



meriam
process technologies

F/N 3908:440-1

a Scott Fetzer company



-CAL Tc

Handheld single function
T/C indicator - simulator

User's Manual

INTRODUCTORY NOTE

ATTENTION: THIS MANUAL MUST BE REFERRED TO INSTRUMENTS WITH SERIAL NUMBER 18784, VER. 2.000 ONWARDS.

This includes all the information you need to install, operate and maintain the **M-CAL Tc** portable indicator-simulator and its accessories. The information covers all models of the instrument, including the basic equipment and its options and accessories. The manual is a complete "USER GUIDE", providing step-by-step instructions for operating the **M-CAL Tc** in each of its designed functions.

The information contained in this publication is derived in part from proprietary and patent data of **Meriam**. This information has been prepared for the sole purpose of assisting operating personnel in the efficient use of the instrument. Publication of this information does not convey any rights to use or reproduce of it for any purpose other than in connection with the installation, operation, and maintenance of the equipment described herein.

M-CAL Tc uses sophisticated analog and digital technologies. *Any maintenance operation must be carried out by qualified personnel **ONLY**. Meriam supplies instructions and operation procedures for any operation on the instrument. We recommend contacting our technicians for any support requirements.*

M-CAL Tc 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 in a single, compact portable instrument. The **M-CAL Tc** is a portable 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 the **M-CAL Tc** is the ideal solution for measurement and simulation of :

- millivolts
- thermocouples

The **M-CAL Tc** has been developed using the most advanced microprocessor technology to provide high accuracy on extended ranges and powerful operation flexibility.

Linearization algorithms of the characteristic thermocouples curves are held in the microprocessor memory in accordance with IEC / ANSI and DIN standards (thermocouple types T, K, J, S, R, E, B, N, C, U, L, F).

A unique automatic Rj compensation system allows the **M-CAL Tc** to provide accurate input and output readings over a wide operating temperature range (-5°C to +50°C). Further, for external RJ joints, an external compensation can be selected with temperature adjustable from -50°C to +100°C.

The selection of the operation mode is made using 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 memory stored values, or a continuous or step ramp output.

The instrument carries out mathematical functions for measuring the average values of unstable signals and, in combination with scale factor mode, provides square root calculation.

The case, made of shock-resistant and self-extinguishing 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 Tc 3908 - A - B

The basic configuration of the instrument includes a soft case and an instruction 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:**
mV
thermocouples type J, K, T, R, S, B, N, C, E, U, L, F
- **Reference junction compensation:**
automatic with Pt100 sensor
- **External with manual setting:**
from -50°C to +100°C
- **Rj compensation drift:**
± 0.025°C/°C
- **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: ±0.005% of the reading/°C
zero : ±0.2 µV /°C
- **Output impedance (emf output and Tc):**
less than 0.5 ohm with maximum current of 0.5 mA
- **Input impedance**
> 5 MΩ
- Maximum input dc over voltage :
± 5V
- **Source resistance:**
1 µV error for 100 Ω source resistance
- **Display:**
high contrast dot matrix LCD
(7x5 dots per character - 16 characters)
- **Technical unit indication:**
Up to 4 characters directly on the display
- **Scale factor:**
Zero and span adjustable within -10000 and +10000
- **Square root:**
in combination with scale factor (display limits 0 and +2500)
- **Calibration:**
automatic procedure
- **Power supply:**
4 alkaline batteries (1.5V) or 4 rechargeable Ni-MH batteries (1.2 V, 0.7 A/hour)
- **Battery life:**
Ni-MH 8 hours, Alkaline 16 hours continuous operation
- **Recharge time:**
8 hours with instrument switched -OFF-
- **Battery voltage:**
display indicated value
- **Program release identification:**
version number indicated on the display
- **Operating temperature range:**
from -5°C to +50°C
- **Storage temperature range:**
from -30°C to +60°C

- **Case:**
ABS
- **Dimensions:**
215 x 96 x 35 mm
- **Weights:**
net 1 Kg
gross with packing 1.5 Kg

