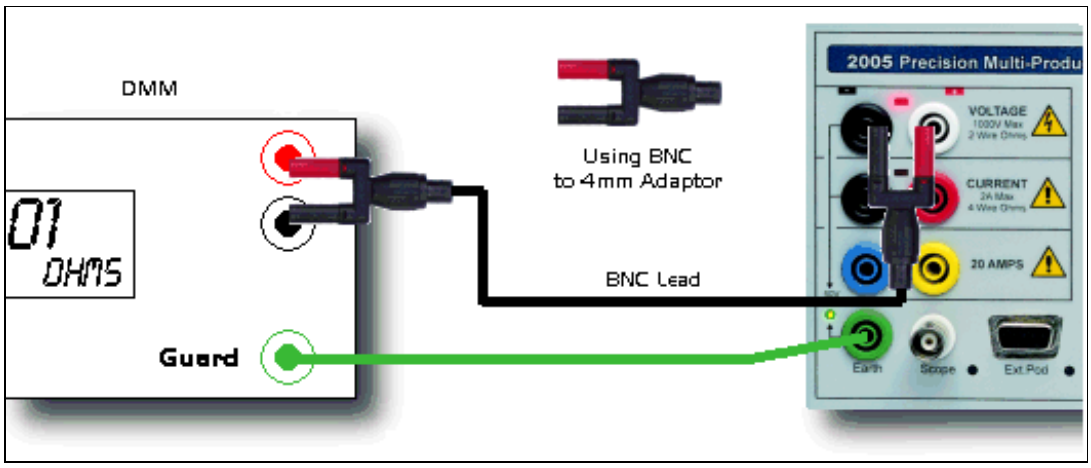
BNC Oscilloscope connection / AC measurements / High resistance measurements	1 coax lead fitted each end with BNC connectors Plating — Silver Length — 1m Rating — 300VAC / 0.5A
Recommended use of BNC lead • Low AC voltage & current measurements • High resistance (1Mohm and above) as shown below This lead is not suitable for low DC measurements due to thermal EMFs created by the contact material used. Please note thermals do not affect the accuracy of AC voltage / current measurements	

BNC Adapters	
BNC to 4mm Adapter 	2 BNC to 4mm shrouded adapters are supplied to allow connection to calibrators & multimeters
BNC 50 Ohm Feed-through Adapter	A 50 Ohm terminator for use with the bandwidth (levelled) sweep function of the oscilloscope calibration option.

