F/N 3112:440-1

meriam
process technologies
a Scott Fetzer company

-CAL Rtd

Handheld single function universal RTD indicator-simulator

User's Manual

INTRODUCTORY NOTE

ATTENTION: THIS MANUAL MUST BE REFERRED TO FOR INSTRUMENTS WITH SERIAL NUMBER 0010088 FOREWARD.

*This manual includes all the information you need to install, operate and maintain the **M-CAL Rtd** Calibrator and its accessories.*

***Meriam** has used the best care and efforts in preparing this book and believes the information in this publication are accurate. **Meriam** products are subjected to continuous improvement; these improvements could require changes to the information of this manual.*
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***M-CAL Rtd** uses sophisticated analog and digital technologies. Any maintenance operation must be carried out by qualified personnel **ONLY**. We recommend contacting our technicians for any support requirements.*

***M-CAL Rtd** is fully tested in conformity with the directive n°89/336/CEE Electromagnetic Compatibility. **Meriam** shall not be liable in any event, including technical and publishing errors or omissions, for any incidental and consequential damages, in connection with, or arising out of the use of this book.*

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1 GENERAL PERFORMANCE

A complete system for testing, measuring and calibrating built into a single, compact portable instrument.
M-CAL Rtd is a portable multifunction calibrator designed to meet, in a modern and practical way, the needs of instrumentation engineers both in laboratory and field work.
Accurate, compact, rugged and easy to use, **M-CAL Rtd** is the ideal solution for measurement and simulation of:

- **ohm**
- **temperature with resistance thermometers**

The **M-CAL Rtd** has been developed using the most advanced microprocessor technology to provide high accuracy on extended ranges with powerful operation flexibility.
Linearization algorithms of the characteristic curves of thermocouples are held in the microprocessor memory in accordance with IEC / ANSI and DIN standards. Platinum RTDs Pt100, Pt200, Pt500, Pt1000; Nickel thermometers Ni100, Ni120; Copper thermometers Cu10, Cu100 fitted with both IPTS68 and new international scale ITS90.
The selection of the operative mode is made on the polycarbonate membrane keyboard with a working life up to one million operations per key.
Both measured and simulated values are indicated on a high quality LCD dot matrix display which assures good contrast even in poor light conditions.
A menu-driven procedure allows the generation of sixty memory stored values, or a continuous or step ramp output.
The instrument carries out mathematical functions for measuring the average values of unstable signals.

The case, made of shock-resistant ABS, is ergonomically designed for easy and practical use.

Model options for four alkaline AA batteries (1.5 V) or four Ni-MH rechargeable batteries AA (1.2 V 0.7A/hour) are available. The Ni-MH models come with an external battery charger / AC power supply as a standard accessory. NOTE: Alkaline powered models are not compatible with AC power.

1.1 Model codes

M-CAL Rtd Part No. 3112 – A – B

Basic configuration of the instrument includes a soft carrying case with belt loop and a user's manual.

Table A	Batteries/line charger
0	Alkaline /none
1	Ni-MH rechargeable with external charger / AC power supply (Specify plug type with order)

Plug Types:

- Ni-MH/120VAC 50/60 Hz – USA plug
- Ni-MH/230VAC 50/60 Hz – Schuko plug
- Ni-MH/230VAC 50/60 Hz – UK plug
- Ni-MH/230VAC 50/60 Hz – European plug
- Ni-MH/100VAC 50/60 Hz – USA/Japan plug

Table B	Report of Calibration
0	No NIST certificate
1	NIST certificate + data

1.2 Specifications

- **In/Out parameters:**
  see table
- **In/Out ranges:**
  see table
- **Resolution:**
  see table
- **Limits of error:**
  see table
- **Common mode rejection:**
  > 130 dB at 50/60 Hz
- **Normal mode rejection:**
  > 60 dB at 50/60 Hz
- **Temperature stability:**
  span: ±0.01% of the reading/°C
  zero : ±0.2 µΩ/°C
- **Simulation excitation current:**
  0.3 to 3mA (up to 400Ω)
  0.03 to 0.3mA (up to 4000Ω)
- **Measurement excitation current:**
  0.5mA (up to 400Ω)
  0.05mA (up to 4000Ω)
- **Rtd cable compensation:**
  100Ω max
- **Display:**
  high contrast dot matrix LCD
  (7x5 dots per character - 16 characters)
- **Scale Factor:**
  Ro and α adjustable for linear interpolation
- **Calibration:**
  automatic procedure
- **Power supply:**
  4 AA Alkaline (1.5V) or rechargeable Ni-MH batteries (1.2V, 0.7 A/hour)
- **Battery life:**
  8 hours (Ni-MH Batteries) - 20 hours (Alkaline Batteries)
- **Recharge time:**
  8 hours with instrument switched -OFF-
- **Battery voltage:**
  display indicated value
- **Firmware release identification:**
  version number indicated on the display
- **Operating temperature range:**
  from -5°C to +50°C (23 to 122°F)
- **Storage temperature range:**
  from -30°C to +60°C (-22 to 140°F)
- **Case:**
  ABS
- **Dimensions:**
  215x96x35 mm
- **Weights:**
  net 1 Kg (2.2 lbs)
  gross with packing 2.5 Kg