1.2.1 Table of ranges and accuracies

IN-OUT ranges

Tc	Total in-out ranges 1°C res.	Total in-out ranges 0.1°C res.	High accuracy range	Accuracy (% of reading)
J	-346 to 2192 °F -210 to 1200 °C	-346 to 2192 °F -210 to 1200 °C	-202 to 2192 °F -130 to 1200 °C	± (0.04%+0.54 °F or 0.3 °C)
K	-445 to 2498 °F -270 to 1370 °C	-382 to 2498 °F -245 to 1370 °C	-76 to 2372 °F -60 to 1300 °C	± (0.04%+0.54 °F or 0.3 °C)
T	-454 to 752 °F -270 to 400 °C	-391 to 752 °F -255 to 400 °C	-58 to 752 °F -50 to 400 °C	± (0.04%+0.54 °F or 0.3 °C)
R	-58 to 3200 °F -50 to 1760 °C	428 to 3200 °F -50 to 1760 °C	1472 to 3092 °F 800 to 1700 °C	± (0.04%+1.26 °F or 0.7 °C)
S	-58 to 3200 °F -50 to 1760 °C	536 to 3200 °F -50 to 1760 °C	1472 to 3200 °F 800 to 1760 °C	± (0.04%+1.44 °F or 0.8 °C)
B	212 to 3308 °F 100 to 1820 °C	1805 to 3200 °F 500 to 1820 °C	2192 to 3308 °F 1200 to 1820 °C	± (0.04%+1.26 °F or 0.7 °C)
C	32 to 4172 °F 0 to 2300 °C	32 to 3200 °F 0 to 2300 °C	32 to 4172 °F 0 to 2300 °C	± (0.04%+1.8 °F or 1 °C)
U	-328 to 752 °F -200 to 400 °C	-328 to 752 °F -200 to 400 °C	-58 to 752 °F -50 to 400 °C	± (0.04%+0.54 °F or 0.3 °C)
L	-328 to 1400 °F -200 to 760 °C	-328 to 1400 °F -200 to 760 °C	-202 to 1400 °F -130 to 760 °C	± (0.04%+0.54 °F or 0.3 °C)
N	32 to 2372 °F 0 to 1300 °C	32 to 2372 °F 0 to 1300 °C	176 to 2372 °F 80 to 1300 °C	± (0.04%+0.72 °F or 0.4 °C)
E	-454 to 1832 °F -270 to 1000 °C	-436 to 1832 °F -260 to 1000 °C	-238 to 1832 °F -150 to 1000 °C	± (0.04%+0.54 °F or 0.3 °C)
F	32 to 2552 °F 0 to 1400 °C	32 to 2552 °F 0 to 1400 °C	176 to 2552 °F 80 to 1400 °C	± (0.04%+0.54 °F or 0.3 °C)
mV	0 to 100	0 to 100	0 to 21 21 to 100	±(0.05%+9µV) ± (0.04%+12 µV)

Note:

- Relative Accuracies shown are based on tests at 23°C ±2°C for 90 days
- Typical 1 year accuracy can be estimated by multiplying the "% of the reading" specifications by 1.6
- All Input ranges: additional error ± 1 digit
- Traceability chart to WECC available on request
- Thermocouple accuracy tested with external Rj at 0°C (32°F).

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 or simulation of mV, or any normalized IEC / ANSI and DIN thermoelectric sensor J, K, T, R, S, B, C, U, L, N, E, F. The microprocessor performs automatic polynomial linearization and cold junction compensation to assure high accuracy. °C or °F selection is made directly from the membrane keyboard.

2.2 Self calibration

The hardware-firmware design allows for an automatic calibration of the instrument. A precise reference source (from 0 to 100 mV) and a 0°C reference system 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 thermocouple 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 [measurement (IN) or simulation (OUT)], the technical unit and the signal value are simultaneously indicated.

2.5 Scale Factor Function

Easy, menu-driven set-up, to read or simulate electrical signal value (0 - 100 mV) in terms of engineering units. Four alphanumeric characters, selected from an internal library, are adjustable on the display, to show the symbol of the parameter (i.e. mbar, % RH, % CO, etc.) The display will indicate the scaled input / output value.

2.6 Square Root Function

Can be programmed during the installation procedure (linear ranges only) to obtain direct readings of flow from a dP transmitter signal. The display limits are 0 and +2500.

2.7 Average Measurements

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

2.8 Ramp Simulation

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.

2.9 Case

The case is designed for easy hand held operation and transportation.

The body is injection molded, shock-resistant and self-extinguishing ABS.

A soft carrying case with belt loop is supplied with the instrument as a standard accessory.