Precision Measurement Lead Set - Applications

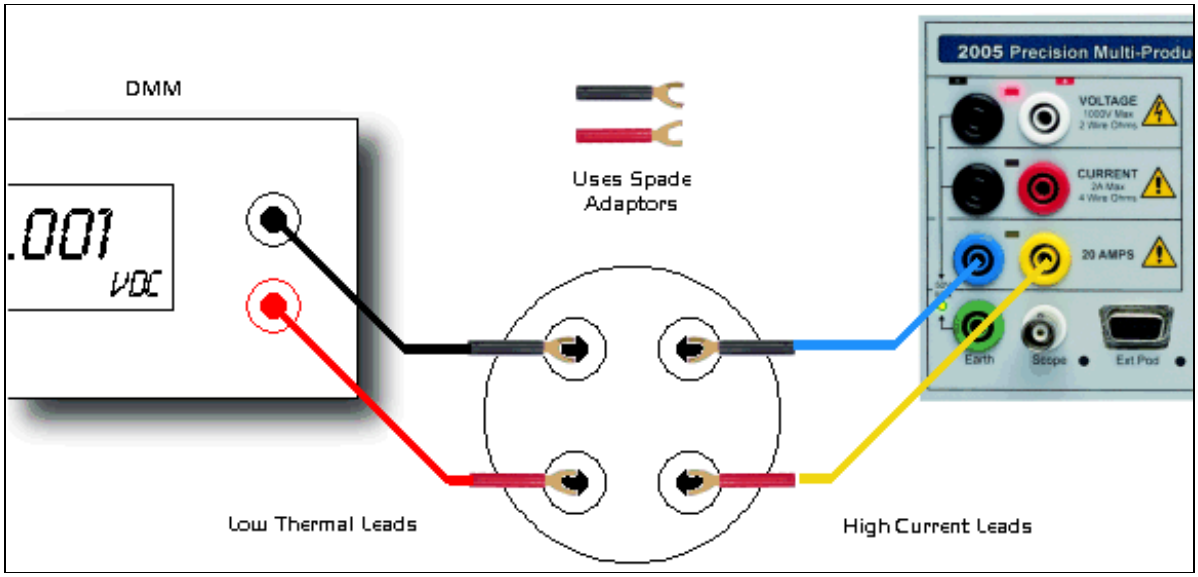
High Resistance Connection

Using the BNC lead with 4mm to BNC adapters



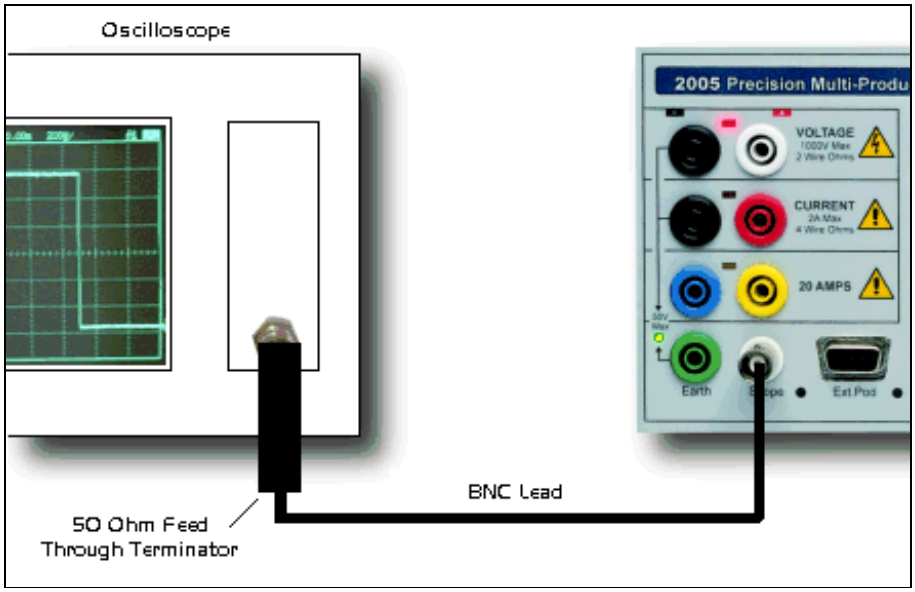
4-Wire High Current Shunt Connection

Using the Low Thermal Voltage & High Current leads with 4mm plug to spade adapters



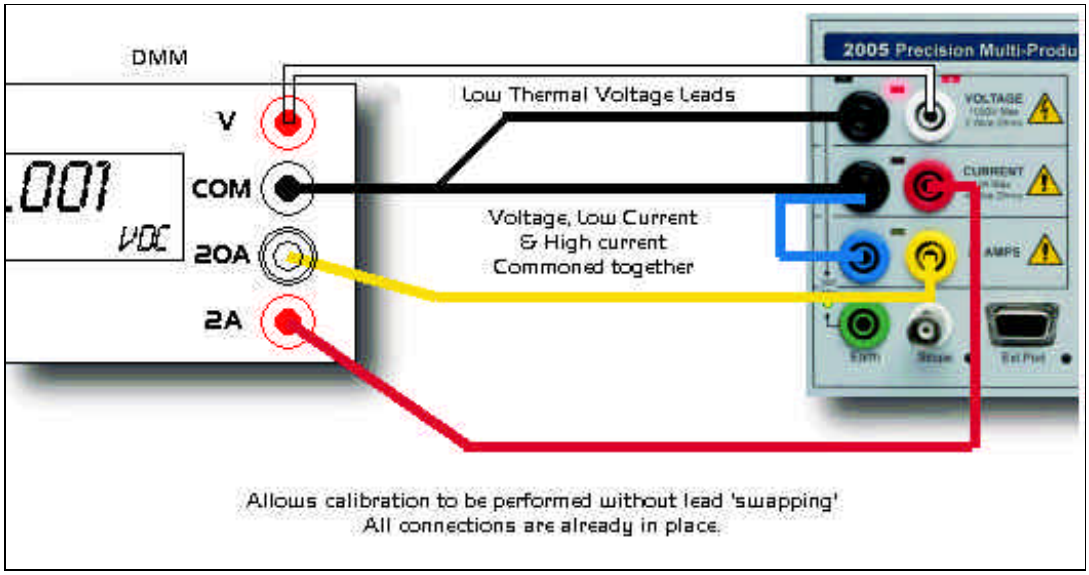
Bandwidth Connection

To Oscilloscope Using 50 Ohm Feed Through Terminator.