1.2.1 Table of ranges and accuracies

IN-OUT RANGES

Sensor or parameter	Total range	Resolution	Accuracy (% of reading)	Reference
Pt100 α=3850	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18F)*	IEC751 - DIN 43760
Pt100 α=3902	-200 to 650°C *-328 to 1202°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	US
Pt100 α=3926	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	US Lab
Pt100 α=3923	-200 to 600°C *-328 to 1112°F*	0.1°C *0.1°F*	±(0.04% +0.2°C) *±(0.04% +0.36°F)*	SAMA
Pt100 α=3910	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.2°C) *±(0.04% +0.36°F)*	OIML 1985
Pt100 α=3916	-200 to 600°C *-328 to 1112°F*	0.1°C *0.1°F*	±(0.04% +0.3°C) *±(0.04% +0.54°F)*	JIS JEMINA 1981
Ni100 α=617	-60 to 180°C *-76 to 356°F*	0.1°C *0.1°F*	±(0.04% +0.2°C) *±(0.04% +0.36°F)*	
Ni120 α=672	0 to 150°C *32 to 302°F*	0.1°C *0.1°F*	±(0.04% +0.3°C) *±(0.04% +0.54°F)*	
Cu10 α=42	-70 to 150°C *-94 to 302°F*	1°C *1°F*	±(0.04% +0.3°C) *±(0.04% +0.54°F)*	
Cu100 α=42	-180 to 150°C *-292 to 302°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	
Pt200 α=3850	-200 to 760°C *-328 to 1562°F*	1°C *1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	
Pt500 a=3850	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	
Pt1000 α=3850	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	
Pt1000 α=3910	-200 to 850°C *-328 to 1562°F*	0.1°C *0.1°F*	±(0.04% +0.1°C) *±(0.04% +0.18°F)*	OIML 1985
Ω IN	0 to 300Ω 20 to 3000 Ω 0 to 400 Ω 20 to 4000 Ω	10mΩ 0.1Ω 0.1 Ω 1Ω	±(0.04% +27mΩ) ±(0.04% +270mΩ) ±(0.04% +27mΩ) ±(0.04% +270mΩ)	
Ω OUT	0 to 300Ω 20 to 3000 Ω 0 to 400 Ω 20 to 4000 Ω	10mΩ 0.1Ω 0.1 Ω 1Ω	±(0.04% +35mΩ) ±(0.04% +350mΩ) ±(0.04% +35mΩ) ±(0.04% +350mΩ)	

Note:
- The relative accuracies shown above are stated for 90 days and the operative conditions are +23°C ±2°C
- The typical 1 year's relative accuracy can be estimated by multiplying the "% of reading" specifications by 1.6.
- All input ranges: additional error ±1 digit.
- The traceability chart and uncertainty data can be supplied on request.

2 GENERAL FEATURES

2.1 Input and output flexibility

Ease of operation has been achieved using advanced microprocessor technology.
Each instrument, through a menu-driven procedure, allows measurement (IN) or simulation (OUT) of ohms, or temperature with all normalized IEC / ANSI and DIN resistance thermometers Pt100, Pt200, Pt500, Pt1000, Ni100, Ni120, Cu10, Cu100.
The microprocessor performs automatic polynomial linearization.
°C or °F and ITS90 or ITS568 selection is made directly on the membrane keyboard.

2.2 Self calibration

The hardware-firmware design allows for an automatic calibration of the instrument.
An high precision resistor (400Ω, 4000Ω) and an ohmmeter are necessary.
The calibration procedure is protected by a security code .

2.3 Keyboard

A tactile polycarbonate membrane keyboard, with a working life of one million operations per key, protects the internal electronics from the surrounding environment.
It allows the selection of the operation mode, the type of resistance thermometers and the setting of simulation values with fast and slow rate of change.
A "bip" sound indicates that the instrument has received and acknowledged the keyboard operator instruction.
Contact closure of membrane keys is acknowledged, as a coded signal, directly by the microprocessor.

2.4 Display

The high quality alphanumeric dot matrix LCD display (7x5 dots per character - 16 characters) allows easy readings even in poor light conditions.
The operation mode [easurement (IN) or simulation(OUT)], the technical unit and the signal value are simultaneously indicated.
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2.5 Scale factor function

Easy, menu-driven set-up, enables the user to read or simulate custom resistance thermometer by adjusting Ro and α (linear interpolation). The display will indicate the scaled input / output value in °C or °F. It is possible to include IPTS90 current correction.

2.6 Average measurements

The measurement of unstable input signals is accomplished with a progressive averaging each 32 conversions (approximately 10 seconds).

2.7 Hold measurement

To hold the actual measurement on the display.

2.8 Simulation mode

Menu-driven set-up to generate a continuous step ramp output.
The total time, the start point, the end point and step size are requested by the set-up procedure to run the program.
A manual repeat increment is also possible (Autostep).

2.9 Store and Autoscan

Up to 60 values can be stored in internal memory to create an automatic calibration procedure.
Autoscan function avoids the need to recall in sequence all stored valves.
Input values can also be stored.

2.10 Case

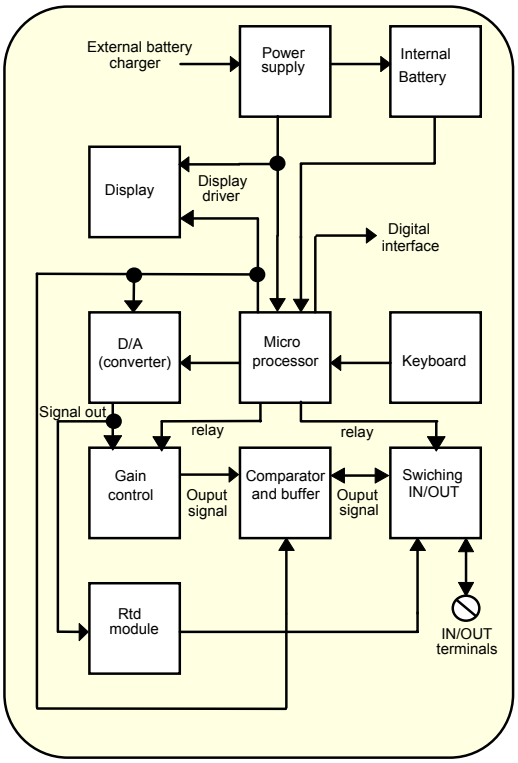
The case is designed for easy hand held operation and transport.
The body is injection molded, shock- resistant ABS .
A soft soft carrying case with belt loop is supplied with the instrument as a standard accessory.

3 PHYSICAL DESCRIPTION

The **M-CAL Rtd** portable calibrator consists of a rugged and compact ABS case, a mother board with all base functions, a tactile polycarbonate membrane keyboard , an LCD display and a group of four Alkaline or Ni-MH rechargeable batteries.
An external battery charger / power supply module is supplied as a standard accessory when the Ni-MH battery option is ordered.
The battery container is located on the back of the case and is accessible by sliding and removing the plastic cover.
The soft case, with belt loop, assures better protection of the instrument against knocks and scratches.

4 FUNCTIONAL DESCRIPTION

The **M-CAL Rtd** portable calibrator block diagram is shown on the figure below:



The functional blocks of the instrument are as follows:

- **power supply**
- **microcontroller (central unit + memory)**
- **input circuit**
- **LCD display**
- **membrane keyboard**
- **digital to analog converter**

4.1 Power supply

The instrument is powered by four internal batteries (AA type).
The voltage battery (approximately 5 V) is connected through the <ON / OFF> key to the power supply circuit that generates a -5V for analog circuits.