3 PHYSICAL DESCRIPTION

The **M-CAL Tc** portable calibrator consists of a rugged and compact 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.

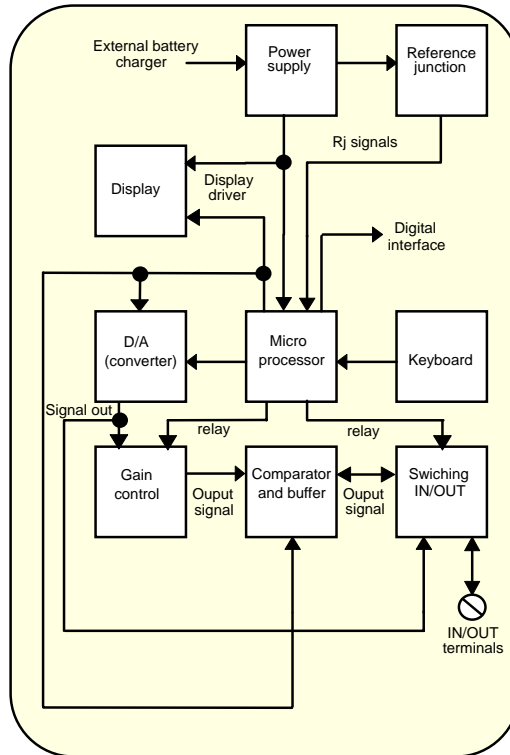
An external battery charger / power supply module is supplied as a standard accessory with rechargeable battery models.

The battery container is located on the back of the case and is accessible by sliding and removing the plastic cover.

The soft case assures better protection of the instrument against knocks and scratches.

4 FUNCTIONAL DESCRIPTION

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



The functional blocks of the instrument are as follows:

- **power supply**
- **microprocessor (central unit + memory)**
- **input circuit**
- **cold junction compensator (Rj)**
- **LCD display**
- **membrane keyboard**
- **digital to analog converter**

4.1 Power supply

The instrument is powered by four internal alkaline or NiMH rechargeable batteries (AA type with a nominal voltage of 1.5 V and 1.2 V respectively) that can be recharged through an external charger module supplied as a standard accessory.

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	Power ON switch
OFF	Power OFF switch
STO	Memory load keys
← / →	Parameter selection or decimal point position
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	Mode selection
AUTO RAMP	Program start
PROG X	Scale factor program
BATTERY	Battery voltage indication
LCD ▀ / LCD -	Display contrast adjustments
FAST	Cursor accelerator
▲	Simulation values cursors
▼	Simulation values cursors
SHIFT	Key secondary function
ENTER	Memory load key

A "bip" sound indicates that the instrument has received and acknowledged the keyboard operator instruction.

The explanation of the key functions is summarized at chapter 8 ("OPERATIONS & APPLICATIONS").

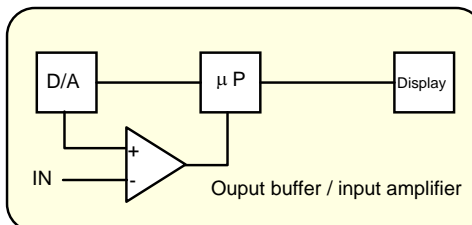
4.3 Input circuit

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 Microprocessor

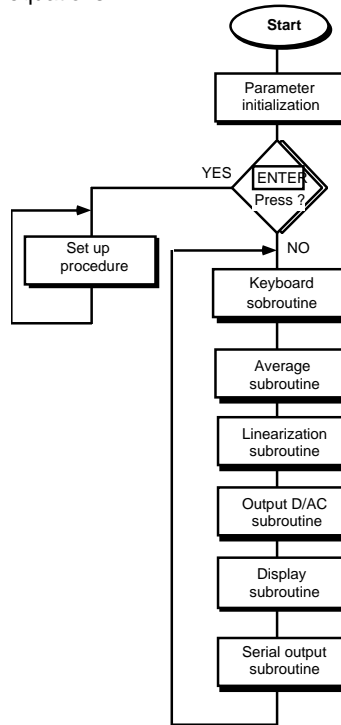
The microprocessor handles all the logic functions of the instrument, performs the linearization for non linear transducers, compensates for the reference junction temperature, drives the digital display, acknowledges all operator instructions.

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 K byte 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 block diagram shows the modular architecture of the operating system firmware.

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 dots matrix.