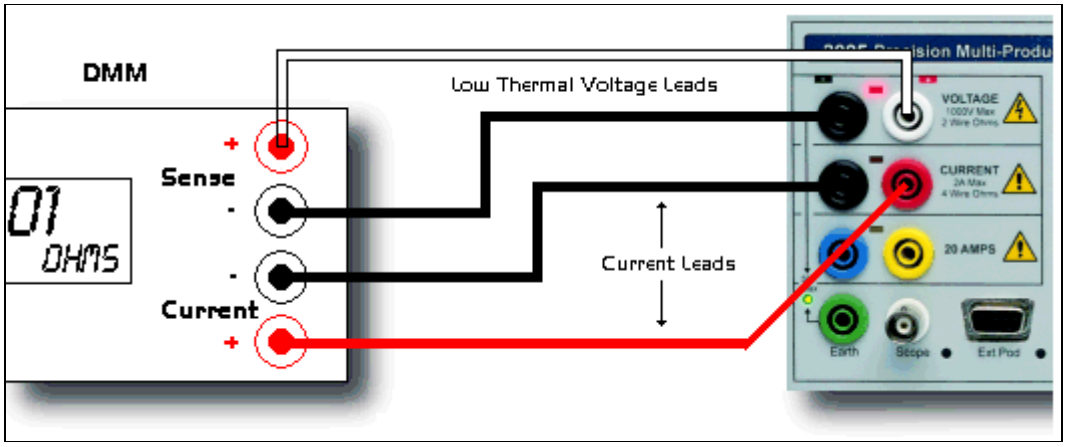
Connection to 4 Terminal DMM

Using Low Thermal Voltage, Current & High Current Leads to Eliminate Lead Swapping



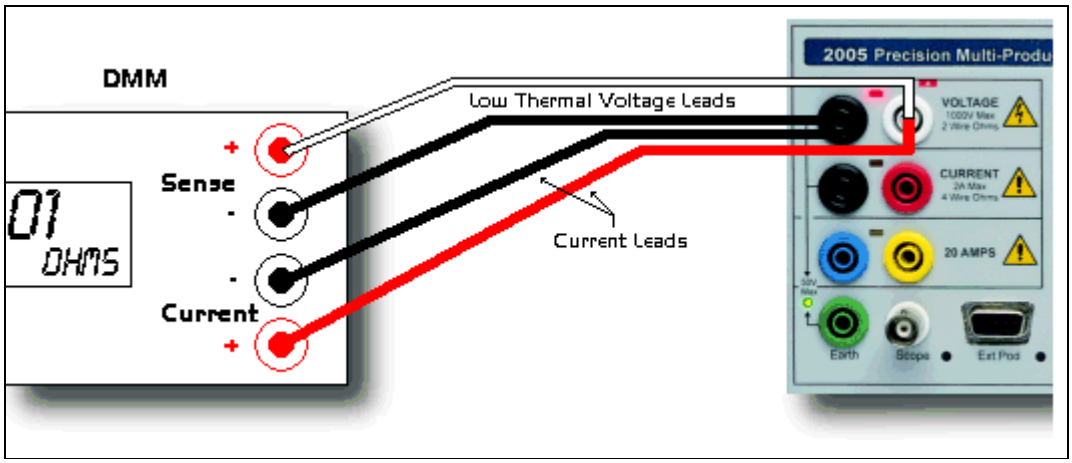
4-Wire Resistance Connection

Using the Low Thermal Voltage & Current leads.



4-Wire DMM to 2-Wire Calibrator Resistance Connection

Using the Low Thermal Voltage & Current leads.