4.2 Operation of keyboard

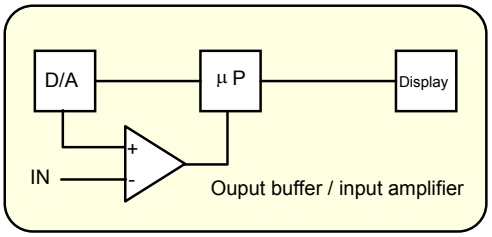
The front panel is a tactile polycarbonate membrane keyboard, and has a working life of one million operations per key.
The contact closure of the membrane keyboard is acknowledged as a coded signal by the microprocessor that recognizes the operators instructions.
Keys are interconnected on a 4 x3 matrix; the microprocessor identifies directly the active key.

ON /OFF	Power ON / OFF switch
STO	Memory load keys
0.1 / 1	Decimal point selection
START	Low limit setting on ramp simulation
END	High limit setting on ramp simulation
STEP	Step value setting on ramp simulation
TIME	Total time setting on ramp simulation program.
0, 1, 2	IN / OUT memories
°C/°F	Technical unit selection
SELECT	Set-up procedure
AVERAGE	Average measurements
IN/OUT	IN / OUT mode selection
AUTORAMP	Program start
HOLD	Hold measurement
BATTERY	Battery voltage indication
ENTER	Memory load key
SHIFT	Key secondary function
LCD ±	Display contrast adjustment
▲	Simulation values increase cursor (1 L.S.D. steps)
▼	Simulation values decrease cursor (1 L.S.D. steps)
FAST	Cursor accelerator(L.S.D. x 100); use in conjunction with ▲/ ▼ keys

A "bip" sound indicates that the instrument has received and acknowledged the keyboard operator instruction.
The explanation of the key functions is summarized at par. 8 ("OPERATIONS & APPLICATIONS").

4.3 Input circuit

The input circuit is based on the output buffer wired as an error amplifier.
The input signal drives the negative channel (-) of the integrated circuit.
The microprocessor recognizes if the D/A converter is generating a voltage signal higher or lower than the input signal and gives correcting instructions to keep the input amplifier output on the nearest value to zero.
In the above conditions the microprocessor will acknowledge the value of the input signal as equivalent to the setting of the digital to analog converter.



4.4 Microcontroller

The microprocessor handles all the logic functions of the instrument, performs the linearization for non linear transducers, compensates for the reference junction temperature, drives the digital display, and acknowledges all operator instructions.
The heart of the circuit is a single-chip microcomputer that utilizes HCMOS technology to provide the low power characteristics and high noise immunity of CMOS plus the high speed operation of HMOS.
On-chip memory systems include a 8 Kbyte ROM and 512 bytes of electrically erasable programmable ROM (EEPROM).
The microprocessor works with an 8-bit communication bus to the EPROM and EEPROM memories.
The single-chip microcomputer incorporates a 256 bytes of static RAM and 8 channel analog to digital converter used to read the Rj value, the setting of the input comparator and the battery voltage.

4.5 Firmware

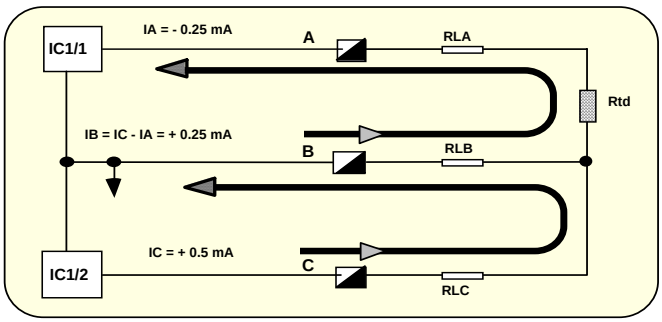
The operating system firmware handles all logic instructions to the internal peripheral circuits and performs the computation of the linearization equations.
The application system firmware is resident on the non-volatile memory (EEPROM) of the microprocessor.
It is used to store the installation parameters (autocalibration data, programs data, etc.).

4.6 Digital display

The digital display, mounted on an auxiliary board , uses high contrast LCD technology .
The character generation is by a dedicated secondary microprocessor driven by the bus of the main microprocessor.
The 16 characters are displayed in a 7 x 5 dot matrix.

4.7 Resistance and Rtd measurements

The resistance thermometer (Rtd) is connected to terminals A - B - C in a 3 - wire configuration (see figure on the next page).
Two constant current generators are provided by the auxiliary module for supplying the Rtd.
The first half of "IC1" generates the negative current
IA= - 0.25 mA that flows from terminal B to terminal A through the Rtd and line resistances RLA and RLB.
IA is kept constant by the microprocessor that controls the zero voltage level.
The second half of "IC1", with the associated resistors, generates the positive current IC that flows from terminal C to terminal B through line resistances RLC and RLB.
Current IC is kept exactly = 2 x IA, so the resultant current IB = IC - IA flows through RLB.
The input measured signal across terminals A and B is the algebraic sum of drop voltages across Rtd and line resistances RLA and RLB. As drop voltages across RLA and RLB are exactly the same (providing that line resistances RLA and RLB are equals), but with opposite poles, the resultant voltage across terminals A and B is proportional to Rtd resistance variation, with no influence of line resistance.
The input measured signal across terminals A and B is the algebraic sum of drop voltages across Rtd and line resistance RLA and RLB.
As drop voltages across RLA and RLB are exactly the same (providing that line resistances RLA and RLB are equals), but with opposite poles, the resultant voltage across terminals A and B is proportional to Rtd resistance variation, with no influence on line resistance.
The measured signal is then handled by the microprocessor that linearizes it and displays the corresponding value in engineering units.



4.8 Resistance and Rtd simulation

The **M-CAL Rtd** calibrator is equipped with an electronic circuit for the active simulation of platinum resistance thermometers, nickel resistance thermometers and resistances.
It is based on the assumption that the instrument to be calibrated will supply the excitation current to the sensor; this current must be between 0.2 and 3 mA (typical working values).
A lower value will generate an insufficient precision level and a higher current won't permit the simulation of high resistance values (maximum voltage drop on the simulated resistance is 2 V).

The excitation current must be applied to the pertinent terminals as indicated in par. 7.1 (simulation).
That current, flowing through resistance " Ra" (precision ±0.01 %), generates a voltage drop that is amplified and sent to the D/A converter.
The output amplifier will simulate the variation of the output resistance as a function of the value set by the operator through the keyboard.
The connection between "+" and "-" terminals must be left open.