4.7 Digital to Analog Converter

A 16-bit digital to analog circuit is driven by the microprocessor to convert the digital value of the selected parameter into an analog current output.

An integrated circuit converts the current signal into a voltage signal.

An integrated circuit selects one of the two available output span as function of the selected range.

The two ranges are:

-10	to	+20 mV	Tc R, S, B, C e and the negative portion of all Tc
-0.2	to	+100 mV	100 mV range and remaining thermocouples

An high stability resistor in combination with an integrated circuit stabilizes the output voltage for load variations.

4.8 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 the internal Ni-MH batteries.

4.9 Thermocouple input / output circuit

A thermocouple temperature sensor, in its most common form, consists of two wires of different composition joined together at one end.

The two wires are joined together at two points which have different temperatures.

One of the joints is at a known temperature. This joint is, by definition, the reference junction.

The reference junction is also often, but less preferably, called the "cold" junction.

The temperature of the reference junction can be held constant or its variation electrically compensated in the associated measuring instrumentation.

The second junction is the measuring junction (or "hot" junction).

A thermocouple is useful for temperature sensing because it generates a measurable electrical signal.

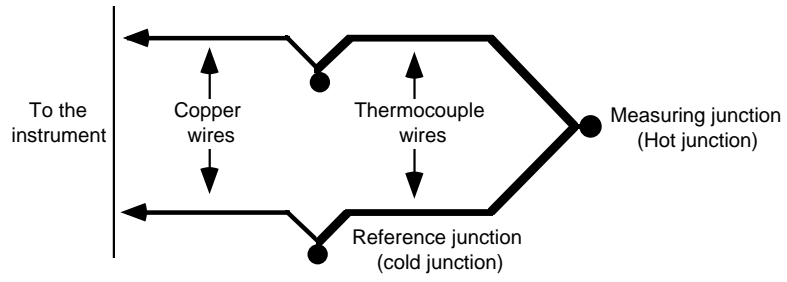
The signal is proportional to the temperature difference between the measuring and reference junctions and is defined, by means of tables, based on the International Temperature Scale.

To improve overall accuracy the terminals are designed with a very low thermal capacity.

Inside the body of the negative polarity terminal is placed a thin film Pt100 resistance thermometer that dynamically measures, with high accuracy, the temperature of the reference junction.

The microprocessor uses the above signal (Pt100) to adjust the input signal to compensate for the Rj temperature.

Reference junction compensation can be internal or external, depending upon the application requirement (see the pertinent procedure in par. 8.5.10.2).



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 Process Technologies** directly or it's 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.

Meriam Process Technologies will keep a data base with all information regarding your instrument.

6 PRE-OPERATIONAL CHECK

The **M-CAL Tc** indicator-simulator is powered by four alkaline or Ni-MH rechargeable 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 \pm 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 recharged for approximately 12 hours.

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

Appropriate extension wires should be used between the thermocouple (or instrument under calibration) and the **M-CAL Tc** unless the thermocouple wires permit direct connection.

Make sure that both thermocouple and compensating cable are connected with the correct polarity. If in doubt, the polarity of the compensating leads can be checked by connecting a length of lead to the indicator, shorting the free ends of the wires together and noting that the indicator reading increases when the wire connection is heated.

Color codes of compensating cables change in different countries, check the appropriate table.

7.1 Wiring practice

Although the **M-CAL Tc** portable calibrator is designed to be insensitive to transients or noise. The following recommendations should be followed to reduce ac pick up in the signal leads and to ensure optimum performance.

The input leads should not be run near ac line wiring, transformers and heating elements.

Input/output leads should, if possible, be twisted and shielded with the shield grounded at the end of the cable.

When shielded cables are used the shield must be connected to the positive terminal.

7.2 Thermocouple wires

When making measurements where additional wires have to be connected to the thermocouple leads, care must be exercised in selecting these wire types, not only where they are claimed to be of the same composition as the thermocouple involved, but also of their "quality".

Performance results where high precision is required and in circumstances where some types of thermocouple wire leads are added to the original installation should be reviewed carefully for the impact of the choice of the additional wire leads.

The quality of the thermocouple wire is established by the limit of error to be expected with its use.

There are three recognizable levels of quality:

- Special or Premium grade
- Standard grade
- Extension wire grade

The error limits determining the grade quality differ from thermocouple type to thermocouple type, reflecting the degree of difficulty in maintaining the precise levels of purity of the metal used.