Virtual Front Panel VFP

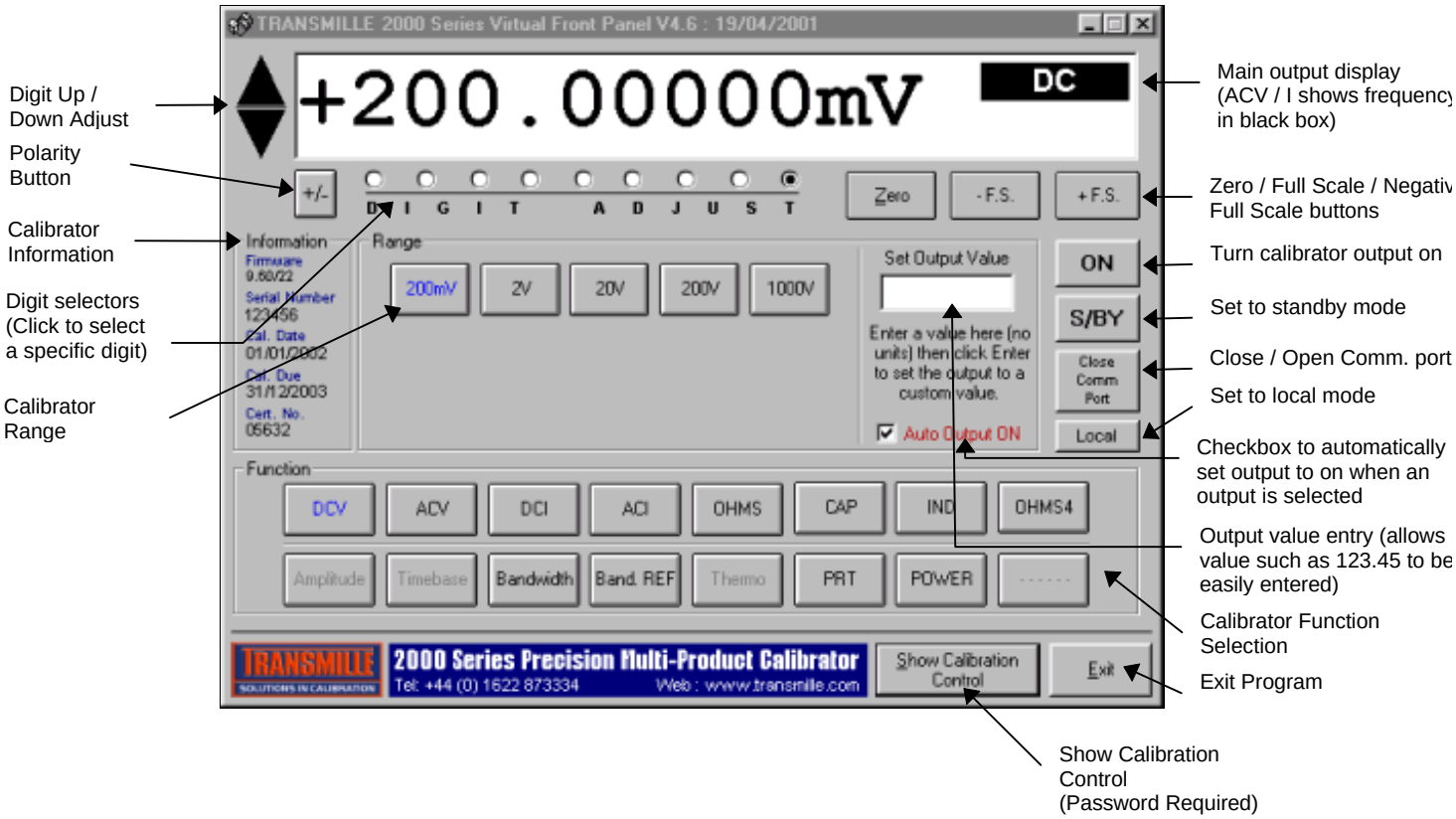
THE 2000 SERIES VFP CAN BE INSTALLED FROM THE TRANSMILLE SOFTWARE CD

An easy to use program which allows control of the 2000 Series calibrator from a PC. Simply install the program and obtain the password from Transmille, connect up the calibrator via the RS232 COM port and begin.

This program also provides tools to adjust the calibration constants, allowing manual re-calibration of the 2000 Series units. Also included are functions which extend the functionality of the 2000 Series calibrators and support the optional adapters.

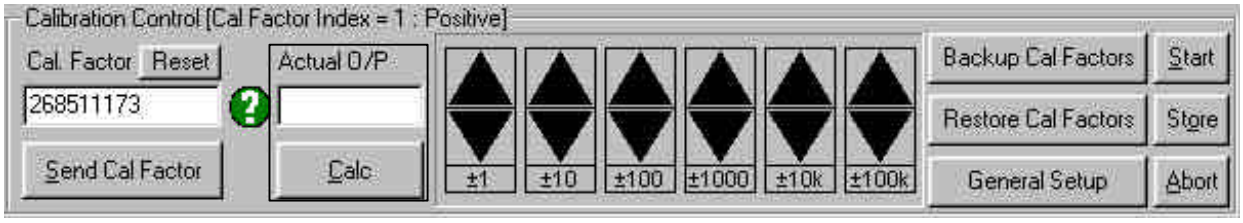
Using the 2000 Series Virtual Front Panel

On starting the program, an easy to use virtual front panel is displayed, allowing easy selection of functions.



Calibration Control

The calibration control is password protected, and allows adjustment of each range of the 2000 Series calibrators using simply up / down buttons. Please see the VFP manual, located on the Transmille software CD for full details.



Carry Cases / Transit Cases

For the 2000 Series Calibrators

Soft Carry Case — OPTION CASE

Designed for carrying the 2000 Series calibrators when working on-site, the soft carry case includes a carry strap. The lightweight design of the calibrator allows easy carrying of the unit, with pockets on each side for accessories & adapters.

The calibrator can be used while still inside the case, with a zip down front and rear to allow connections.

Note : This case is for hand transport of the calibrators only - for suitable shipping / transit cases see below.

Laptop Case — OPTION CASE 2

For the complete portable solution, a laptop case is available which zips onto the soft carry case.

Complete operation of a system can then be made without needing to remove the items from their cases - simply plug in and start calibrating.

Hard Transit Case — OPTION CASE T

Designed for transporting the 2000 Series calibrators this rugged transit case is suitable for shipping the 2000 series as well as protecting the calibrators in particularly harsh environments (oil rigs etc.). The hard wearing design includes extra corner protection and a secure locking mechanism.

Additional space is provided inside for accessories and adapters.