4.9 Rechargeable Battery Models; operation from line source

A auxiliary charger / power supply module is supplied as a standard accessory with all Ni-MH rechargeable battery models. The charger / power supply module allows operation from 110-120 or 220-240 V ac 50/60 Hz depending on the plug type specified on the order.

Calibrators with rechargeable batteries can be operated directly from a line source through the charger / power supply module.

The plastic case of the battery charger / power supply incorporates the line voltage plug and cable for connection to the instrument. The charger circuit is designed with an insulating transformer and a voltage stabilizer circuit. The step-down transformer reduces the power line (110-120 Vac or 220-240 Vac nominal) to a value of 10 Vac.
The above voltage is full wave rectified, filtered and stabilized.
The output voltage of 6.45 Vdc is the ideal value to recharge internal Ni-MH batteries

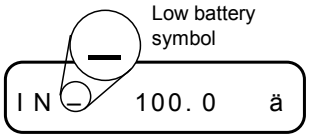
5 UNPACKING

Remove the instrument from its packing case and remove any shipping ties, clamps, or packing materials.
Carefully follow any instructions given on any attached tags.
Inspect the instrument for scratches, dents, damage to case corner etc. which may have occurred during shipment.
If any mechanical damage is noted, report the damage to the shipping carrier and then notify **MERIAM** directly, or its nearest agent, and retain the damaged packaging for inspection.

A label located on the back of the case indicates the serial number of the instrument.
Refer to this number for any enquiry for service, spare parts supply or application and technical support requirements.

6 PRE-OPERATIONAL CHECK

The **M-CAL Rtd** indicator-simulator is powered by four Alkaline batteries (Ni-MH rechargeable batteries as option).
For Ni-MH batteries, the external battery charger may be ordered for either 110 -120 V or 220 -240 Vac power source.
To modify the charger's power voltage follow the instructions in par. 8.2.
Before using the instrument carefully verify the nominal voltage value of the charger; in case of modification do not forget to correct the pertinent label.
The instrument should be used in environments where the temperature does not exceed the specified limits (from -5°C to +50°C) and where the relative humidity is lower than 95%.



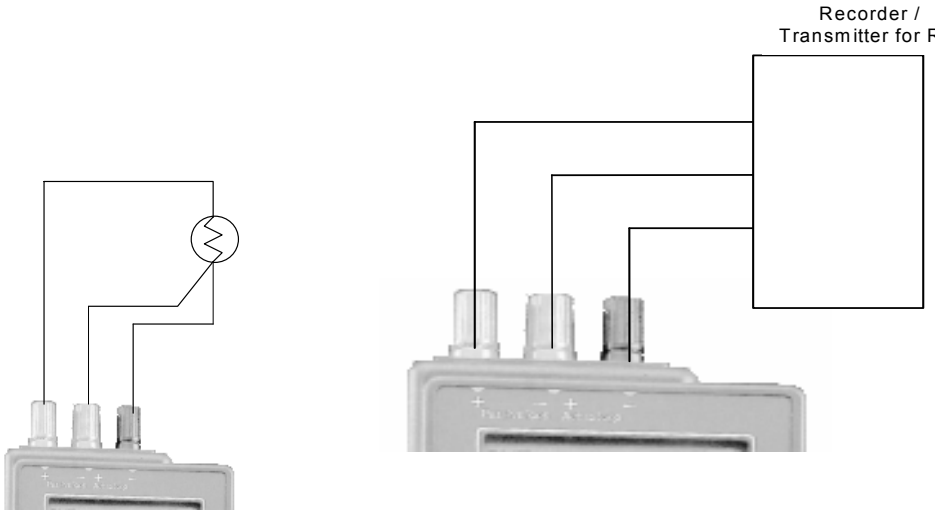
In case of "low" battery condition (voltage lower than 4.5 V ±0.1 V) the display will show the appropriate symbol.
A dotted symbol means that the battery package has enough power energy for about 30 minutes operation.
A black symbol means that the battery charge is below the minimum acceptable voltage level: operation of the instrument is no longer possible.
In this condition the batteries must be either replaced (if alkaline battery model) or recharged (if Ni-MH rechargeable battery powered).

WARNING.

FOR MODELS SUPPLIED WITH NI- MH RECHARGEABLE BATTERIES…
DO NOT USE NORMAL ALKALINE BATTERIES!!!
ALKALINE BATTERIES, WHEN CONNECTED TO A DC VOLTAGE SUPPLY, UNDERTAKE AN OVERHEATING PROCESS WITH A RISK OF EXPLOSION.

7 ELECTRICAL CONNECTIONS

Although the **M-CAL Rtd** portable calibrator is designed to be insensitive to transient or noise, the following recommendations should be followed to reduce ac pick up in the signal leads and to ensure good performance.
The input leads should not be run near ac line wiring, transformers and heating elements.
The figure below shows the typical input/output wiring and connections:



8 OPERATIONS & APPLICATIONS

The **M-CAL Rtd** portable calibrator has been factory calibrated before shipment.
During start-up the operator should only select and load the pertinent application parameter as indicated in the following paragraphs.

8.1 Rechargeable batteries (option)

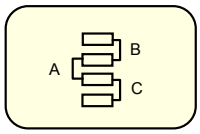
On request the **M-CAL Rtd** portable calibrator can be powered by four built-in rechargeable batteries.
The instrument is shipped with an average level of charge.
After unpacking, a full charge of the battery is recommended; connect the instrument to the charger module ("OFF" condition) for a minimum period of 12 hours.
The Ni-MH rechargeable batteries do not suffer when used in cyclic operations.
Cyclic operation is understood as a method of operation by which the battery is continually charged and discharged.
Note that a battery, at its lower limit of charge, risks a non uniform cell polarization. This condition makes it difficult to recharge with the charger supplied.
Avoid leaving the instrument, with batteries totally or partially discharged, for a long time without recharging.
To charge the batteries use only the standard module. The module incorporates protection and current limiting devices not normally found in other commercial chargers.

- When the **M-CAL Rtd** is connected to the battery charger module, by pressing **<SHIFT>** + **<BATTERY>** keys the indication below will be displayed:

If a numeric value appears, it indicates that the charger is possibly faulty.
Replace the battery charger module. If the fault indication persists, replace the battery charger or contact MERIAM Service Department.