The table below summarizes the error limits for Premium and Standard grades, while Extension grade wire is characterized by limits of error exceeding those in the table.

Errors up to $\pm 4^{\circ}\text{C}$ may be experienced when using Extension grade thermocouple wire for J and K thermocouple.

8 OPERATIONS & APPLICATIONS

8.1 Rechargeable batteries option

Alkaline battery models are powered by four AA alkaline batteries shipped installed in the unit and come ready to use out of the package.

Ni-MH rechargeable models are shipped with batteries at an average level of charge. After unpacking, a full charge of the batteries is recommended. Connect the unit ("OFF" condition) to the charger module for a minimum 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 rechargeable 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 installed rechargeable batteries totally or partially discharged for a long period of time without recharging. To charge the batteries, use only the original supplied charging module. The module incorporates protection and current limiting devices not normally found in other commercial chargers.

- When the **M-CAL Tc** is connected to the battery charger module, by pressing **<SHIFT> + <BATTERY>** keys the indication of fig. 8.1.A will be displayed

Battery: Line Op

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**.

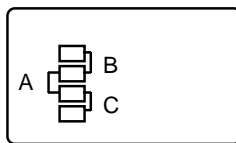
8.2 Battery charger; power supplied from power line ac

The external battery charger is configured, before shipment, for a supply voltage of 110 -120 V ac or 220 - 240 Vac, per 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 replace the mains plug, loosen the three bottom screws.

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 220-240 V 50/60 Hz

Jumpers "B" e "C": power line at 220-240 V 50/60 Hz

8.3 Power "ON"

ATTENTION: All values in the following figures are only listed as examples only.

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

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

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



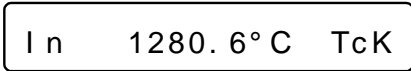
TM...M-CAL..Tc..TM

- 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:



Test OK Ver 2.000

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

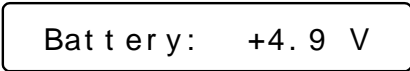


In 1280.6°C TcK

- Faulty conditions will be indicated as described in par. 8.6.

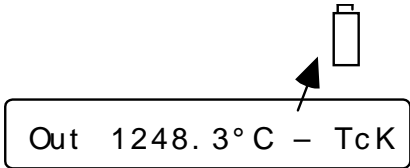
8.4 Battery voltage indication

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



Battery: +4.9 V

- 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 (IN) or simulation (OUT)], the "low battery" condition will be shown with the following indication:



Out 1248.3°C - TcK

An empty symbol means that the battery has enough energy for about 30 minutes operation.
A black symbol means that the battery charge is below the minimum. Alkaline batteries should be replaced; Ni-MH rechargeable batteries must be recharged.

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 shown below, related to a measured value of +1032 °C with thermocouple type K).

In	1032. 2° C	TcK
----	------------	-----

- 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 (i.e. for a simulated value of 0°C - thermocouple type "K" - the indication will be the following one).

Out	0. 0° C	TcK
-----	---------	-----

- The output value can be adjusted by pressing <▲> or <▼>.
- Keep the key pressed to cause a continuous increase or decrease 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:

mV	X	J K T F
----	---	---------

mV	X	R S B C
----	---	---------

mV	X	U L N E
----	---	---------

- Switch the instrument -ON-.
- Press the <SELECT> key to obtain one of the menu pages above.
Press <▲> or <▼> key to select the appropriate page.
- Select the required parameter or sensor, moving left or right the flashing cursor, with <←> or <→> key (i.e. to activate the thermocouple "T" choose the page and cursor position as indicated below):

mV X J K **T** F

- 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:

I N +62.8 °C Tc T

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

8.5.3 °C / °F selection

- To change the technical unit from °C to °F (or vice versa) press **<SHIFT> + <°C / °F>** keys; e.g. With a °C selection:

Out 0.0 °C Tc K

by pressing the **<SHIFT> + <°C / °F>** keys you will obtain an indication in °F:

Out 32 °F Tc K

8.5.4 Decimal point position

- The decimal point position, to increase or decrease the resolution upon the application, is made by pressing the keys **<←>** or **<→>**. The instrument will automatically convert value in °C or °F from decimal to integer (and vice versa) when they are in the range limits stated. Example: 32.5°F displayed temperature becomes 32°F after pressing the **<→>** key. Pressing the **<←>** key returns the display to 32.5°F.