8.2 Battery charger (for Ni-MH batteries). Power supplied from power line ac

The external battery charger is configured, before shipment, for a supply voltage of 100 -120 - 230 or 240 Vac, upon order specification.
The nominal voltage value is indicated on the front label of the charger; if power supply voltage has to be modified, correct the indication on the front label.
To modify the power supply voltage place the jumper, mounted on the circuit board of the charger, as indicated below:



Jumper	**"A":**	power line at 230 V 50/60 Hz
Jumpers	**"B" e "C":**	power line at 120 V 50/60 Hz

8.3 Power "ON"

ATTENTION : ALL VALUES IN THE FOLLOWING FIGURES ARE ONLY LISTED AS AN EXAMPLE.

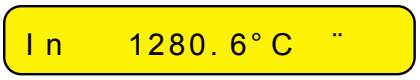
During set-up and load memory remember that the instructions of the manual related to key operation have the following meaning:

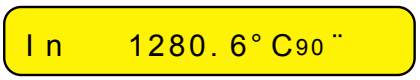
<A> + **<B>** Press the **<A>** key and keeping the pressure on the key, press then the **<B>** key.
<A>, **<B>** Press in sequence first the **<A>** key and then the **<B>** key.

- To power the instrument press the **<ON>** key. The following indication will appear for a few seconds:

- With power -ON- the instrument will run a diagnostic routine for the self-checking of critical circuits and components.
- A positive check will be shown with the indication below for about one second:

- The number indicates the version of the firmware installed on the instrument.
- The instrument will be operative with the previously selected mode, e.g. as follows:

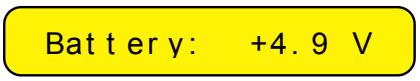




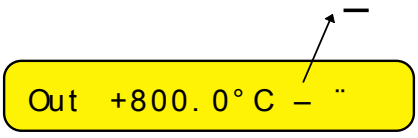
- If the number "90" is shown on the right side of the display indicates that the instrument is configured for ITS90 (International Temperature Scale 1990).
  No number indicates that the instrument is configured for IPTS68 (International Practical Temperature Scale 1968). Faulty conditions will be indicated as described in par. 8.6.

8.4 Battery voltage indication

- To recall the battery voltage on the display press **<SHIFT>** + **<BATTERY>** keys.
  The indication will be as follows:



  The "low" limit of the battery voltage, for the correct operation of the instrument, is +4.6 V.
- Press any key to reset the operation mode.
- During normal operating modes, (measure or simulation), the "low battery" condition will be shown with the following indication:



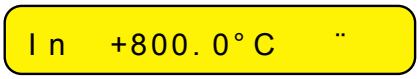
An empty symbol means that the battery has enough energy for about 30 minutes operation.
A black symbol means that the battery charge level is below the minimum: alkaline batteries must be replaced or Ni-MH rechargeable batteries must be recharged for a full period of 12 hours.

8.5 Operating mode set-up

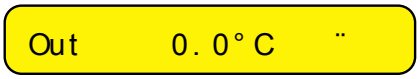
To select the required operating mode follow the procedures indicated below.

8.5.1 IN / OUT function selection

- Switch the instrument -ON-.
  After diagnostic routine, the calibrator will be forced into the "IN" function with the active parameter previously selected (e.g. with the indication below related to a measured value of 800.0°C with resistance thermometer type Pt100):



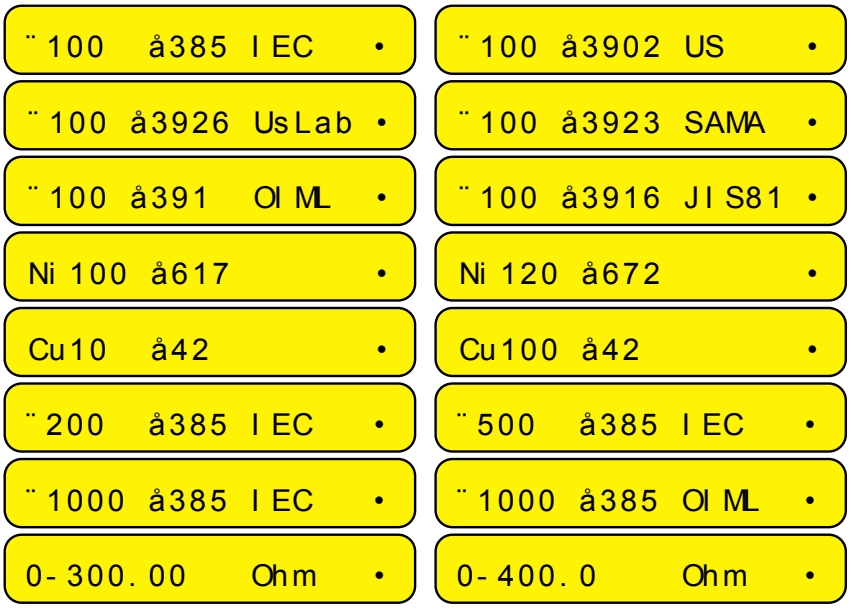
- Open input terminals will cause a fluctuation of the reading up to the limit of "Underflow" or "Overflow".
- To select the simulation mode press the **<IN/OUT>** key (indication below - simulated value of 0.0 for resistance thermometer type Pt100):

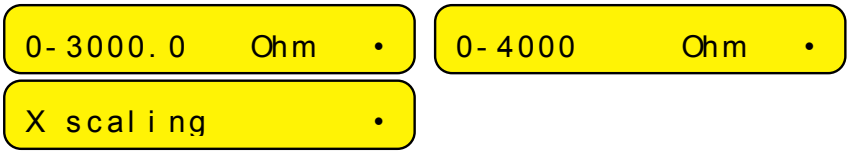


- The output value can be adjusted by pressing **<▲>** or **<▼>** key.
- Keep the key pressed to cause a continuous variation of the simulated value; the speed of variation will change by pressing keys **<FAST>** + **<▲>** or **<FAST>** + **<▼>** (one third significative digit per step)
- Press simultaneously the **<▲>** and **<▼>** keys to set to zero the simulated value.

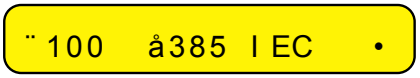
8.5.2 Parameter or sensor selection

- To select the electrical parameter or the sensor required by the application follow the procedure indicated below.
- Switch the instrument -ON-.
- Press the **<SELECT>** key to obtain one of the menu pages indicated below:



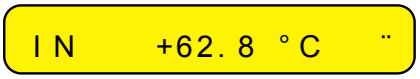


- Press <▲> or <▼> key to select the appropriate sensor.



(i.e. to activate the Pt100 with α = 0.00385 according to IEC standard choose the sensor as indicated above)

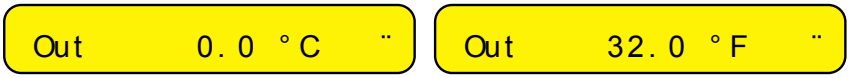
- Press the **<ENTER>** key to load the selection in the memory; the instrument will return to the previous function with the new selected thermocouple, as follows:



- By pressing any other key instead of <ENTER>, the instrument will not acknowledge any change and will return to the previous parameter or sensor.

8.5.3 °C / °F Selection

- To change the technical unit from °C to °F (or viceversa) press **<SHIFT>** + **<°C/°F>** keys (see the following indication):



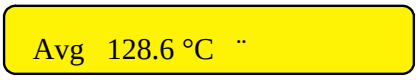
8.5.4 Decimal point position

- The decimal point position, to increase or reduce the resolution is adjustable with keys **< 0.1>** and **<1>.**

8.5.5 Average readings

The use of the "Average" mode is advised with unstable input signals.
The average represents a progressive integration of the input signal on the last 32 conversions (approximately 10 seconds).

- To enable the "Average" mode press **<SHIFT>** + **<AVERAGE>** keys.
  The display will indicate as follows:

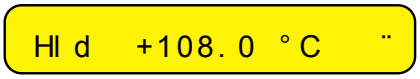


- To disable the "Average" mode press again **<SHIFT>** + **<AVERAGE>** keys.

8.5.6 Hold feature

To hold an input measurement:

- Press **<SHIFT>** + **<HOLD>** keys. The display will indicate:



- To disable the "hold" mode, press any other key different from **<ENTER>** key.

8.5.7 IN / OUT data memory

The availability of a 60-step memory represents an important feature whether in simulation or in measurement modes.
In the measurement mode it can be useful to store input values pertinent to special test conditions.
In the simulation mode the permanent availability of calibration values can be useful, e.g. during the calibration of the scale of a recorder, indicator, transmitter.
The 60 memories are divided in 20 groups of three. The 20 groups of memory (3 each group) are identified with one of the following letters:

A-B-C-D-E-F-G-H-I-J-K-L-M-N-O-P-Q-R-S-T

To select a different active group, follow this procedure:

- Press the **<SELECT>** key to obtain the following indication:

- Press **<0>** key to obtain the following indication:

- Press**<** ▲**>** or **<** ▼ **>** key, to select the required group (from A to T).
- Press **<ENTER>** to confirm selection and selected group will become active.
- Either in measuring or simulation mode, to store memory press keys:
  <SHIFT> + **<0>**
  <SHIFT> + **<1>**
  <SHIFT> + **<2>**
  The folowing data are memory stored:
  -operation mode
  -simulation value and parameter
  -decimal point position
  -technical unit (°C or °F)
  -internal or external Rj mode
  -International temperature Scale (IPTS68 or ITS90)

- The memory stored values, relevant to the active group, can be manually recalled pressing the pertinent **< 0 >** or **<1>** or **<2>** key.
  The stored values and group selected will be kept in the memory also when the instrument is switched -OFF-.

8.5.7.1 Data memory manual scanning

The 60 stored records can be manually scanned, through the keyboard, from the first (group A - memory 0) to a programmable last step (group "n" - memory "n").

The numeric value and the parameter indicated below are an operative example e.g. to memory load 6 calibration points of the scale of a potentiometric recorder (temperature with a resistance thermometer Pt100).

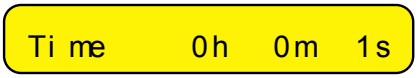
1 = -50°C
2 = 0°C
3 = +100°C
4 = +200°C./
5 = +300°C
6 = +400°C

As described in the previous paragraph memory store the calibration data as follows:

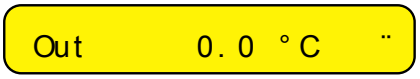
point 1 = group A - memory 0
point 2 = group A - memory 1
point 3 = group A - memory 2
point 4 = group B - memory 0
point 5 = group B - memory 1
point 6 = group B - memory 2

To enter the simulation program set-up follow the below indicated procedure.

- Press the <**ENTER**> + <**RAMP/TIME**> keys to obtain one of the following indication:



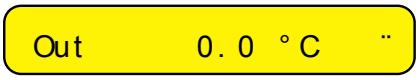
- Press the <▼> key to select the last above (Time:Autoscan)
- Press the <**ENTER**> + <**RAMP/TIME**> keys to memory store the selection.
- Press one of the two <**0.1°**> or <**1°**> to return to the main operative page e.g. as it follows:



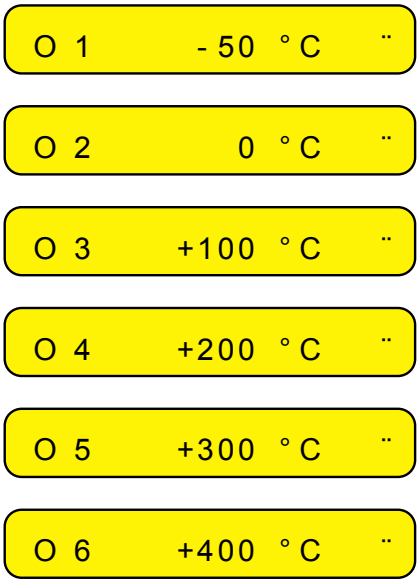
- Press the <**SELECT**> key to enter the procedure of the selection of the last group required with the following indication:

- Press the <0> key to obtain the following indication:

- Press the <▲> or <▼> keys to select the required last group enabled.
- Press the <**ENTER**> key to memory store the above data. The display will return to the main indication e.g. as it follows:



- Press the <**RAMP**> key in sequence to obtain the following data:

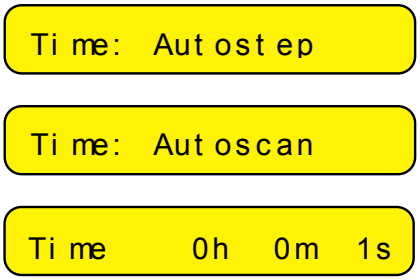


- The "O" on the left side of the display indicates that the instrument is running a simulation (O=Out)
  The progressive number from 1 to 6 are the memory step enabled
- To exit the procedure press one of the <**0.1°**> or <**1°**> key.
  The memory stored data will be kept also when the instrument is switched -Off- and therefore ready for next requirement unless they are modified.