On mV or V mode one of the following decimal point position can be obtained:

0.00	mV
0.000	mV

8.5.5 International Temperature Scale selection

The memory of the instrument stores both linearization of the old International Practical Temperature Scale of 1968 (IPTS 68) and the new International Temperature Scale of 1990 (ITS 90).

The active linearization is indicated after engineering unit °C or °F as follows:

Blank	IPTS 68
90	ITS 90

- The change from one scale to the other is possible directly from the keyboard by pressing the **<SHIFT> + <FAST>** keys.

8.5.6 Rj mode selection

The instrument can operate with an internal automatic cold junction (Rj) compensated or a remote programmable from -50 to 100°C. Internal automatic cold junction compensation mode is indicated by a small "rj" superscript to the right of the displayed temperature unit. External compensation mode is indicated by a blank space to the right of the displayed temperature unit.

- To change the reference junction (Rj) compensation mode, press **<SELECT>** key and then the **<IN/OUT>** key; this displays the current Rj compensation type. Press the **<FAST>** key to toggle from internal to external (e.g. 0.0°C) . Press **<ENTER>** to exit and confirm the selected Rj compensation type.

8.5.7 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:

Avg	128.6°C	TcK
-----	---------	-----

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

8.5.8 IN / OUT data memories

The availability of a 60 slots of memory represents an important feature both in simulation and in measurement modes. In the measurement mode it can be useful to store a number of input values pertinent to three special test conditions.

In the simulation mode, the permanent availability of 60 calibration values can be useful, e.g.. during the calibration of the scale of different recorders.

8.5.8.1 Data memory configuration

- To store each memory slot press the keys:

<SHIFT> + <0>
<SHIFT> + <1>
<SHIFT> + <2>

The following data is stored:

- operation mode
- measured or simulated value
- decimal point position (e.g. 0.1°C or 1°C)
- °C or °F technical unit
- internal or external Rj mode
- type of sensor or selected parameters (e.g. thermocouple type)
- International Temperature Scale (IPTS 68 or ITS 90)
- 60 memory slots are available

Memory slots are split in 20 groups of three memories for a total of 60 memories. Each group is identified by a letter:

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

To select the required group follow the procedure indicated below:

- Press the **<SELECT>** key to obtain one of the menu pages
- Press the **<0>** key to obtain the following indication:

Sel STO Group: A

- Press the **<▲>** or **<▼>** keys to select the required group number
- Press the **<0>** key to confirm the selection and to return to the previously selected operation mode.

8.5.8.2 Data memory manual recall

To recall data memory values, first select the appropriate or required group number and then press the **<0>**, **<1>** or **<2>** key.

8.5.8.3 Manual step advance

To use manual step advance feature press the **<ENTER>** + **<RAMP>** keys. At the "time display", keep the **<▼>** key pressed until the display reads [Time: Autoscan] appears on the display. Then press **<ENTER>** + **<RAMP>** keys together to save the Autoscan setting.

Press **<←>** or **<→>** to exit.

To run the program with manual step advance, press the **<RAMP>** key obtaining, for example, the following indication:

O1 - 50.0 TcK

The symbol on the left of the display has the following meaning:

O = Output
i = input

- Press the **<RAMP>** key to advance one step of the program. After the "end" point the manual sequence will start again from the point 1.
- Press the **<▲>** or **<▼>** keys or **<SELECT>** or **<←>** **<→>** keys to exit the program.

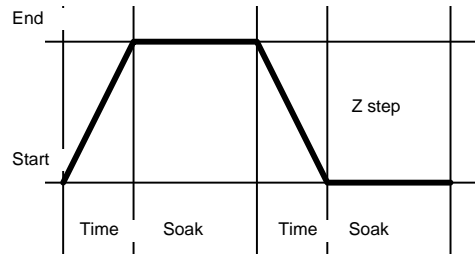
8.5.9 Automatic simulation cycle

The instrument can be programmed for simulating two types of pre-programmed continuous or step ramp output.

By programming the incremental steps to its minimum value (0.1 or 1 degree resolution) the step ramp can be assimilated to a continuous ramp.

Select first the technical unit (°C or °F), the type of thermocouple and then follow the procedure indicated below.

The procedure will consider a simulation in mV.



To memory load the cycle parameters, follow the procedure indicated below:

- Select the required technical unit or electrical parameters
- Select the required decimal point position
- Press **<SHIFT> + <TIME>** keys to enter the cycle set-up procedure obtaining the following indication:

Time 0h 0m 50s

related to the "time" in hours, minutes and seconds. The maximum setting is limited to 5 hours 33 minutes 20 seconds (20.000 seconds)

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

Start 0.0mV

- Press the **<▲>** or **<▼>** cursors to set the "Start" level of the cycle
- Press the **<ENTER> + <START>** keys to memory store the new value
- Press the **<END>** key to obtain the following indication:

End 100.0mV

- Press **<▲>** and **<▼>** cursors to set the "End" level of the cycle
- Press the **<ENTER> + <END>** keys to memory store the new value
- Press the **<STEP>** key to obtain the following indication:

Step 1.0mV

- Press **<▲>** and **<▼>** cursors to set the required step.
- Press the **<ENTER> + <STEP>** keys to memory store the new value.
- Press the **<SHIFT> + <TIME>** key to obtain the following indication:

Time 0h 0m 50s

- Press **<▲>** and **<▼>** cursors to set the required ramp time - max. 5h-33m-20s (20000 seconds)
- Press **<ENTER> + <TIME>** keys to memory store the new value
- A setting of 0h-0m-00s (AUTOSTEP) allows a manual step advance each time the **<RAMP>** key is pressed.
Soak will be equal to the time of the ramp.
- Press the **<SELECT>** key to obtain the following indication:

Ramp: Up	repeated cycle only Up ramp
Ramp: Up Down	repeated cycle only Up Down ramp
Ramp: Up Soak Down	repeated cycle only Up Soak Down ramp
Ramp: 1 Up	single cycle only Up ramp
Ramp: 1 Up Down	single cycle only Up Down ramp
Ramp: 1 Up Soak Down	single cycle only Up Soak Down ramp

- Press the <▲> or <▼> key to select one of the programs stated above.
- Press <ENTER> + <SELECT> keys to memory store the new selection.
- Press the <←> or <→> key to exit the set-up procedure.

8.5.9.1 Simulation cycle

- To run the automatic simulation cycle press the <RAMP> key.
- The display indicates the actual cycle position as shown below:

Pr g 18.0mV

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 (30 ms). For a correct set-up take into consideration the following equation:

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

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

$$\text{Time} \approx \frac{\text{End} - \text{Start}}{\text{Step}} \times 0.03$$

Example:

In the case of the following set-up:

Start = 0
End = 1000°C

Step = 1°C
Time = 10 sec.

$$\frac{10 \times 1}{1000 - 0} = \frac{10}{1000} = 0.01$$

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:

$$\text{Time} = \frac{1000 - 0}{1} \times 0.03 = 30 \text{ sec.}$$

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

8.5.10 Open Tc fault test

If you want to verify a thermocouple connected to input terminals in measuring mode, press the **<FAST>** key . After a few seconds, the message "Tc is open" will appear if the thermocouple is broken, otherwise the message "Tc is OK" will show that it works fine.

The above test is valid for thermocouples with resistance up to 100 ohm.

8.5.11 Scale factor mode

The "scale factor" mode is an easy menu-driven set-up to read or to simulate electrical signals value (0 to 100 mV) in terms of technical units.

The example explains the procedure of installing the "scale factor" function for the calibration of a potentiometric recorder with a scale from 0.0 to 400.0 mbar corresponding to an electrical linear input signal 0 to 100 mV.

- Press **<SHIFT>** + **<PROGRAM X>** keys to enter the set-up procedure.
The display will indicate as follows:

LO : +0. 0 Pr og

- Press **<← >** or **<→ >** key to shift the decimal point position.
- Press keys **<▲ >** and **<▼ >** to adjust the required value.
- Press the **<ENTER >** key to load in the memory the new value:

Hi : +400. 0 Pr og

- Press **<← >** or **<→ >** key to shift the decimal point position.
- Press keys **<▲ >** and **<▼ >** to adjust the full scale value.
- Press the **<ENTER >** key to load in the memory the new value.
The display will indicate the page shown below:

Type : 0- 100 mV

- Press the <ENTER> key
- The display will indicate one of the two menu pages below:

Mode : Squar e

Mode : Li near

The first page indicates square root mode.