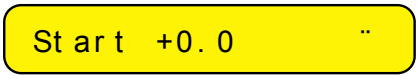
8.5.8 Simulation Programs

The instrument, through an easy to follow menu-driven set-up, can be programmed for simulating a continuous or step ramp output .
By programming the incremental steps to its minimum value (0.1 or 1 °C resolution) the step ramp can be assimilated to a continuous ramp.
Select first the technical unit (°C and °F), the type of thermocouple and then follow the procedure indicated below .
The procedure will consider simulation set-up in "°C" for resistence thermometer Pt100.

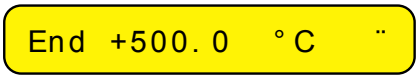
- To enter the set-up procedure press **<SHIFT>** + <**TIME>** keys;
  the display will indicate one of the following pages:



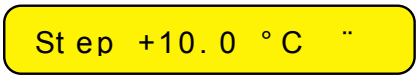
- Press the <▲> or <▼> keys to obatin the indication last above:
- Press the keys <▲> and <▼> to adjust the total time of the program from 0 to 20000 seconds.
- Press **<ENTER>** + **<TIME >** keys to "load memory" the value.
- Press **<START>** key to obtain the following indication:



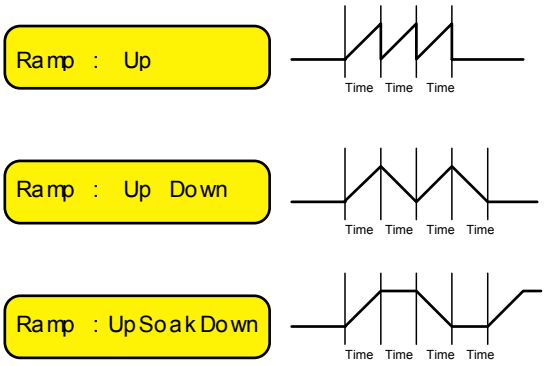
- Press <▲> and <▼> keys to set a new value.
- Press **<ENTER>** + **<START>** keys to "load memory" the new value.
- Use the same procedure to set the "end limit" and the "step value" through keys **<END>** and **<STEP>**
- Press **<END>** key to obtain the following indication:



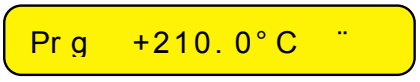
- Press the <▲> and <▼> keys to set a new value.
- Press **<ENTER>** + **<END>** keys to load memory the new value
- Press **<STEP>** key to obtain the indicationbelow:



- Press <▲> and <▼> keys to set a new value
- Press **<ENTER>** + **<STEP>** keys to load memory the new value.
- Press **<SELECT>** key to obtain the indicationbelow:



- Press <▲> and <▼> keys to set different ramp.
- Press **<ENTER>** + **<SELECT>** keys to load memory with the new value.
- To simplify the setting procedure, press simultaneously <▲> and <▼> keys to zero the indicated value.
- To exit the set-up procedure press **< 0.1>** or **<1 >** key.
  The instrument will return to the operative mode previously in use.
- To start the ramp program set the instrument in simulation mode (-OUT-) and press the **<AUTORAMP>** key.
  On the display will appear the following indication:



- To exit the simulation program press one of the two <**0.1°**> or <**1°**> keys.

Autoramp Application Note

During the set-up procedure the operator must consider the limitation on steep ramps due to the minimum time required by the step generation (30ms).
For a correct set-up take into consideration the following equation:

$$\frac{\text{Time x Step}}{\text{End - Start}} > 0.03$$

If the above requirement is not ful filled the operator can still estimate the actual time using the following equation:

$$\text{Time} \cong \frac{\text{End - Start}}{\text{Step}} \text{ X } 0.03$$

Example
In the case of the following set-up:

Start = 0
End = 1000°C
Step = 1°C
Time = 10 sec.

$$\frac{10 \text{ x } 1}{(1000 - 0)+1} = \frac{10}{1001} = 0.01$$

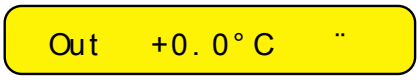
The result of the equation does not meet the correct requirements as 0.01 is lower than 0.03. Therefore the total time of ramp will be:

$$\text{Time} = \frac{(1000-0)+1}{1} \text{ x } 0.03 = 30 \text{ sec.}$$

To obtain a total time of 10 sec., the operator should set the step value at 3°C.

8.5.9 ITS90 - IPTS68 Temperature Scale selection

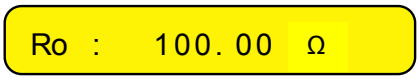
- To change the linearization curve from IPTS68 to ITS90 (or viceversa), press **<SHIFT>** + **<FAST>** keys:



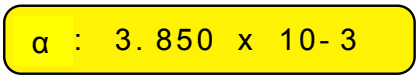
8.5.10 Scale Factor Mode

The "scale factor" mode is an easy menu-driven set-up to read or to simulate custom Rtd with Ro and α adjustable (linear interpolation).
You can set Ro from 8.00Ω to 210.00Ω or from 80.0Ω to 2100.0Ω
You can set a from 1.000×10^{-3} to 10.000×10^{-3}.
The example explains the procedure of installing the "scale factor" function for the calibration of a potentiometric recorder with a special Rtd input with:
Ro = 110Ω and
$\alpha = 3.85 \times 10^{-3}$.

- Press **<SELECT>** key, use **<▲>** and **<▼>** keys to select "X scaling" mode and press again **<SELECT>** key to enter the set-up procedure.
The display will indicateas follows:



- Press **< 0.1>** or **< 1 >** key to shift the decimal point position (400Ω / 4000Ω range).
- Press **<▲>** and **<▼>** key to adjust the required value.
- Press the **<ENTER>** key to load in the memory the new value.
  The display will indicate as shown below:



- Press keys **<▲>** and **<▼>** to adjust the full scale value
- Press the **<ENTER>** key to load in the memory the symbol.
  The display will indicate the scaled In/ Out value.