- Press keys <▲> and <▼> to select the required page and load memory with the function by pressing the <ENTER> key.
The display will then show:

WORD : ββββ

- This step allows the setting of four alphanumeric characters as a symbol of the measured or simulated parameter.
- By pressing keys <<-> or <-> the needed character, identified by being underlined, will be activated.
- Press <▲> and <▼> keys to scroll the internal library of characters and symbols (picture below) and select the pertinent one.

Library of characters

□	7	8	0	P	9	h	+
!	6	9	N	Q	f	i	+
"	5	:	M	R	e	j	>
#	4	:	L	S	d	k	
\$	3	<	K	T	c	l	<
%	2	=	J	U	b	m	z
&	1	>	I	V	a	n	y
°	0	?	H	W	~	o	x
(/	@	G	X	_	P	W
)	.	A	F	Y	^	a	v
*	-	B	E	Z	J	r	u
+	,	C	D	L	¥	s	t

i.e. you can obtain symbols as indicated:

WORD: % RH

WORD: mbar

If the application does not require a dedicated symbol but the indication of the electrical parameter (i.e. mV) leave on the display four blanks.

With a random display indication remember that the four blanks will be settable, through single digit setting, by pressing the **<▼>** key for a few seconds.

- Press the **<ENTER>** key to load the new symbol in memory .
- To enable the "scale factor" mode enter the set-up procedure with the **<SELECT>** key.
- Move the flashing cursor on the position "X" :

mV **X** J K T F

- Press the **<ENTER>** key.

The display will indicate the scaled In/ Out value.

8.5.12 Installation parameter mode

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

PCAL : +1 N=0

(The numerical value indicated is only an example. Display of [PCALERROR0 N=0] is normal with no lead leads connected to an outside device:

8.5.12.1 Firmware version code - Serial number

From the above step of the procedure it is possible to view the software version code .

- Press the **<IN/OUT>** key to obtain the following indication:

#61200 v 2.003

The number on the left of the display is the unit's serial number. The number on the right indicates the installed firmware code 2.000. This 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 with the following indication:

PCAL +1364 N=0

- Switch the instrument **-OFF-** to end the procedure.

8.5.12.2 External reference junction compensation set-up

- From step 8.5.12 you can set the appropriate Rj compensation.
- Press the **<RAMP>** key to obtain the following indication:

RJ : 0.0 °C

- If the application requires a different remote reference junction compensation (i.e. the internal temperature of a remote, field mounted, temperature controlled junction box) set the required temperature value through the \blacktriangle and \blacktriangledown keys.
- Press the **<RAMP>** key to load in the memory the required type of reference junction compensation. The display will indicate the following reading or similar ([PCALERROR0 N=0] is normal with no lead leads connected to an outside device):

PCAL : +1 N=0

- Switch the instrument **-OFF-** to end 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:

Er r or Checksum 1

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

Er r or Checksum 2

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

Er r or Checksum 3

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

Er r or Checksum 4

- indicates a possible loss of calibration data.

Er r or Checksum 5

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

Er r or Checksum 6

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

Er r or C h e c k s u m 7

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

!!! E R R O R 9 !!!

- indicates a data writing on the EEPROM memory not verified.

- U N D E R -

- indicates "underflow" conditions.

+ O V E R +

- indicates "overflow" conditions.

E r r o r 2

- indicates an environment temperature (in correspondence with the IN / OUT terminals) exceeding stated limits.

E r r o r 6

- Indicates that the load is exceeding stated limits.
The current generated by the instrument must not exceed 0.5 mA.

E r r o r 7

- indicates a possible error during "Scale Factor" computation.

E r r o r 0

- The error code indicates that the input value is exceeding the limits.

The above indicated faulty conditions can be announced both during the auto diagnostic 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 Tc** 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 Tc** 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	50 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 batteries.

Store the instrument in the original package at a temperature from -30°C to +60°C, with R.H. less than 90% (non condensing).

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 Certificate of 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 confirm that the characteristics of the instrument correspond to the required ones, and that the instrument calibration is traceable to National and International Standards.

APPENDIX

A1 EMC Conformity

The instrument case, made in shock-resistant injection moulded ABS + polycarbonate has an internal metal coating to fulfil the provision 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 responsibility that the product :

Portable indicator-calibrator type M-CAL Tc

(Name and type)

P/N 3908

(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)