8.5.11 Installation parameter mode

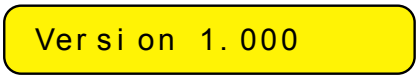
- To start this procedure press the **<ENTER>** key before switching the instrument -ON- .
- The display will indicate as follows:

(the numerical value indicated is only an example)

8.5.11.1 Firmware release code

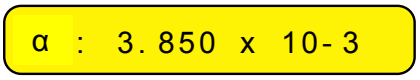
From the above step of the procedure it is possible to display the memory program release code.

- Press **< IN /OUT>** key.
  The reading on the display indicates that the instrument is equipped with a memory version 1.000:



The above information is extremely useful to understand the update status of the instrument and to simplify information exchange with MERIAM engineers during repair or service operations.

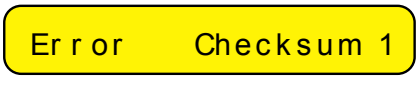
- Press any key to exit the procedure.
  The display will indicate again as it follows:



- Switch the instrument -OFF- to end this step of the program procedure.

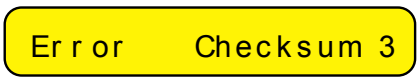
8.6 Faulty operating conditions

During start up, measuring or simulation modes, faulty condition of the instrument will be announced with coded messages as follows:



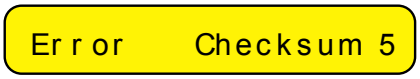
- indicates a possible loss of data on "AUTORAMP" program or on the three manual memories ("0", "1", "2")

- indicates a possible loss of data on "PROGRAM X"

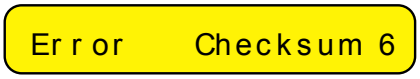


- indicates a possible loss of data on "AUTORAMP", "PROGRAM X" and / or on the three manual memories ("0", "1", "2") - (error 1 + error 2)

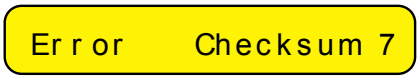
- indicates a possible loss of calibration data



- indicates a possible loss of calibration data, and / or "AUTORAMP" data and/or on the three manual memories (error 1 + error 4)



- indicates a possible loss of calibration data and/or "PROGRAM X" data (error 2 + error 4)



- indicates a possible loss of calibration data, and /or "AUTORAMP" data, "PROGRAM X" and on the three manual memories error 3 + error 4)

- indicates a data writing on the EEPROM memory not verified

- indicates "underflow" conditions

- indicates "overflow" conditions

- indicates a possible error during "Scale Factor" computation

- indicates that the D/A converter has reached it's minimum/maximum value.

The above indicated faulty conditions can be announced both during the autodiagnostic routine or in measuring or simulation modes.
If the faulty condition is critical for the type of application it is recommended to re-run the pertinent set-up procedure.

9 MAINTENANCE

The **M-CAL Rtd** portable calibrator has been factory tested and calibrated before shipment.
The calibration should be verified and re-adjusted if the instrument is showing an error exceeding the declared specifications or when a critical active or passive component is replaced (either at component level or at board level)
The **M-CAL Rtd** portable calibrator uses sophisticated analog and digital technologies.
Service requires highly trained personnel.

9.1 Safety recommendations

Primary elements (i.e. thermocouples, resistance thermometers, etc.) are normally linked to electrical potentials equal or near to the ground potential. However, in some applications, there may be present a common mode voltage to earth.
Check for the voltage between input terminals and ground as this voltage can be transmitted to other devices connected to the calibrator.

9.2 Spare parts

A900032-02022	Soft case
A900032-02025	100 mA fuse
A900614-00014	Ni-MH rechargeable battery
A900032-02003	Battery charger module 120 V ac USA plug
A900032-02004	Battery charger module 230 V ac Schuko plug
A900032-02005	Battery charger module 240 V ac UK plug
A900032-02006	Battery charger module 230 V ac European plug
A900032-02007	Battery charger module 100 V ac USA/Japan plug

9.3 Storage

If the instrument is left unused for a long time, it is recommended to remove the batteries.
Store the instrument in the original package at a temperature from -30°C to +60°C, with R.H. less than 90%.
If the instrument has been unused for a month check the battery voltage. Replace alkaline batteries if necessary. Recharge Ni-MH batteries, if necessary, for at least 12 hours.

10 CERTIFICATES

10.1 Warranty

Meriam warrants its products against defects in materials and workmanship. Meriam Standard Terms and Conditions are available upon request. If the unit should malfunction, it must be returned during the warranty period, transportation prepaid, to **Meriam** for evaluation. Upon examination, if the unit is found to be defective within the warranty period it will be repaired or replaced at no charge.
Meriam's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorised modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion, current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of **Meriam's** control.
This warranty applies to the original purchaser only. Please include a copy of the original invoice when returning warranty items for repair.

Direct all warranty and repair requests/inquiries to the **Meriam** Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO **MERIAM**, PURCHASER MUST OBTAIN A RETURN MATERIAL AUTHORIZATION (RMA) NUMBER FROM **MERIAM**'S CUSTOMER SERVICE DEPARTMENT IN ORDER TO AVOID PROCESSING DELAYS.
The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

10.2 Certificate of conformity

Each instrument is shipped with a Letter of Conformity, to grant that the characteristics of the instrument correspond to the required ones, and that the instrument calibration is traceable to National and International Standards.
The instrument has been found to conform in all respects to specifications, drawings, workmanship standards and order requirements.

APPENDIX

A1 EMC Conformity

The instrument case, made in shock-resistant injection moulded ABS + polycarbonate has an internal metal coating to fulfil the prevision of the directive 89/336/CEE Electromagnetic Compatibility.
In the following page you will find the EMC declaration of conformity

A2 Declaration of Conformity

We : Meriam Process Technologies
(Supplier's name)

10920 Madison Avenue, Cleveland, OH 44102 USA
(Address)

declare under our sole responsability that the product :

RTD Indicator - Simulator type M-CAL Rtd
(Name and type)

p/n 3112
(Model)

to which this declaration relates is in conformity with the following normative documents :

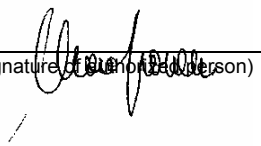
EN 50082-2 (3/95)
IEC 1000-4-2 / IEC 1000-4-4 / IEC 1000-4-11
ENV 50140 - ENV 50141 - ENV 50204

EN 55011
(Title, number and date of issue of normative documents)

following the prevision of directive :

89/336/CEE Electromagnetic Compability (EMC)

Sesto S. Giovanni, January 08th, 1996
(Place and date of issue)


(Signature of authorized person)